Testimony of
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on behalf of the
ENERGY STORAGE ASSOCIATION

before the
United States House of Representatives
Committee on Energy and Commerce
Subcommittee on Energy

Hearing entitled
"Powering America: Defining Reliability in a Transforming Electricity Industry"

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Summary of Remarks:

- Energy storage technologies enable electricity supplied from any source to be saved for use later, precisely when and where it is most needed.
- There are a variety of energy storage technologies—not only different kinds of batteries, but also mechanical storage and thermal storage technologies.
- The electric grid has distinct and separable resilience and reliability needs. “Reliability” is the ability to maintain operations during normal conditions. “Resilience” is the ability to maintain or restore electric service following a sudden and disruptive external event. “Flexibility” is critical to both reliability and resilience by ensuring uninterrupted power is delivered to consumers when and where they need it.
- Storage today is a cost-effective resource, providing flexibility to meet both the reliability and resilience needs of the grid. There are a multitude of energy storage system installations along the entire grid infrastructure, already providing reliability and resiliency services.
- Battery storage is uniquely capable of instant response to charge or discharge at full power in milliseconds. It located at all levels of the grid and at on-site locations, owned and operated by utilities, private parties and consumers.
- Policies must keep pace with technology and market advances by (1) removing barriers to energy storage participation in markets; (2) designing markets to improve price signals for flexibility and resilience; (3) incorporating the resilience value of distributed energy resources, including storage; and (4) expanding conventional definitions of reliability to capture flexibility and resilience.

Chairman Upton, Ranking Member Rush, and Members of the Subcommittee—

On behalf of the Energy Storage Association (ESA), thank you for the invitation to speak today on the role that energy storage plays in the reliability and resilience of our electric power system.

Since its founding 27 years ago, ESA has been the leading national voice of the energy storage industry working to make a more resilient, efficient, sustainable and affordable grid – as is uniquely enabled by energy storage. ESA promotes the development and commercialization of safe, competitive, and reliable energy storage delivery systems for use by electricity suppliers and consumers. ESA's 150 members comprise a diverse group of power sector stakeholders, including electric utilities, independent power producers, project developers, technology manufacturers, integrators, component suppliers, and system support services—of advanced batteries, flywheels, thermal energy storage, compressed air energy storage, supercapacitors, and other technologies.

Our electric system is bound to a simple reality of physics—supply must precisely match demand at every moment, everywhere. If it does not, the result is equipment damage, service disruption, or blackouts. What we call "reliability" is the ability to maintain that match of electric supply and demand every moment every day, and to do so in the face of variable, unpredictable, and sometimes extreme system conditions. "Resilience" is the ability to maintain or rapidly restore that match of supply and demand following a sudden and disruptive external event. "Flexibility" is critical to both reliability and resilience, to ensure uninterrupted power is delivered to consumers whenever and wherever they need it.

Energy storage technologies enable electricity supplied from any source to be saved for use at a later time, precisely when, where, and in whatever form it is most needed. That very simple concept enables an enormous amount of capabilities for the electric grid—be it supplying back-up power, reducing peak system demands, relieving stressed grid infrastructure, filling in the gaps from variable generation sources, or maintaining the optimal function of inflexible generation sources. These capabilities are, at heart, more efficient ways to ensure that supply and demand reliably match, and to make that balance resilient to a greater range of threats. Indeed, energy storage is the hub of an efficient, resilient, sustainable and affordable energy system that can adapt to any supply mix.

When you hear the word "energy storage," what comes to mind? For most people, they think of a battery—and for good reason. Batteries are everywhere—in our phones, computers, appliances, our cars, and increasingly our electric grid. There are a variety of energy storage technologies[1]—not only different kinds of batteries, such as flow batteries, but also mechanical storage technologies (like pumped hydro and flywheels) and thermal storage technologies (like ice storage and molten salt). Each has its own performance characteristics and best-suited applications, but all do the same job of storing energy for use when it is most needed, be that across seconds, hours, or days. In effect, it decouples the element of time from supply and demand.

