Energy Storage Association

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Second Installment of the Quadrennial Energy Review
Comments of the Energy Storage Association

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Respondent Information

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Introduction

Since its inception 26 years ago, the ESA has promoted the development and commercialization of competitive and reliable electric storage delivery systems for use by electricity suppliers and their customers. ESA's membership comprises a diverse group of electric sector stakeholders, including utilities, independent power producers, manufacturers of advanced technologies -- such as batteries, flywheels, thermal electric storage, compressed air electric storage, supercapacitors, and other technologies -- component suppliers, and system integrators.

ESA's over 180 member companies have expertise in transmission- and distribution-level grid operations relevant to electric storage, as well as firsthand knowledge of the regulatory challenges to financing and operating commercial electric storage facilities to realize full system benefits. We thank the Department of Energy (DOE) for the opportunity to provide recommendations for Federal action to guide the modernization of the nation's electric grid and ensure its continued reliability, safety, security, affordability, and environmental performance.

Fundamentally, energy storage is the key enabling technology for grid transformation. In simplest terms, energy storage enables electricity that is generated to be used at a later time, when it is most needed. Using energy storage can save businesses and households money by reducing the amount of spare capacity, in the form of excess power plants and wires, that utilities need to build to meet system peak demands. Energy storage also makes the grid more reliable by evening out fluctuations in supply and demand and serving as back-up for outages and disruptions in supply. Finally, energy storage allows integration of a larger supply of clean energy by compensating for the variability of wind and solar power, as well as integration of a larger supply of distributed energy resources (DER).

A critical barrier to greater use of energy storage in the U.S. is that the electric system was not designed with energy storage as an option. Energy storage is unlike any other resource and does not fit existing electric system rules—sometimes it acts like supply, sometimes it acts like demand, sometimes it acts like infrastructure, and it can switch between these roles at will. That multi-service capability is what make storage so valuable. But when storage has to fit the existing system rules and processes, it cannot offer its multiple capabilities and is effectively undervalued. At the same time, utilities already know how to build wires and procure power plants, and they do not today have guidance to support doing things a different way. As a result, storage is not on the menu of investment options put forward by utilities or discussed by regulators.

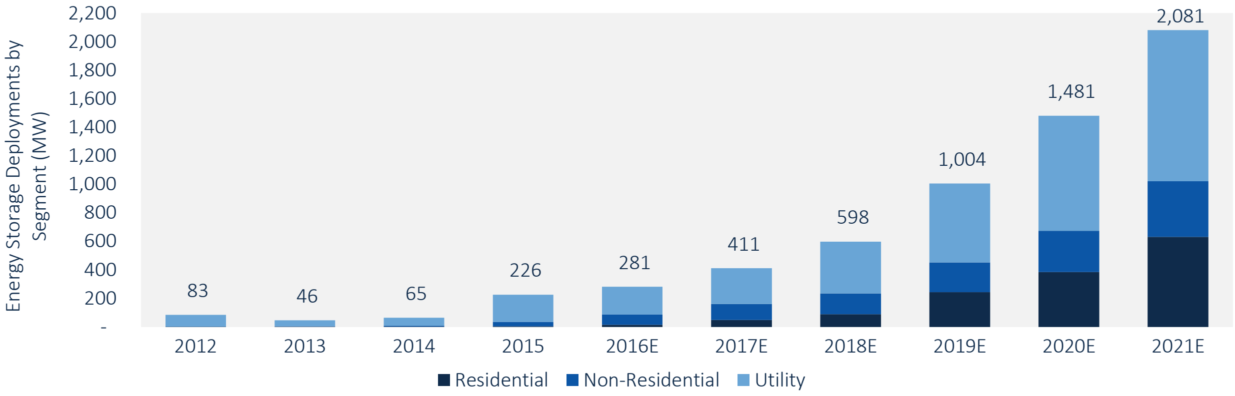
This is problematic if the U.S. is going to attain a more modern, more distributed, and cleaner electric system, as well as keep it reliable and affordable. Incorporating storage into planning, procurement, and operations is a non-trivial set of public policy developments, and ESA encourages DOE to consider the following points in development of the QER and subsequent Federal actions.

Key Points for QER Consideration

> *Storage is already providing reliable service at scale to the electric system and will continue to grow as costs decline.*

Since 2012, over 400 MW of advanced energy storage has been deployed, primarily in applications for frequency regulation. Annual installations are expected to grow into GW scale deployments, with behind-the-meter storage deployments growing to match front-of-meter deployments.

