U.S. House Committee on Energy and Commerce, Subcommittee on Energy
July 18, 2018 Hearing
Powering America: Role of Energy Storage in the Nation's Electricity System
Questions for the Record Submitted to Mr. Kiran Kumaraswamy

Questions from Honorable Greg Walden

Question 1: FERC issued Order 841, earlier this year, and asked the ISO/RTO's to ensure their market rules are not creating barriers to the participation of energy storage resources in their capacity, energy and ancillary service markets. As these market operators are contemplating their responses.

(a) From your perspectives, are the markets working? Are energy storage resources able to compete? If not, what are the barriers?

Answer 1: As mentioned in my written testimony, we are pleased to see the action from FERC in creating market changes to fully allow energy storage resources to participate and deliver services in wholesale power markets. Many of the rules that exist in today's markets were based on and put in place for technologies that existed 10-15 years ago; as a result, because energy storage offers significant improvements in speed, precision and accuracy over older technology, some of these rules may not apply. This has been the biggest barrier for storage participation in markets till now. FERC Order 841 will remedy this by modifying market rules to focus on requirements to provide specific market services. If a resource can qualify under the revised criteria, it should be allowed to participate, deliver the service and get compensated.

Question 2: Large-scale energy storage has many applications and provides unique attributes such as frequency control to improve the reliability and resilience to the nation's electricity system. According to a recent report by EIA, 88 %of large-scale battery storage power provides frequency regulation.

(a) Can you explain in further detail how energy storage resources provide "frequency regulation"?
(b) Is there a reason why the majority of large-scale battery storage power is used for frequency regulation?
(c) Are other energy storage attributes being underutilized?

Answer 2: Energy storage resources have the benefit of providing nearly instantaneous response to changes in grid frequency. They can do so because they do not have rotating machines like we typically see in power plants, but rather are operated by power electronics which have no inertia and can consequently offer significantly faster response time. Energy storage resources provide a very fast, accurate and precise response to second-to-second variations in frequency. This makes them a great resource for providing frequency regulation services. For example, in the PJM regulation market, energy storage resources get a signal every 2 seconds and they provide the output within that timeframe. In fact, all resources providing these services get scored on how

well they responded to that signal, and storage resources consistently score the highest in terms of accuracy of following the signal. In addition, storage can provide other applications for the electric grid, such as providing peaking capacity and addressing transmission/distribution needs of utilities, both of which are being demonstrated by a growing number of projects across the country, especially in the southwestern U.S. The ability of storage to provide high-quality frequency regulation was the starting point, and now we are moving on to some of these other high-value applications that storage can provide to utilities and grid operators.

Questions from Honorable Fred Upton

Question 1: According to EIA, about 90% of large-scale battery storage capacity in the United States is installed in regions covered by five of the seven organized markets (ISO/RTO's). Nearly 40% of existing large-scale battery storage power capacity lies in PJM footprint, the next being CAISO with 18% existing power capacity.

(a) What circumstances led to the PJM market having this large share of large-scale battery storage capacity?
(b) Could market rules in PJM be utilized in other competitive electricity markets?

Answer 1: In 2012, PJM market implemented rule changes to comply with FERC Order 755 and established a "pay-for-performance" mechanism to compensate resources based on the accuracy of providing frequency regulation. This mechanism enabled energy storage to earn a premium on market revenues based on their higher performance capabilities relative to traditional generation resources, while at the same time helping improve the efficiency of the regulation market. The availability of this premium and the market construct that values the higher quality of resources providing this service were the main reasons for increase in storage capacity in PJM. These rules could definitely be utilized in other markets; however, in markets like MISO/SPP, existing market rules still do not fully compensate energy storage for the higher quality regulation service.

Question 2: In your testimony you mention using energy storage in conjunction with a gas turbine to increase the utilization of the existing gas turbine, while lowering emission and operating costs.

(a) How can integrating energy storage with an existing gas turbine increase its utilization?
(b) Could this be applied to other generation resources?