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[1] Electrochemical energy storage (known as a "battery") converts electricity into a reserve of potential energy by creating an electrical gradient between two terminals separated by an electrolyte; electrons can then be discharged as they separate from ions moving between the two terminals. Mechanical energy storage converts electricity into a reserve of potential energy by pressurizing a substance, accelerating the rotation of a mass, or moving a mass against gravity; the depressurizing of the substance, rotation of the mass, or falling of the mass can be harnessed to turn a generator and produce electricity. Thermal energy storage converts either electricity or heat into a large temperature differential between a mass and its surrounding temperature; that mass can then re-transfer heat to a steam turbine that turns a generator and produces electricity, or the mass can provide direct heating or cooling services. Pure electrical energy storage does not convert electrical input but rather slows the transfer of electrons within an electric field, thereby enabling discharge on demand over short intervals.

For the purpose of today's hearing, I will focus my remarks on the role of battery storage, the fastest growing grid storage technology. Today nearly 800 megawatts (MW) of battery storage are installed nationwide,[2] with megawatt-scale installations in 21 states.[3] This represents nearly 1 GWh of energy storage available for use.[4] Battery storage technologies—primarily lithium-ion batteries—are declining rapidly in cost: dropping by 50% every 3 to 4 years and projected to continue at this rate.[5] Driven by these cost declines, the U.S. is forecast to quadruple installed storage capacity in just five years, representing a $3 billion in annual sales in the U.S.[6] Of greater significance, though, is that sharp cost declines also mean that battery storage will provide ever larger sizes and longer durations more cost-effectively, increasing their range of applications. In fact, the largest battery in the world is currently under development in the U.S. and will capable of providing 100 MW of power for four hours—enough to power 50,000 homes through the peak demands of the day.[7]

Storage is uniquely flexible among all grid resources. *First*, storage is the only resource promoting reliability in every part of the grid: co-located with generation, connected to the high-voltage transmission system, placed on the lower-voltage distribution grid, and located in

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[2] Known capacity additions prior to 2012, in addition to total from GTM Research, *U.S. Energy Storage Monitor: Q3 2017*, Sep 2017, available at https://www.greentechmedia.com/research/subscription/u-s-energy-storage-monitor

[3] DOE Global Energy Storage Database, accessed 9 Sep 2017, available at http://www.energystorageexchange.org

[4] *Ibid.*

[5] See, for example:

- IHS, *Future of Grid Connected Energy Storage*, Nov 2015, available at https://technology.ihs.com/512285/grid-connected-energy-storage-report-2015
- UBS, *US Battery Storage: Upstream Supply Chain Biggest Winner of EVs*, Oct 2016, available at https://neo.ubs.com/shared/d1Wg6h8EJsbg/
- McKinsey & Bloomberg New Energy Finance, *An Integrated Perspective on the Future of Mobility*, Nov 2016, available at https://www.bbhub.io/bnef/sites/4/2016/10/BNEF_McKinsey_The-Future-of-Mobility_11-10-16.pdf
- O. Schmidt et al., "The future cost of electrical energy storage based on experience rates," *Nature Energy*, Vol 2, 17110 (2017).
- B. Nykvist & M. Nilson, "Rapidly falling costs of battery packs for electric vehicles," *Nature Climate Change* 5 (2015), p 329-332.

[6] GTM Research, *U.S. Energy Storage Monitor: Q3 2017*, Sep 2017, available at https://www.greentechmedia.com/research/subscription/u-s-energy-storage-monitor

[7] Assumes 6 hours of consumption (5 PM to 11 PM) and average household consumption of 1.23 kW, per 2015 EIA data on annual residential electricity consumption, available at https://www.eia.gov/tools/faqs/faq.php?id=97&t=3

buildings, as well as in microgrids. It is modular and can be scaled to any size, from a home system of a few kilowatts (kW) to a central facility 10,000 times larger. *Second*, storage provides value to all power sector participants: utilities, independent providers, and consumers can all own and operate storage for a variety of reliability services and other cost-saving applications. *Third*, storage is the only grid resource that operates as both supply and demand: supply when discharging and demand when charging, giving it effectively twice the operating range of conventional generation and the unique flexibility to mitigate oversupply as well as undersupply conditions. *Fourth*, storage is capable of near-instantaneous response and precise control, able to ramp its output to charge or discharge at full power in milliseconds. It is that precise control that allows storage to efficiently provide essential reliability services of frequency response, voltage control and ramping, as well as enhance resilience during sudden disruptions.[8] *Fifth*, storage can provide a diversity of functions for the bulk power system, the distribution grid, and end-users, even providing multiple services interchangeably over time to meet the greatest need in any given moment. *Sixth*, storage can be deployed quickly, with build times for MW-scale installations at less than 6 months. Importantly, storage is agnostic to the supply of electricity, and its flexibility can be used to optimize grid functions for any supply mix. That's why we call storage the "bacon of the electric grid"[9] —it makes everything better. Nuclear, coal, gas, wind, solar, hydro, demand response and system efficiency: you name it, storage enhances its utilization.