Figure 1 Projected Annual Advanced Energy Storage Deployments (MW)[1]



While reports of energy storage costs vary, all such reports agree that the costs of energy storage will continue to decline. GTM Research reports that battery energy storage installed costs are expected to fall 17% by year end 2017. IHS reports that installed costs of battery energy storage has declined 53% since 2012 and are expected to decline another 50% by 2019.[2] Similarly, Navigant's reported costs for large format lithium-ion energy storage batteries have declined over 80% since 2009 and expected to

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[1] GTM Research. "U.S. Energy Storage Monitor: Q2 2016." Available at https://www.greentechmedia.com/research/subscription/u.s.-energy-storage-monitor

[2] See IHS. "Price Declines Expected to Broaden the Energy Storage Market." Nov 23, 2015. Available at http://press.ihs.com/press-release/technology/price-declines-expected-broaden-energy-storage-market-ihs-says

continue declining.[3] As DOE investigates energy storage's role in the future grid, it will be critical to include expected cost declines in long-term planning models.

> *Storage technologies are viable alternatives to generation, transmission, and distribution investments.*

Battery energy storage is increasingly being deployed to meet peaking needs. In California, prior to the establishment of an energy storage procurement target, Southern California Edison (SCE) announced a landmark decision to procure over 235 MW of battery storage, including a 100 MW front of the meter battery storage facility that will provide peaking capacity, also along with other services.[4] Subsequent procurement by other California utilities have sought battery storage for similar service. In Washington, Puget Sound Energy will soon be deploying a battery storage system that will be providing peaking capacity, along with other services.[5]

Additionally, behind-the-meter energy storage is being utilized as a load-modifying resource to assist with demand management and distribution system peak load reductions. As a part of SCE's 2013 economic battery storage procurement, 85 MW will come from distributed behind-the-meter battery storage to provide local capacity. In New York, within the scope of New York's Reforming the Energy Vision (REV) process, storage technologies are being deployed in behind-the-meter applications in approved demonstration projects, as well as for other front-of-meter virtual power plant distribution architecture alternatives – notably in the Brooklyn-Queens Demand Management project that will use storage and other resources to delay investment of over $1 billion in a substation upgrade.[6] Similarly, behind-the-meter energy storage is expected to be a significant resource in PSEG's peak load reduction efforts.[7] Additionally, behind-the-meter deployments are economically pursued today in California and other states where commercial and industrial customers face significant demand charges and/or have high power quality and reliability requirements.

Front-of-meter distribution-connected energy storage is also expected to be used to defer distribution system upgrades. In Connecticut, electric distribution companies have included battery storage as the central component of their proposed Grid Side System Enhancement demonstration projects. All proposed projects will include net benefits to the grid, with a primary focus on deferring distribution feeder and substation capacity upgrades.[8] Some battery energy storage is providing transmission deferral in combination with other resources. For example, the Boothbay Smart Grid Reliability Project in Maine has deployed energy storage as part of a suite of resources to avoid building a new

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[3] See slide 8 of Navigant's presentation to IEEFA Energy Finance 2015, March 2015, available at http://policyintegrity.org/documents/7_Jaffe_Navigant_IEEFA_March_17.pdf#8

[4] See "Local Capacity Requirements RFO," Southern California Edison, accessed May 2, 2016, available at https://www.sce.com/wps/portal/home/procurement/solicitation/lcr/!ut/p/b0/04_Sj9CPykssy0xPLMnMz0vMAfGjzOK9PF0cDd1NjDz9nQxdDRyDPS1cXD1cDYL9zfQLsh0VAQ4EJ6E!/

[5] See Puget Sound Energy Glacier Battery Storage Project at https://pse.com/inyourcommunity/pse-projects/system-improvements/Pages/Glacier-battery-storage-project.aspx

[6] See http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=45800

[7] See https://www.psegliny.com/page.cfm/AboutUs/Proposals/SouthFork and https://www.psegliny.com/page.cfm/AboutUs/Proposals/SouthFork

[8] See Grid-Side Enhancement Demonstration Project proposals by CL&P and UIL at http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/8525797c00471adb85257f53007086cd?OpenDocument and http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/8525797c00471adb85257f53006aef95?OpenDocument, respectively.

