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Energy Game-Changer: Electric Storage Systems

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Storage has become a premier cleantech investment opportunity. Ernst & Young reported that energy storage totaled more than a third of the US$1.1 billion US venture capital investment in cleantech for Q3 2011, which was the highest of any single sector that quarter.[1] In 2009, investment bank Piper Jaffray projected that the energy storage market would be at least US$600 billion over the next 10 to 12 years.[2] In the US alone, the Department of Energy ("DOE") has projected that over the next 5 to 10 years, between 10 and 100 gigawatts of energy storage will need to be installed, creating a US$35 billion industry.[3] This article provides a brief overview of this fast-growing industry and describes recent developments in its regulatory treatment in the United States.

Why now?

The need for energy storage is not new. Electric power generation and consumption must be kept in balance in order to maintain a stable grid. This is typically done by varying generation levels to respond to changes in consumption (load), both to meet daily and seasonal variations in load levels and moment-to-moment fluctuations. Energy storage in the form of pumped hydro and hydro with pondage has a long history of use on the grid for such purposes.

But technologies for electric energy storage systems, such as battery technologies,[4] flywheel technology, compressed air energy storage, electrochemical capacitors and superconducting magnetic energy storage,[5] are becoming more efficient and more cost-effective, and a host of applications for these new technologies are being explored in the context of the needs of today's grid. These technologies have the capability to provide substantial value to the grid by helping to "move" energy from the period in which it is generated to the time it is needed: providing voltage and regulation service to help keep the grid stable and in balance; dampening load fluctuations; providing back-up power to end-users; and as operating reserves, to name only a few of the possible uses.[6]

These newer alternatives also increase the potential to use storage to defer new capital investments in generation, transmission and/or distribution by utilizing existing infrastructure more fully. For example, if generation can be transmitted during off-peak hours into a region that is transmission-constrained during peak periods and stored, transmission upgrades may be deferrable. Energy storage also has the versatility to be deployed at the distribution or even end-user level. End-user storage could include, for example, residential battery systems coupled with solar installations that are charged from the onsite resource for later use by the end-user or for sale to the grid during peak periods.[7] As the Federal Energy Regulatory Commission ("FERC") has acknowledged, energystorage "can operate in ways that resemble production, transmission and/or distribution," in some cases, performing multiple functions simultaneously.[8] With some projections of the capital expenditures necessary to upgrade the grid exceeding US$100 billion through 2020,[9] the potential for energy storage to offer cost-effective alternatives to traditional infrastructure investments is a strong driver, fueling interest in the industry.

Part of the current appeal of energy storage is its ability to complement renewable energy resources. Indeed, one of the most significant barriers to the exponential growth potential of renewable electric power is that intermittent or variable energy resources ("VER"), such as wind and solar, often have limited ability to respond to a grid operator's direction. For obvious reasons, they cannot generate in the absence of "fuel" in the form of wind or sun. Some grid-scale VER can follow a grid operator's direction to ramp down when load drops, but in some cases, for example, with small-scale rooftop solar, even that degree of flexibility is unavailable. As VER's share of the market increases, they may displace resources in the economic stack that can be more easily ramped up or down or that provide ancillary services, as well as energy, thus compounding their effect on the flexibility of grid operation and/or making grid operation more expensive, particularly in low-load hours.[10] Further, peak generation periods for some VER do not coincide with peak periods of demand; for example, in California, wind blows most during the night and dies down during the day. On top of that, the availability of wind and sunlight cannot be relied upon.[11] Contrast this with an energy grid's demand for constant and dependable power and the rift between renewables and stable grid operation becomes apparent.

But, energy storage can facilitate the integration of VER into the grid. According to Maurice Gunderson, senior partner at CMEA Capital, energy storage systems are a "game-changer in the alternative energy battle."[12] Energy storage can help by making the energy available later, when needed, and adding operational flexibility to the grid. For example, solar thermal generation plants with molten salt storage can continue to put power into the grid after sundown; and as described below, AES has installed battery storage in conjunction with several wind facilities which provides regulation service to the grid as well as smoothing the delivery of wind power into the system.