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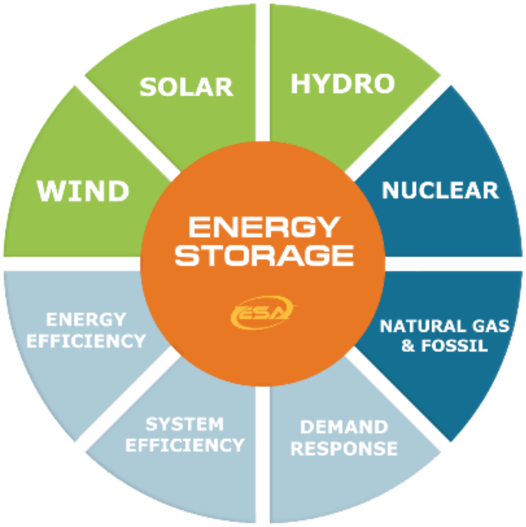
[8] For example, storage can synchronize to the grid and maintain appropriate frequency with even greater fidelity than the mechanical governor devices common to conventional generation that are required in generator interconnection agreements.

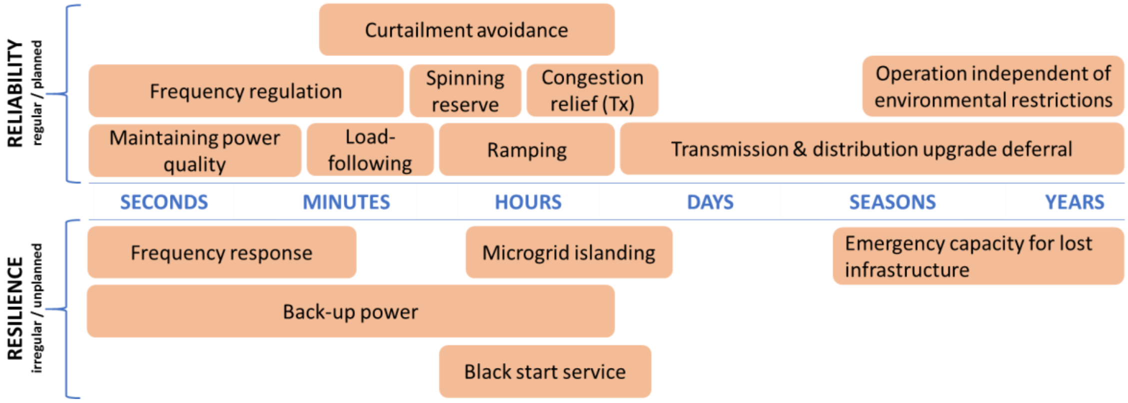
[9] Originally attributed to Katherine Hamilton, 38 North Solutions.



Source: Energy Storage Association, 2017

As the Department of Energy's recent *Staff Report on Electricity Markets and Reliability* noted, storage currently provides most essential reliability services, flexibility attributes, and other reliability characteristics under consideration in today's hearing.[10] The flexibility of storage enhances both reliability and resilience.

Flexibility of Battery Storage Addresses Uncertainty at Various Time Intervals



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[10] See Figure 4.13, "Mapping Reliability Attributes Against Resources," in U.S. Department of Energy, *Staff Report on Electricity Markets and Reliability*, Aug 2017, available at https://energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf

Source: Energy Storage Association, 2017

The diversity of energy storage system applications along the entire delivery infrastructure is striking, with several examples captured below:

- *Storage maintains power quality and provides on-site backup power to keep businesses, homes, and industrial facilities resilient to service disruptions.* On-site storage can maintain electric service following hurricanes, as happened recently in Florida when homeowners[11] and sheltering sites[12] kept their lights on with solar-paired storage. This is also why Tesla has just sent shipments of hundreds of battery storage systems to Puerto Rico.[13] On-site storage is also especially important for local critical infrastructures affected by electric service disruptions serving its citizens. For example, Irvine Ranch Water District in California is installing 7 MW of batteries at its critical water treatment and pumping infrastructure to ensure continuity for public health.[14] Similarly, New Jersey has installed storage at critical facilities, such as schools, to use as shelter from hurricanes.[15] Microgrids integrating energy storage are demonstrating their capability to operate in island mode, isolated from the larger grid, to maintain service. Recently, utility Ameren islanded its Champaign, Illinois microgrid for 24-hours relying solely on wind, solar, and batteries. Military installations like Ft. Bliss in Texas have incorporated