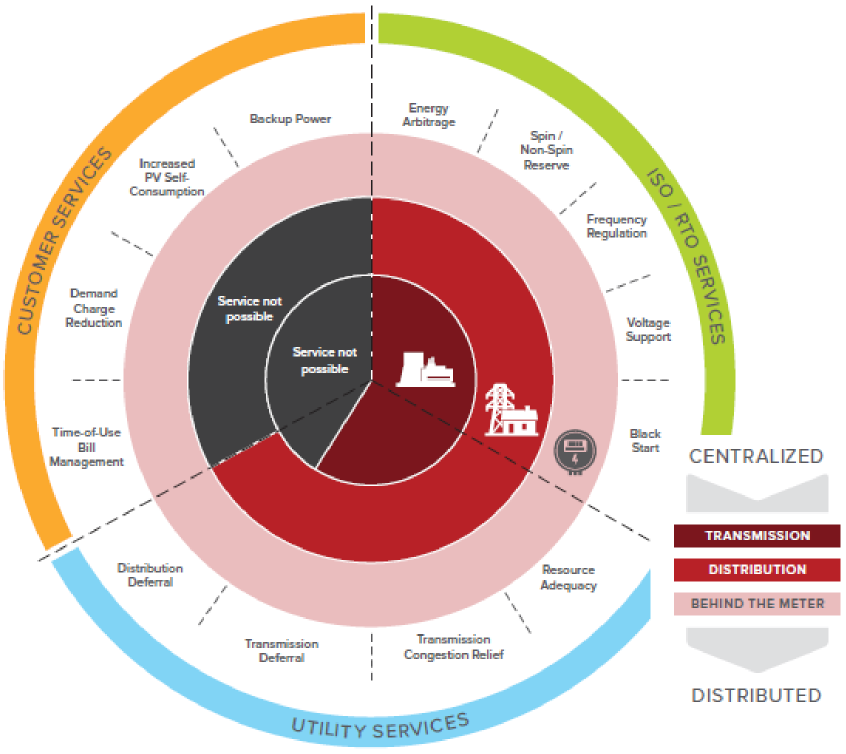
transmission line.[9] This use case for battery storage is expected to grow as wholesale energy markets determine how to treat storage as a transmission asset or as a non-traditional transmission alternative.[10]

DOE should ensure that its QER analytical activities take into account storage as viable alternative to generation, transmission, and distribution.

Storage technologies improve the efficiency and utilization of existing grid assets.

Energy storage is fuel-neutral and can be charged from any resource on the grid. Energy storage provides significant flexibility in grid operations, as it can respond and ramp nearly instantaneously at full output to either inject electricity to of withdraw electricity from the grid. The possible services provided by energy storage vary with the location of the equipment in the electric power system. Systems directly connected to the transmission and distribution system can provide bulk services, ancillary services, and infrastructure services. Systems located behind a customer meter can enable energy management and onsite reliability and, in some cases, may have the capability to offer the aforementioned services as well.

Figure 2 Energy Storage Services by Grid Location[11]



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[9] See http://www.utilitydive.com/news/maine-turns-to-battery-storage-to-avoid-transmission-investment/400440/

[10] See for example the April 19, 2016, presentation of the MISO Planning Subcommittee, available at https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PSC/2016/20160419/20160419%20PSC%20Item%2002%20Non%20Transmission%20Alternatives.pdf

[11] Fitzgerald, Garrett, et al. "The Economics of Battery Energy Storage." Rocky Mountain Institute. October 2015.

Placed in these different parts of the electric system, energy storage can increase the capacity utilization of other assets. For example, co-locating energy storage with coal- or gas-fired assets can increase those assets' efficiency by providing short-duration rapid response, reducing the need for inefficient cycling of plants to provide frequency regulation and eliminating the need to reserve capacity for frequency response. This efficiency can lead to emissions reductions as well.[12] Transmission-connected storage can resolve congestion and avoid build-out of excess transmission capacity, particularly in situations where capacity is unexpectedly short, such as in SCE's 2014 Local Capacity Resource procurement of storage. Distribution-connected storage can increase the hosting capacity for DERs, in addition to similarly avoiding the build out of excess distribution capacity. And behind-the-meter storage can combine with other DERs, like demand response and distributed solar generation, to provide more value than each the sum of values of each resource taken individually.

Recommended Federal Actions

Provide analysis of energy storage system-wide benefits with focus on key areas.

While storage industry players can communicate to policymakers and officials about the costs and benefits of deploying their technologies in various applications, DOE could assist policymakers and officials in identifying and quantifying system-wide benefits within the state and regional context. The National Renewable Energy Laboratory has completed such analysis in a number of instances, most recently with respect to the CAISO system.[13] Replication of similar studies by the DOE and National Laboratories would be help state regulators and utilities determine the value of storage asset investments in the public interest and in the context of state energy goals.

