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# BATTERY STORAGE - SET FOR MASSIVE GROWTH

Energy storage has always been somewhat of a "holy grail" for the utility industry and its customers. Traditional storage technologies include batteries, pumped hydro, compressed storage, thermal storage, and flywheels. While all have their place, interest in one of these technologies in particular, battery storage, has been growing exponentially in the last two years as a result of rapidly-advancing technologies that can guarantee dependable and large-scale storage, continually falling prices, ease of installation and maintenance, and the ability to set up virtually anywhere in the U.S. (unlike options such as pumped hydro and compressed storage, which require specific local geographical features).

This three-part white paper will look at the various aspects of the growing battery storage trend:

- Part I will look at utility-scale energy storage - battery systems being planned and used by utilities themselves.

- Part II will look at customer-owned energy storage - batteries being used by industrial, governmental, commercial and residential customers.

- Part III will look at how the future of the trend might play out, particularly as it relates to advances in battery storage technologies, government regulations of battery usage, and industry-created standards for battery storage.

## Part I: Utility-Scale Energy Storage

Utilities see a host of potential benefits of integrating battery storage into their arsenal of "grid tools." These include reduction in outages, deferral of capital investments to distribution and even transmission equipment, transmission congestion relief, cost savings in electricity production costs, the ability to bring more renewables on-line, and possibly even the elimination of the need for new peaker plants.

ISOs and RTOs also see benefits, including energy arbitrage, frequency regulation, voltage support, "black start," and as spin or non-spin reserves.

According to a September 2015 report by Frost & Sullivan, "Global Utility Scale, Grid-Connected Battery Energy Storage System Markets," the market for battery storage is expanding rapidly, driven by impressive technological breakthroughs and growth in manufacturing capabilities. "The rising profile of the market has caught the attention of governments, which are now rolling out favorable policy initiatives, such as subsidies, preferential tariffs, and targets in core markets," said the report.

The worldwide market earned revenues of almost half a billion dollars in 2014 and is expected to earn almost eight-and-a-half billion by 2024. Approximately 430 megawatts of battery energy storage systems are currently in operation, while estimates are for between 10 and 12 gigawatts by 2024. The U.S. is expected to lead the way, followed by China, Japan and Germany.

"Battery storage has the ability to impart flexibility to the grid across a variety of end-use applications," said Ross Bruton, energy and power research analyst for Frost & Sullivan, in a press release. "Its greatest advantages are the provision of distributed, variable renewable energy firming and energy time-shift, and rapid short-term electricity balancing for ancillary markets."

Electric utilities are taking notice of the growing market, the advances in technology, and the many benefits of energy storage for their utilities and customers. In fact, these days, it is rare for a U.S. utility not to be at least looking at energy storage, and many have actually been involved in projects, large and small, in recent years.

Testifying at a hearing of the Committee on Energy and Natural Resources of the United States Senate in March 2015, Lisa M. Barton, executive vice president, transmission, for American Electric Power (AEP), noted that, "Energy storage via battery technology has long been viewed as a game changer for the electricity industry, if it could be implemented cost-effectively." Currently, noted Barton, the electricity infrastructure is built to address peak loads, recognizing significant fluctuations in energy consumption throughout the day and throughout the year. "If cost-effective energy storage devices such as batteries became commercially available, they could effectively change the existing planning parameters and applications of our assets in a profound manner," she said.

NextEra Energy, a clean energy provider with revenues of $17 billion and about 45,000 megawatts of generating capacity, which works with utilities around the country, is actively getting involved in battery storage. At a Wolfe Research conference in New York in October 2015, Jim Robo, chairman and CEO of NextEra, predicted that storage projects could ultimately displace the need for peaker power plants in the U.S. "Post 2020, there may never be another peaker plant built in the United States," he said. "It is very likely that you will just be building energy storage instead."

Robo continued: "Obviously, battery storage is the holy grail of the renewable energy business. If we can deliver firm power to our renewable customers at a cost-effective rate, I think you will see renewables explode

even faster than they already have." He added that NextEra Energy wants to be the leader in energy storage in the country. "We have a dialogue going on with almost every large utility in the country around renewables, and we are starting to expand that dialogue now into storage," he said. The company is planning to deploy about $100 million worth of battery storage projects over the next 12 months in regions served by PJM, as well as in Arizona, and possibly California.