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[11] P. Kelly-Detwiler, "After Irma: Solar Plus Storage - A Small Beacon Of Light In A Sea Of Darkness," *Forbes*, 17 Sep 2017, available at https://www.forbes.com/sites/peterdetwiler/2017/09/17/after-irma-solar-plus-storage-a-small-beacon-of-light-in-a-sea-of-darkness/

[12] J. Dean, "Solar power helped shelter shine through Irma," Florida Today, 24 Sep 2017, available at http://www.floridatoday.com/story/news/2017/09/24/solar-power-helped-shelter-shine-through-irma/694322001/

[13] D. Hull, "Tesla Is Sending Battery Packs to Storm-Ravaged Puerto Rico," *Bloomberg News*, 28 Sep 2017, available at https://www.bloomberg.com/news/articles/2017-09-28/tesla-is-sending-battery-packs-to-storm-ravaged-puerto-rico

[14] P. Maloney, "Tesla, AMS ink 34MWh storage deal with California water system," *Utility Dive*, 29 Sep 2016, available at http://www.utilitydive.com/news/tesla-ams-ink-34mwh-storage-deal-with-california-water-system/427202/

[15] H. Trabish, "New Jersey makes first awards in energy storage program to boost grid resiliency," *Utility Dive*, 24 Mar 2015, available at http://www.utilitydive.com/news/new-jersey-makes-first-awards-in-energy-storage-program-to-boost-grid-resil/378490/

storage into their microgrids to enable similar islanding and mission assurance in the event of energy supply disruptions.[16]

Storage is increasingly distributed throughout the grid to enhance reliability and resilience. For example, during recent heat waves in California, aggregated energy storage has relieved peak demands across the grid, responding with just minutes notice and doing so repeatedly.[17] Similarly, building chillers and water heaters are being increasingly aggregated and deployed as reliable demand response, another form of market-based energy storage. Utilities like Hawaii's HECO are increasingly working with customers who own storage to utilize their assets for distribution grid reliability.[18] By distributing these assets throughout the grid, aggregations of storage are reducing risk of failure of any single, central grid resource. And the advent of battery electric vehicle fleets will push still further in this direction. For example, utility ConEdison is piloting a fleet of mobile batteries that can unplug from one substation and move to another, allowing a grid that can reconfigure around evolving conditions.[19]

- As an example of the recovery aspect of resilience, *storage provides blackstart capability, which restores the grid after system blackouts and enables other generators*

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[16] J. St John, "The Military Microgrid as Smart Grid Asset," *Greentech Media*, 17 May 2013, available at https://www.greentechmedia.com/articles/read/the-military-microgrid-as-smart-grid-asset

[17] "Stem Energy Storage Network Delivers Emergency Grid Relief in California Heat," *BusinessWire*, 26 June 2017, available at http://www.businesswire.com/news/home/20170626005354/en/

[18] J. Spector, "Stem Pilot Marks a Step Forward for Commercial Energy Storage in Hawaii," *Greentech Media*, 2 Feb 2017, available at https://www.greentechmedia.com/articles/read/stem-tests-model-for-networked-commercial-energy-storage-in-hawaii-solar

[19] P. Maloney, "How ConEd's mobile battery REV demo could build a new storage business model," *Utility Dive*, 7 Mar 2017, available at http://www.utilitydive.com/news/how-coneds-mobile-battery-rev-demo-could-build-a-new-storage-business-mode/437364/

to turn on again. Imperial Irrigation District installed a 33 MW battery precisely for this role and has successfully restarted its natural gas generators from outage conditions.[20]

- *Storage provides faster, more efficient and cost-effective response to short-run grid fluctuations,* which avoid unexpected outages from system imbalances. In the mid-Atlantic PJM market and in the Electric Reliability Council of Texas (ERCOT) system, fast-responding energy storage is modulating output at every second to maintain a stable grid frequency more efficiently, reducing the need for more Regulation reserves. In the Midcontinent Independent System Operator (MISO), Indianapolis Power & Light is similarly using battery storage to provide fast frequency response,[21] arresting deviations to grid stability from unexpected losses of power plants faster than generators. Particularly in systems where asynchronous generation[22] is increasing, such response capability is increasingly valuable.