Support the development of generation and transmission planning models that appropriately incorporate energy storage.

Despite increasing recognition of the value of storage and its rapidly declining costs, long term planning does not yet include it.[14] Utility resource planning is informed by production cost models that do not model energy storage resource dispatch accurately. Production cost models forecast hourly demand over a period, often 10 years, and then utilize resource parameters to calculate optimized resource portfolios. These models treat energy storage resources purely as a time-shift resource—that is, as a resource providing a single application of arbitraging between periods of lower and higher demand. Energy storage provides value through a diversity of other applications, and a single facility is capable of switching between these multiple applications to provide the greatest system value at a given point in time. As a consequence, production cost models constrain the technical performance inputs of energy storage to fit existing constructs. Additionally, the benefits of intra-hourly services cannot be incorporated into the resource optimization; for example, the models do not account for either the benefits of energy storage's fast-responding frequency regulation service or the ability of energy storage

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[12] See http://www.greentechmedia.com/articles/read/how-energy-storage-can-cut-peaker-plant-carbon-for-the-clean-power-plan

[13] Josh Eichman, et al. "Operational Benefits of Meeting California's Energy Storage Targets." National Renewable Energy Laboratory. December 2015. Available at http://www.nrel.gov/docs/fy16osti/65061.pdf.

[14] For a more extensive treatment, see Navigant, "Survey of Modeling Capabilities and Needs for the Stationary Energy Storage Industry," May 2014, available at http://energystorage.org/system/files/resources/survey_of_modeling_capabilities_and_needs_for_the_stationary_energy_storage_industry_-_executive_summary_final_may_2014_0.pdf

to minimize system ramping constraints. As a result, production cost models will systematically under-procure energy storage resources relative to the system benefits they provide.

Additionally, it bears mentioning that other common utility modeling and optimization tools, such as transmission system planning models and real-time grid operations software, either do not allow effective specification of energy storage resources or are not transparent in how they treat energy storage resources to produce their outcomes. Finally, there is not currently a method to integrate the inputs and results of various system planning tools regarding energy storage. While an integrated tool may not be feasible due to computational limits and complexity, a standardized approach on how to value energy storage using available tools is also lacking. The development of such a standardized approach would aid the proper application and value-assessment of energy storage when compared to traditional resources, and thereby enable truly least-cost resource planning and grid operations.

DOE and the National Labs can play a useful role in the development of modeling and analysis that updates resource planning models to integrate new technologies like energy storage.

> *Ensure strong coordination between DOE offices within the agency and with the storage industry.*

Given that energy storage technology is rapidly maturing and entering grid operations at scale, it is increasingly critical that relevant DOE offices coordinate and share in analytical activities. Coordination is especially important as storage applications enhance, interact, and at times replace numerous grid systems represented throughout the DOE agency and affiliated group ecosystem. DOE should ensure that its Office of Energy Efficiency & Renewable Energy (EERE) and its Office of Electricity Delivery and Energy Reliability (EDER) meaningfully coordinate and share analytical activities associated with energy storage. Additionally, the Grid Modernization cross-cutting initiative can and should fund multiple National Labs on shared analytical projects that leverage the strengths of each. Finally, the DOE should strengthen its outreach to the storage industry through appropriate Advisory Councils, ensuring that storage industry members have avenues to provide input to analytical work and provide peer assessment of proposed projects to fund.

Responses to Specific Questions

> *What policies can be put in place to increase access to rural, low-income communities, and remote communities?*

Policies that increase access to energy storage are critical for rural and remote communities. While utilities may have an obligation to serve those communities and rural co-operatives may count those communities as members, rural and remote communities tend to experience much lower rates of electric reliability. This is in part due to the high cost of maintaining adequate infrastructure relative to the small volume of customer demand served. Energy storage can cost-effectively defer network upgrades and/or maintain adequate reliability for such communities. Energy storage can provide this service as a grid-connected asset, such as in the Boothbay, ME, transmission deferral project,[15] as well as a component of a microgrid, such as in the Borrego Springs, CA, microgrid project.[16]

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[15] See http://www.pressherald.com/2015/06/08/grid-feeding-battery-system-of-the-future-humming-in-boothbay/

[16] See http://www.utilitydive.com/news/inside-the-nations-first-renewables-plus-storage-microgrid/401476/

Often, however, utilities and co-operatives serving rural and remote communities either do not have experience with energy storage project operations or do not have adequate access to capital for energy storage. For the first, federal- or state-funded demonstration projects and pilot programs focused on rural and remote communities, such as through DOE programs in conjunction with state energy offices, would be useful catalysts for learning-by-doing. For the second, extending grant and loan programs for rural and remote communities, such as the USDA's Rural Energy for America Programs, to include energy storage investments would improve access to capital.