Recent Storage Projects

While energy storage systems are still expensive,[13] projects are being installed around the world. As the California Public Utilities Commission ("CPUC") staff aptly points out, the absolute cost of energy storage is not as important as its cost-effectiveness, taking into account "the full range and types of costs and benefits" provided by storage.[14]

Countries around the world have promised to put billions of dollars to work in support of energy storage. For example, the DOE, through the American Recovery and Reinvestment Act ("ARRA"), has allocated US$185 million to develop storage projects. The DOE's investment has supported US$585 million in private investment. Recent grid-scale energy storage projects in the US supported by DOE grants include:

Primus Power
This is a California-based project involving the installation of a 25 MW/3-hr battery plant for the Modesto Irrigation District in California. The storage facility provides equivalent flow capacity to 50 MWs of natural gas engines. It is used to compensate for the variable nature of wind energy. The total cost of the facility was US$73 million. The project received a US$14 million grant from the DOE.

Xtreme Power/Duke Energy
Duke Energy received a US$21 million grant from the DOE to help finance a 36 MW/15-min turnkey battery plant in No-Trees, TX. The storage facility provides ramp control and wind-smoothing capabilities for a 153 MW wind farm.

PG&E
The DOE awarded PG&E a US$25 million grant to aid in the financing of a 300 MW/10-hr CAES project in California. The project will be used for load leveling, as a reserve and for peak shifting. Total project cost is US$356 million.

While a substantial amount of research and development of energy storage is ongoing, storage projects have left the drawing board and entered the market. In June 2011, FERC reported that the "first flywheel energy storage plant in Stephentown, New York is in full operation. The 20 MW facility is the world's first grid-scale flywheel energy storage unit. It consists of 200 high-speed Beacon flywheels to provide fast-response frequency-regulation services to the New York electricity grid."[15] This project, which was also a recipient of a US$43 million US loan guarantee, was initially owned by Beacon Power Corp. before it filed for bankruptcy in October 2011 and sold the project. The project was acquired by Stephentown Spindle, LLC.[16]

AES Energy Storage has placed several energy storage systems into operation. The AES ES Westover facility, a 20 MW advanced lithium-ion battery facility that uses bidirectional inverters and DC battery subsystems, provides frequency regulation to the New York Independent System Operator, Inc. ("NYISO"). The project was supported by a DOE loan guarantee of US$17 million and entered service in phases beginning in 2010.[17] AES Energy Storage's Laurel Mountain project, a 32 MW battery system located in West Virginia at the site of a 125 MW wind farm, which began operating last year, plays a dual role. The wind facility generates energy. But, as explained by AES Energy Storage, "[t]he energy storage portion of the project provides frequency regulation in the PJM market while also being available to help manage the rapid rate of change of output that can occur with fluctuations in wind conditions."[18]

The US is not the only show in town when it comes to energy storage. There are more than 150,000 MWs of installed energy storage capacity worldwide as of 2Q 2012.[19] Asia accounts for the lion's share, more than 60,000 MWs. In July 2012, Japan's Ministry of Economy, Trade and Industry said that the storage market will grow to US$250 billion by 2020 and that Japan will account for half of that market.[20] Noteworthy global energy storage projects include:

Güssing Renewable Energy GmbH – Austria Projects

US-based fuel cell manufacturer ClearEdge Power has contracted to provide Güssing with 50 MWs of fuel cell storage. The project will cost US$500 million and be completed over the next eight years (8.5 MWs to be shipped in the next 36 months).

AES Gener/A123

Battery developer A123 recently completed installation of 20 MWs of lithium-ion battery storage to be used as a spinning reserve for AES Gener's 500 MW Chilean power plant, Angamos. Previously, A123 installed a 12 MW spinning reserve storage system for AES Gener, the first such system installed in Chile.

China's State Grid

BYD installed 36 MWh of battery storage to support 140 MWs of renewable power in China. The project may be the world's largest battery storage system. The total project is worth more than US$500 million and is supported by China's "Golden Sun" program.