- *Storage is also being deployed to help transmission and distribution infrastructure adapt to changing conditions,* maintaining reliability during multi-year upgrades, and deferring or altogether avoiding costly upgrades. For example, utility AEP's Presidio project in Texas and Balls Gap project in West Virginia used batteries to maintain reliable service

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[20] P. Maloney, "California muni IID completes first US demonstration of black start battery capability," *Utility Dive*, 19 May 2017, available at http://www.utilitydive.com/news/california-muni-iid-completes-first-us-demonstration-of-black-start-battery/443099/

[21] "IPL Announces Commercial Operation of Battery-Based Energy Storage Array During White House Summit on Renewable Energy and Storage," *BusinessWire*, 16 June 2016, available at http://www.businesswire.com/news/home/20160616006603/en/IPL-Announces-Commercial-Operation-Battery-Based-Energy-Storage

[22] Traditional generation utilizes spinning mass, usually in the form of a turbine, to generate electricity. The rate at which those turbines spin is synchronized to the electric grid's normal operating frequency of 60 Hz, and the inertia in those turbines can moderate deviations in grid frequency. Asynchronous generation either utilize spinning mass that is not inherently synchronized to grid frequency—such as wind turbines—or non-mechanical generation—such as solar photovoltaic modules; such generators use inverters and controls systems to provide their electricity at the same frequency as the electric grid.

while transmission upgrades were completed.[23] Storage has also been deployed to increase the capabilities of the distribution system. For example, the utility Arizona Public Service has deployed batteries at its substations to enable reliable service and avoid wires upgrades as more of its customers install rooftop solar power systems.[24]

- *Storage meets the peak demands of electric grids, contributing to resource adequacy.* Large pumped hydro resources such as Michigan's Ludington Pump Storage Plant have traditionally met this role, charging off-peak to provide eight hours of generation at peak capacity. As costs decline across the industry, a broader array of storage technologies is also fulfilling this role. Lithium-ion batteries are now providing four hours at peak capacity to meet utilities' resource adequacy needs,[25] with those durations expected to increase as prices fall. Flow batteries[26] and molten salt storage[27] are proving capable of more than six hours of peak capacity on the bulk system today.

- *Storage is being deployed to respond quickly to broader infrastructure failures.* After the Aliso Canyon gas storage facility unexpectedly shut down, over 80 MW of battery storage facilities were built in less than six months to make up local capacity shortfalls[28]—a stunning achievement given that it would have taken two or more years

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[23] Edison Electric Institute, *Transmission Projects at a Glance – American Electric Power*, available at http://www.eei.org/ourissues/ElectricityTransmission/Documents/Trans_Project_A-D.pdf#4 and "AEP Milton NaS Battery Energy Storage System," DOE Global Energy Storage Database, available at http://www.energystorageexchange.org/projects/268

[24] "APS, AES bring energy storage to Arizona customers," from website of APS, 8 Dec 2016, available at https://www.aps.com/en/ourcompany/news/latestnews/Pages/aps-aes-bring-energy-storage-to-arizona-customers.aspx

[25] J. Pyper, "Tesla, Greensmith, AES Deploy Aliso Canyon Battery Storage in Record Time," *Greentech Media*, 31 Jan 2017, available at https://www.greentechmedia.com/articles/read/aliso-canyon-emergency-batteries-officially-up-and-running-from-tesla-green

[26] "National Grid Distributed Energy Storage Systems Demonstration - Vionx Energy," from website of DOE Global Energy Storage Database, accessed 28 Sep 2017, available at http://www.energystorageexchange.org/projects/26

[27] P. Fairley, "A Tower of Molten Salt Will Deliver Solar Power After Sunset," *IEEE Spectrum*,21 oct 2015, available at https://spectrum.ieee.org/green-tech/solar/a-tower-of-molten-salt-will-deliver-solar-power-after-sunset

[28] D. Ola, "How California pulled off the world's fastest grid-scale battery procurement - Part II," *Energy Storage News*, 3 May 2017, available at https://www.energy-storage.news/blogs/how-california-pulled-off-the-worlds-fastest-grid-scale-battery-procurement. See also J. Pyper, "Tesla, Greensmith, AES Deploy Aliso Canyon Battery Storage in Record Time," *Greentech Media*, 31 Jan 2017,

for a gas turbine to be deployed.[29] You're seeing the arrival of "just-in-time" capacity additions, which offers grid planners far more flexibility to deal with uncertain forecasts of future needs.