Finally, regulated utilities do not generally have incentives to invest in energy storage relative to other options. Utilities are already familiar with building and using conventional transmission and distribution infrastructure assets, and rate recovery for these assets is generally well-founded and predictable. Investments in energy storage that may be more cost-effective are perceived as riskier, either in unfamiliarity with storage operations and/or lack of certainty about whether such assets will be granted rate recovery by utility commissions. Policies that require utility consideration of energy storage in planning and procurement alongside conventional investments in transmission and distribution assets, such as through a PURPA 111(d) standard, as well as PUC-provided performance awards for choosing more cost-effective storage investments, would address these structural disincentives.

> *What are the major barriers to distributed generation deployment, including financial, technical, transactional and distribution system limitations?*

Distributed storage deployment is limited by inappropriate utility modeling for distribution interconnection, which in many states looks at storage as both a generator and a load. Some potential solutions include:

- Interconnection of storage needs to consider both the charging impacts and the discharging impacts, but do so in a distinct and appropriate way, rather than create onerous requirements. Discharging should be very similar to interconnection of inverter-based distributed generation (i.e., solar). Charging should be treated like any other load increase—the rules for the charging of storage should be essentially the same as any customer increasing their load.
- Interconnection rules designed for wind or solar should recognize that the addition of storage makes them a dispatchable resource. Worst case scenario modeling is not necessarily appropriate or needed. System owners can commit to charging or discharging in specified patterns to avoid grid impacts/upgrades which can drastically reduce the cost and time of interconnection.
- Utilities should consider an expedited interconnection process for behind-the-meter, non-exporting storage. In this way, the storage can look to the grid a lot like a large appliance providing demand response and should require very little study.

Additionally, there are a number of other barriers to distributed storage that could be ameliorated as follows:

- Designing rate structures that send economic signals to energy storage customers to encourage them to operate their system in a manner that benefits the electric grid as well as the customer.
- Creating or modifying markets for ancillary services and demand response to enable energy storage customers to offer those services, either individually, or in the aggregate.

- Updating interconnection standards to ensure that energy storage systems have fair and efficient access to the electrical grid.
- Clarifying eligibility rules for Net Energy Metering (NEM) programs to maintain integrity of those programs while also allowing storage systems to participate.
- Implementing a broader scope for distribution system planning and management than historically seen to create an electrical system that fully takes advantage of the benefits of energy storage when deployed with other distributed energy resources.
- Coordinating oversight of energy storage systems with other governmental authorities to ensure safety without imposing duplicative or conflicting regulatory requirements.

Finally, with respect to providing wholesale grid services, energy storage at the distribution level must pay retail energy and demand charges while charging in many states. This makes the operating cost of storage at the distribution level higher than at the transmission level, providing a disincentive for storage investments at the distribution level. Regulatory schemes in which the transmission and distribution charges are based on total energy withdrawn from the grid over a billing period do not net out the energy injected back to the grid as part of the storage project's operations. In essence, under this regulatory scheme, storage projects, which withdraw and inject energy as part of their normal operations and which only ultimately use or consume the net of their injections and withdrawals, are unduly penalized. Effectively, the energy is charged twice–once when initially withdrawn from the grid by storage projects, and then again later when the energy is injected back to the grid and is ultimately consumed by another end-user.

> *How can policy levers be employed to remove barriers in each type of market to facilitate policy goals?*

By enabling electric storage resources to participate fully in wholesale electricity markets, public policy can ultimately ensure that those markets allow the widest range of solutions to compete to provide service. That competition is critical to ensuring that markets remain as competitive and efficient as possible. FERC has recently inquired into this subject in Docket No. AD16-20 on the access of storage resources to markets for wholesales services. Additionally, there are related issues that impede market participation of storage resources. Storage resources continue to face unique impediments to interconnection, which provides physical access to markets; FERC has recently inquired into this subject in Docket No. RM16-12. Incomplete price formation—stemming from either market design flaws or the absence of markets for some services—devalues the flexibility services that storage resources provide; FERC has recently inquired into this subject in Docket No. AD14-14 and made incremental progress in Order 825. Storage resources also still face barriers to service as transmission assets, particularly when also technically capable of providing generator services.