The growth of utility-scale energy storage gained momentum in California following the state's PUC-triggered 2015 mandate (AB-2514) requiring that the state's three major IOUs (San Diego Gas & Electric, Pacific Gas & Electric, and Southern California Edison) bring 1.325 gigawatts of energy storage on-line by 2020.

Already, all three IOUs have made significant inroads into the requirement, and they are doing so not just because it is required, but because they see the tangible benefits. Southern California Edison (SCE), for example, which only set an initial target of 50 megawatts of battery storage, has already solicited procurement for 250 megawatts, despite the fact that SCE could have sunk much of that funding into thermal storage and demand-side resources.

However, one of the first utilities in California to take steps toward large-scale energy storage was not one of the IOUs, but the Imperial, California-based Imperial Irrigation District (IID), the third largest public power utility in the state and the nation's largest irrigation district.

Since IID is not an IOU and is thus not subject to AB-2514, why did it get involved in storage? The impetus for the utility's interest in energy storage was the result of a September 2011 blackout that started in Arizona, when an Arizona utility accidentally shut down a transmission line, sending more power than expected into an IID transmission line, and shutting it down. The outage cut a wide swath through southern California and left 2.7 million customers without power, at a time when temperatures swelled into the triple digits, and customers were left without air conditioning. As part of its settlement with FERC over its role in causing the blackout, IID agreed to invest in battery technology to help prevent future outages.

The result is the $38 million Battery Energy Storage System (BESS) Project, which will be able to store 30 megawatts of power and deliver approximately 20 megawatts to the grid, making it one of the largest battery storage systems in the western United States.

IID sees the project as providing four benefits. First is power balancing. In fact, since IID serves as its own balancing authority, power balancing is the priority of the project. As a balancing authority, IID has operational requirements, which include Area Control Error (ACE) and integration of renewables and spinning reserves.

Second is solar integration. For example, the battery will help bring at least 50 megawatts of new IID solar power onto the grid, with the battery storage providing the generated solar at night or on cloudy days.

Third is spinning reserve. IID sees batteries as a means to further reduce fossil fuel needs by replacing some of the spinning reserves that would normally require natural gas.

Fourth is power restoration. The batteries add another level of reliability to IID's system. Should an outage or issue occur, IID would be able to use the batteries to "black-start" its El Centro Generating Station, one of its main internal sources of generation.

While these four services could be provided by a traditional generating unit, the battery system will be able to provide these services much more quickly. Without the battery, IID would need to procure another gas unit, get it permitted, and then burn fossil fuels.

In October 2015, Xcel Energy's Colorado subsidiary filed an application with the Colorado Public Utilities Commission to test the benefits of microgrids and battery storage when coupled with distributed solar generation. These projects are on the heels of two earlier Xcel projects, launched in 2012, one of which involved the integration of 1.3 MW of solar power with a 1-MW 2-MWh battery storage system in Aurora, Colorado.

In December 2014, Puget Sound Energy (PSE) and Renewable Energy Systems Americas signed agreements to cooperate in launching a battery storage project in Whatcom County that could eventually pave the way for larger scale efforts in PSE's service territory. As part of the project, electricity will be stored in state-of-the-art battery modules that are as large as 40-foot shipping containers, containing the same amount of energy found in 1.7 million AA batteries. The unit will be capable of providing up to 18 hours of power during an outage for the core area of Glacier, Wash.

PSE is working with the state's Department of Commerce on the pilot project. In mid-2014, the department's Clean Energy Fund awarded PSE $3.8 million to engineer and construct the two-megawatt, 4.4 megawatt-hours lithium-ion battery unit. The unit will also perform "peak shaving," which involves harnessing electricity when customers' energy consumption is low, storing it, and then releasing it back into the system when demand is higher. The unit will also support greater integration of renewable generation, such as wind and solar.

Several miles southwest, at its Everett, Washington, substation, the Snohomish County Public Utility District dedicated its first battery storage system in January 2015. This project was also funded by the Department of Commerce Clean Energy Fund, to the tune of $7.3 million. It includes two large-scale lithium-ion batteries. Later this year, the utility will deploy multiple advanced vanadium-flow batteries at a second substation.

The existing Snohomish units utilize Modular Energy Storage Architecture (MESA), which provides a standard, non-proprietary, and scalable approach to energy storage. The "open standards" approach is expected to result in the expanded application of plug-and-play type energy storage systems to help solve the expanding needs of today's electric grid, which continues to depend more and more on intermittent resources, such as wind and solar. Another goal of MESA technology involves developing standard electrical and communication interfaces to connect batteries, power converters, and software components into modular energy storage systems.