Regulation of Storage in the United States

Interest in investing in energy storage in the United States can be sustained only so long as such investments deliver a return, which requires consideration of the economic regulatory structure for storage. Our traditional regulatory structures are based on function, but the versatility of storage turns the paradigm on its head. Therefore, not surprisingly, the economic regulation of storage is still evolving. As noted in a staff report issued by the CPUC, "regulators do not yet know how [electric energy storage] costs and benefits should be allocated among the three main elements [i.e., generation, transmission and distribution] of the electric system."[21]

FERC has looked at energy storage as both transmission and generation. In 2010, FERC issued a declaratory order at the request of Western Grid Development, LLC ("Western Grid"), finding its proposed energy storage device projects to be wholesale transmission facilities.[22] Western Grid explained that the devices, sodium sulfur batteries, would function similarly to capacitor banks and operate at the direction of the California Independent System Operator Corporation ("CAISO"). Western Grid distinguished the facilities from generation because the units would absorb and discharge electric energy, not convert one form of energy into another. The facilities would be used to provide voltage support and help mitigate transmission overloads. It proposed to install its devices on the CAISO grid and collect a cost-of-service rate through the CAISO tariff, as do other owners of transmission operated by CAISO.

FERC found that Western Grid's devices would be transmission facilities, if operated as proposed.[23] The finding was limited to the specific facts and circumstances presented and turned specifically on Western Grid's proposal that it would purchase the energy needed to charge the facilities and receive a retail credit for discharge, but would not retain any differential, and would not arbitrage wholesale energy market prices.[24] Any revenue gained from charging and discharging energy would be credited back to customers. Over the objections of several intervenors, FERC also found that Western Grid would be entitled to receive certain rate incentives that are available pursuant to Section 219 of the Federal Power Act ("FPA")[25] for transmission that benefits consumers by "ensur[ing] reliability and reduc[ing] the cost of delivered power by reducing congestion."[26] In making this somewhat controversial finding to treat the batteries as transmission, eligible to receive incentives, FERC recognized "storage devices can resemble any of [generation, transmission or distribution] or even load."[27]

In contrast, in 2010, FERC found AES ES Westover, LLC to be an "exempt wholesale generator," or "EWG," which is, by definition, an entity engaged directly and exclusively in the generation and sale of electric energy. As noted above, AES ES Westover owns and operates a lithium-ion battery facility. However, unlike the Western Grid facility, AES ES Westover proposed to use the facility to sell ancillary services, specifically, Regulation and Frequency Response Service to the NYISO.[28] Accordingly, it sought and obtained market-based rate authority from FERC.[29] Subsequently, FERC also granted EWG status to the AES Laurel Mountain project, which would sell wind energy as well as regulation services from the combined wind farm/battery storage facility, also pursuant to market-based rate authority. Similarly, the owner of the flywheel storage system located in Stephentown, New York, is also an EWG that sells regulation service to NYISO pursuant to market-based rate authority.[30]

Storage facilities capable of providing frequency regulation may benefit from FERC's Order No. 755, which required regional transmission organizations and independent system operators under its jurisdiction to develop two-part rates for frequency regulation service; the specific rates payable would be determined by the market. Specifically, the Commission required (i) a capacity payment that includes the marginal unit's opportunity costs, payable to all frequency regulation service providers that clear the market, and (ii) a payment for performance that would reward providers that more accurately follow the dispatch signal, upward or downward.[31] While the benefits of Order No. 755 are not directed solely to energy storage providers, to the extent that storage providers are able to provide superior service, they will be entitled to payments that reflect their superior performance.

FERC has also turned its attention to treatment of energy storage resources within the Uniform System of Accounts. On June 22, 2012, FERC issued a notice of proposed rulemaking pursuant to which it proposes to create a new electric plant account within the production (i.e., generation) functional classification and to amend two existing electric plant accounts within the transmission and distribution functional classifications to record the installed cost of energy storage equipment owned by public utilities and licensees. Additional proposed changes address other accounting issues for energy storage facilities over the course of their life cycle including a methodology for accounting for "fuel" costs of charging or maintaining pressure as required by the resource. FERC proposes amendments to the annual reports, Form Nos. 1 and 1-F, that would require utilities with energy storage operations to report detailed financial and operational information on energy storage assets and activities in new schedules for all functions.[32] If implemented, the new reporting obligations will help increase our understanding of the costs and saturation of storage.

The CPUC has also turned its attention to energy storage. In a recent decision, it adopted a framework proposed by staff "that will allow us to analyze energy storage in a comprehensive manner and determine how this important resource can be integrated with our existing policies and properly valued."[33]

Conclusion

The technical capability, cost-effectiveness and regulatory environment for storage are all still evolving. But investors have already seen the potential, and the incremental growth of storage—proposed and operational—heralds a potentially bright future.