- *Storage is a key resource for supplementing the natural variability of wind and solar resources* as they reach higher levels of installations. Projects like the Hawaii co-op Kauai Island Utility Cooperative (KIUC) solar and storage projects[30] and Texas generator E.ON's wind and storage projects[31] are increasingly common. That said, storage provides this value regardless of where on the grid it is located. For example, standalone storage is increasingly providing ramping services in grids like CAISO, which must efficiently maintain system reliability as gigawatts of solar power steadily come off the system over a short period each evening.[32]

- Of course, *storage is also critical for "baseload" resources like nuclear, natural gas and coal plants.* Since coal and nuclear power are not designed to vary their output significantly or quickly, much of the 20 gigawatts (GW) of pumped hydro storage facilities in the U.S. were built in the latter half of the 20th century to absorb the oversupply from these inflexible resources during periods of low demand. For that

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available at https://www.greentechmedia.com/articles/read/aliso-canyon-emergency-batteries-officially-up-and-running-from-tesla-green

[29] Slide 21 of J. Lin, "Energy Storage: Power System Game Changer," presentation at Minnesota Energy Storage Summit 2015, 14 July 2015, available at http://energytransition.umn.edu/wp-content/uploads/2015/06/Energy-Storage-Power-System-Game-Changer-by-Janice-Lin-.pdf#21

[30] G. Bade, "Hawaii co-op signs deal for solar+storage project at 11¢/kWh," *Utility Dive,* 10 jan 2017, available at http://www.utilitydive.com/news/hawaii-co-op-signs-deal-for-solarstorage-project-at-11kwh/433744/. See also R. Walton, "Tesla's dispatchable solar+storage project in Hawaii brought online," *Utility Dive*, 13 Mar 2017, available at http://www.utilitydive.com/news/teslas-dispatchable-solarstorage-project-in-hawaii-brought-online/437858/

[31] P. Maloney, "E.ON to build nearly 20 MW of battery storage at Texas wind farms," *Utility Dive*, 2 Mar 2017, available at http://www.utilitydive.com/news/eon-to-build-nearly-20-mw-of-battery-storage-at-texas-wind-farms/437211/

[32] P. Maloney, "California ISO approves proposals to bolster storage and demand response," *Utility Dive,* 4 Feb 2016, available at http://www.utilitydive.com/news/california-iso-approves-proposals-to-bolster-storage-and-demand-response/413365/

> matter, natural gas-fired power plants can operate more efficiently when energy storage reduces the need for cycling those plants. In fact, that's one reason why General Electric has introduced the first gas turbine-battery hybrid unit in the world and why other turbine and engine makers, like Wärtsilä and Siemens, have acquired or merged energy storage businesses. Power companies have co-located storage at their gas plants, like the AES Tait gas plant in Ohio and their Warrior Run coal plant in Maryland.

With all these capabilities of energy storage, you might be wondering: why isn't it everywhere already? Even as prices for energy storage systems have plummeted in recent years, policy has yet to catch up to technology. The electric system was designed before storage was a commonly available and widespread resource, and so the rules governing the grid and electricity markets were developed without contemplating the role of storage. We in the energy storage industry see four general themes to enable storage to contribute further to grid reliability and resilience.

First, we urge policymakers to remove barriers to energy storage participation in electricity markets. Presently, the Federal Energy Regulatory Commission (FERC) is considering a proposed rule[33] directing wholesale market operators to remove regulatory barriers to storage participation. Additionally, FERC is also considering a proposed rule[34] that will update interconnection rules designed for generation to apply more fairly to storage, among other provisions. ESA strongly supports these efforts to ensure physical and market access for

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[33] Notice of Proposed Rulemaking, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Docket No. RM16-23-000, 157 FERC ¶ 61,121 (2016), available at https://www.ferc.gov/whats-new/comm-meet/2016/111716/E-1.pdf

[34] Notice of Proposed Rulemaking, *Reform of Generator Interconnection Procedures and Agreements*, Docket No. RM17-8-000, 157 FERC ¶ 61,212 (2017), available at https://www.ferc.gov/whats-new/comm-meet/2016/121516/E-1.pdf

storage, which is necessary to maximize the competitiveness of wholesale markets and ensure lowest system costs to households and businesses. At the state level, commissions must remove barriers to customers interconnecting storage to distribution grids and resolve uncertainties over how to treat storage assets for the purposes of utility cost recovery.