Proposals premised on valuing resource flexibility in wholesale markets are also critical. For example, Capacity markets in all wholesale electricity markets have focused on resource adequacy – having enough firm resources to meet the highest expected level of demand, planned on investment timescales – without taking into account system quality – the optimal mix of capabilities deployed to ensure that in every moment supply balances with demand, deployed on operational timescales. Traditionally, this orientation has not been problematic, as the need for flexibility was bounded and predictable, and thus resources procured for resource adequacy could be relied upon to provide system quality at operational timescales. If trends of recent years continue, however—with more variable generation and higher local and system load factors—the demand for the kind of flexibility traditionally associated with peaking and cycling plants will no longer be either bounded or predictable. System quality will fundamentally need to be a concern on investment timescales as well, since simple resource adequacy may not be capable of meeting system quality requirements in the future. Similarly, planning studies that inform Capacity needs will need to reflect system operations more closely. The process today requires that generation be available every hour of every day, but as the system becomes more flexible, there will be need for resources that offer flexible attributes that may not be needed every hour of every day. This broad thinking underlies several necessary enhancements in Capacity markets to improve the investment signals for and appropriate utilization of fast, flexible, dependable resources, such as energy storage.

> *What value streams do electricity technologies provide to the system that are or are not monetized (and to which stakeholders do they accrue)?*

In general, flexibility services tend to lack a market structure and are not monetized as part of the electric system. For example, with the advent of proven technologies that are specifically designed to mitigate grid disturbances, including frequency response, it is no longer cost-effective to require generators to maintain frequency response capability. Non-generator resources can provide frequency response performance superior to that of generators; in particular, energy storage technologies provide instantaneous response and ramping performance critical for cost-effective and more efficient frequency response service. Moreover, frequency response services can be procured competitively, as is shown in the UK and Netherlands markets. However, markets do not price or compensate frequency response service.

Other examples are common. Resources with ramping capability are not compensated in most markets. Generator unit start-up and shut-down costs and not incorporated into wholesale prices, and uplift payments to generators are out-of-market settlements—which inherently devalues flexible resources. No product yet exists for “positive” demand response, in which highly controllable load, such as storage charging, could balance unexpected and sudden reductions in system load or manage over-generation. Some services that depend on cost allocation, such as voltage and local reliability commitments, could instead use price signals for more market-efficient service provision. Moreover, existing products other than frequency regulation lack differentiation of price based on resource performance; for example, Spinning Reserve compensates a resource with 5-second response the same as a resource with 5-minute response, even if the former can provide more system value.

Other values not taken into account besides flexibility include optionality, resiliency, and environmental benefits. The optionality of a storage project helps manage planning uncertainty, reducing the risk of unrealized benefits and stranded assets and/or additional costs to meet unanticipated needs. Storage projects may also provide resiliency benefits not considered as a part of utility service, such as local emergency power or maintenance of critical infrastructure loads. Finally, storage projects may provide environmental benefits through reduced resource use, such as lack of water use, as well as reduced emissions.

> *How can system resilience be maintained in the face of evolving trends and changing conditions, i.e., increased consumer choice, DER, smart grids, climate change, regional migration, fuel diversity?*

Energy storage is an incredibly useful resource for managing uncertainty and ensuring system resilience. Storage allows grid operators far more flexibility to balance generation and load, which may become increasingly challenging with higher penetration of DERs and other trends described above. Moreover, with the opportunity to install energy storage on all parts of the electric grid, it can be deployed as a strategic asset to enhance resiliency efforts. For example, New Jersey's Energy Resilience Bank funds energy storage as emergency back-up power for essential service at sites of critical need.[17] Other studies suggest storage could economically assist with resilience in even in residential cases.[18]

In addition to incorporating consideration of storage into grid modernization and energy system reliability planning, system resilience can also be supported by incorporating storage into disaster relief planning and providing funding support. For example, FEMA funds would be useful if they could be deployed for preventative investments in energy system resiliency, in addition to investments in storage to replace damaged electric system assets following disasters.

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[17] See http://www.njcleanenergy.com/renewable-energy/programs/energy-storage

[18] See http://www.cleanegroup.org/ceg-resources/resource/resilience-for-free-how-solar-storage-could-protect-multifamily-affordable-housing-from-power-outages-at-little-or-no-net-cost/