Answer 2: Typically, peaking gas turbines are utilized only for a small fraction of the year (typically 5-6% of the year) to satisfy peak demand conditions of the grid. By hybridizing gas turbines with storage – similar to how a Toyota Prius' gas engine is hybridized with a battery –

energy storage can help the traditional resource to be better utilized, allowing the gas turbine to turn on only when needed and add flexibility to the gas plant. We are seeing similar ideas being implemented on run-of-river hydro projects where the addition of storage to hydropower turbines can add flexibility and increase utilization.

Question 3: Energy storage resources allow for electricity to be storage during off-peak time periods and then deployed in times of high demand, such as hot summer months.

(a) How does the ability to "energy time-shift" help electricity providers?
(b) How would electricity providers meet demand without energy storage resources?

Answer 3: As additional renewable generation is added to the grid -- particularly solar generation -- there is a risk of generating too much energy during the daylight hours while not having enough firm capacity to capture and redeploy that energy as the sun sets for people's evening energy needs, as they return home, cook dinner, and use or charge electronic devices and vehicles.

As solar becomes a bigger portion of energy generation, grid operators will need solar resources to provide more than just zero-marginal cost energy. Solar resources will need to provide firm, flexible energy commitments even when the sun goes down, as well as critical grid services like frequency regulation and spinning reserves to stabilize the grid.

One solution to ensuring the long-term growth of solar is to deploy solar with storage either collocated or as standalone systems. The deployment of storage with solar provides flexible capacity by both absorbing over-generation midday and discharging it during the evening hours when low-cost, carbon-free energy is needed. This allows grid operators to use a clean, carbon-free resource to provide enough capacity to serve their customers during peak demand periods rather than relying on traditional polluting fossil fuel plants.

The other way of managing this ramping need in the evening time is through the addition of peaking gas turbines, which are a less efficient and more expensive way to meet peak needs. Peaking gas turbines, while having the capability to address evening ramp, offer no capability to address solar overgeneration in the middle of the day by storing energy. Energy storage can perform both these functions, which makes storage a more prudent choice for our electricity networks.

Question 4: In 2012, PJM, which covers all or parts of 13 eastern states and DC, created a new frequency regulation market product for fast-repsonding resources, such as battery storage:

(a) What do you believe were the reasons behind PJM creating this new market product?
(b) Are there similar frequency regulation products in other wholesale electricity markets?

Answer 4: AES deployed its first project in PJM before 2012 to demonstrate the capability of energy storage in addressing frequency regulation challenges. At the time, there was no fast regulation signal or market premium for storage resources providing this service. AES' successful demonstration of storage capabilities, in addition to other stakeholders that worked with PJM, was the main reason for the creation of FERC Order 755, which provided the systematic framework to compensate resources based on the level of service ("pay for performance"). PJM market's rule changes in reflection of Order 755 really set the stage for storage growth in this market.

Similar products are available in other markets like MISO/SPP, but none of those, truly reflect the spirit of FERC Order 755 in terms of paying for actual performance. This lack of premium for actual performance, coupled with other structural issues, still create an issue for storage participation in some of the other markets.

Questions from Honorable Jerry McNerney

Question 1: How would each of you properly value storage.

Answer 1: Integration of energy storage resources provide various benefits to the grid. However, while some of the benefits can be monetized through wholesale products and services, there are several categories of benefits that our wholesale power markets do not compensate fully. As an example, existing thermal generation plants run more efficiently when paired with energy storage, which leads to reduced emissions. Energy storage also enables traditional generation facilities to start up and stop less frequently, reducing maintenance and fuel costs, and reduces curtailment of intermittent renewable generation. None of these benefits are currently compensated by our power markets. The best way to address this would be to reform wholesale market products to reflect these benefits; however, we recognize this would be a long and arduous process, one that takes several years. In the interim, policies such as an investment tax credit for standalone energy storage could serve as a proxy for these currently uncompensated categories of benefits that storage delivers for our electric grid.