Second, we recommend that policymakers design markets to provide more precise and comprehensive price signals for flexibility and resiliency attributes of resources. Wholesale markets, guided by FERC, need to allow resources to compete to provide flexibility and resilience, as well as be compensated for the service provided. Order 755, which established the concept of pay-for-performance in frequency regulation service, could be expanded to other market services. Additional energy market products, such as ramping and load-following, could drive price formation on flexible services. Unpriced reliability services, such as frequency response, should be compensated in a competitive manner when possible.[35] State regulators, for the sake of their ratepayers, should incorporate flexibility and resilience attributes into their cost-benefit analyses of utility investments, as well as consider rate designs that better align customer behavior with both local and system needs. And both FERC and state regulators should develop frameworks enabling storage to provide its multiple services, be that as both a wholesale and retail asset[36] or as both a transmission and generation asset.[37]

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[35] ESA notes that FERC is presently considering a proposed rule that would compel all assets to possess frequency response technical capability without compensation, which undermines any future effort to develop a market product for frequency response. See Notice of Proposed Rulemaking, *Essential Reliability Services and the Evolving Bulk-Power System—Primary Frequency Response*, Docket No. RM16-6-000, 157 FERC ¶ 61,122 (2016), available at https://www.ferc.gov/whats-new/comm-meet/2016/111716/E-3.pdf

[36] FERC is considering rules presently regarding storage providing both wholesale and retail service in Notice of Proposed Rulemaking, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Docket No. RM16-23-000, 157 FERC ¶ 61,121 (2016), available at https://www.ferc.gov/whats-new/comm-meet/2016/111716/E-1.pdf

[37] FERC has previously provided guidance on storage operating as both transmission and generation; see Policy Statement, *Utilization of Electric Storage Resources for Multiple Services When Receiving Cost-Based Rate Recovery*, Docket No. PL 17-2-000, 158 FERC ¶ 61,051 (2017), available at https://www.ferc.gov/whats-new/comm-meet/2017/011917/E-2.pdf

Third, we recommend that policymakers consider the contribution of distributed energy resources (DERs) to system reliability and resilience. Most of the electric reliability problems that households and businesses experience arise from the distribution system, not the bulk power system. As the prevalence of DERs increases, storage can play a critical role in risk management and assuring the continuity of service for communities. And as DERs increasingly participate in wholesale markets, FERC and NERC should consider the contributions they can provide to bulk power system reliability as well.

Fourth, we recommend that policymakers consider expanding the definition of reliability to capture resilience and the need for flexibility, in light of a transforming electric system. As variable generation increases to higher levels of penetration and as consumers evolve into prosumers, grids must be more flexible to react to more frequent short-duration changes to net demand. There is a greater value to flexibility that may not be met adequately by resources designed only to meet system peak. For example, New Mexico utility PNM's integrated resource plan recently assessed the capability of its fleet to respond to (1) events caused by not having enough available resource capacity (i.e., resource adequacy), and (2) events caused by not being able to respond quickly to meet the variable nature of higher levels of renewable resources. In so doing, PNM was able to more accurately determine conditions when storage is more cost-effective than gas capacity for providing reliability.[38] When reliability contemplates resilience and flexibility as well as resource adequacy, optimal portfolios may seek to include storage more readily than they would otherwise. CAISO has introduced a flexible resource

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[38] See analysis in Tables 41 and 42 in *PNM 2017-2036 Integrated Resources Plan*, 3 July 2017, available at https://www.pnm.com/documents/396023/396193/PNM+2017+IRP+Final.pdf/eae4efd7-3de5-47b4-b686-1ab37641b4ed#128

adequacy concept, which is an additional set of resources intended to meet reliability and resilience needs under a high-renewables world.

Energy storage is here and it is growing fast. We are at a moment where the U.S. can take advantage of this new technology to cost-effectively enhance the reliability and resilience of our electric system with any mix of supply resources. I thank the Committee for the opportunity to speak to these critical issues, and I welcome your questions.