1. Ernst & Young, *Large Energy Storage deals push US VC investment in cleantech to $1.1 billion in Q3 2011*, (Nov. 2, 2011), *available at* http://www.ey.com/US/en/Newsroom/News-releases/Large-Energy-Storage-deals-push-US-VC-investment-in-cleantech. Energy storage was the third largest sector in cleantech for 2011, representing US$932.6 million of the US$4.9 billion invested in cleantech in 2011. Ernst & Young, *2011 U.S. Venture Capital Investment in Cleantech Steady at US$4.9 Billion Despite Tough Economy,"* (Feb. 1, 2012), *available at* http://www.ey.com/US/en/Newsroom/News-releases/2011-US-venture-capital-investment-in-cleantech.
2. Elaine S. Kwei, Preetesh U. Munshi & Jesse Pichel, *Energy Storage: Game-Changing Component of the Future Grid*, at 4-5 (Feb. 2009), *available at* http://www.eosenergystorage.com/articles/PiperJaffrayEnergyStor2009-02.pdf.
3. U.S. Dep't of Energy, Office of Electricity Delivery & Energy Reliability, *Energy Storage Program Planning Document*, 5-6 (February 2011), *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/OE_Energy_Storage_Program_Plan_Feburary_2011v3.pdf. The Office of Electricity Delivery & Energy Reliability has enacted the Energy Storage Systems Program, with the goal of advancing storage technology and deployment and reducing the cost of energy storage by 30% over the next three years with the help of a US$200 million funding level.
4. Including: sodium sulfur, flow batteries, lead acid, advanced lead carbon and lithium-ion.
5. Cal. Pub. Utils. Comm'n, Policy & Planning Div., Staff White Paper, *Electric Energy Storage: An Assessment of Potential Barriers and Opportunities*, at 4 (July 9, 2010) ("CPUC White Paper") (identifying superconducting magnetic energy storage as being capable of storing energy "indefinitely with low loss" and "discharg[ing] almost instantaneously with high power output for a brief period of time with less loss of power than for other technologies"), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/71859AF5-2D26-4262-BF52-62DE85C0E942/0/CPUCStorageWhitePaper7910.pdf.
6. The California Public Utilities Commission staff has identified 20 potential applications for the California market. *Order Instituting Rulemaking Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems*, C.P.U.C. D.12-08-016, Decision Adopting Proposed Framework for Analyzing Energy Storage Needs, at 23 (issued Aug. 6, 2012) ("CPUC Energy Storage Decision").
7. Other end-user technologies that have been in existence for decades could be more widely used if proper economic incentives are provided. For example, large office conference centers and office buildings can be (or have been) equipped with thermal storage devices that chill or freeze fluid during off-peak hours so that it can be used to cool the building during peak hours.
8. *Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies*, 139 FERC ¶ 61,245 at P 67, FERC Stats. & Regs. ¶ 32,690 at P 67 (2012); *id.* at P 55.
9. Ashley Halsey III, *Aging power grid on overload as U.S. demands more electricity*, Wash. Post, Aug. 1, 2012, A1.
10. *See* Cal. Indep. Sys. Operator, Corp., *Integration of Renewable Resources, Operational Requirements and Generation Fleet Capability at 20% RPS*, at 92-93 (Aug. 31, 2010), *available at* http://www.caiso.com/Documents/Integration-RenewableResources-OperationalRequirementsand GenerationFleet CapabilityAt20PercRPS.pdf (identifying grid issues and recommending, among other things, use of tools that would provide greater operational flexibility).
11. On June 22, 2012, FERC issued Order No. 764, requiring VER to provide meteorological and forced outage data to their interconnected transmission provider in order to improve forecasting of VER generation. *Integration of Variable Energy Resources*, Order No. 764, 139 FERC ¶ 61,246, FERC Stats. & Regs. ¶ 31,331 (2012). In the same order, FERC directed transmission providers to offer intra-hour scheduling, with the intent that more granular scheduling will provide greater accuracy as VER adjust their operations throughout the day in response to prevailing conditions. Such measures improve the ability of the grid operator to predict and react to changes in VER output. But notwithstanding such improvements in predicting and managing the variability, the output remains subject to the forces of nature.
12. Eric Wesoff, *Update: California Energy Storage Bill AB 2514 Signed Into Law by Governor* (Sept. 29, 2010) (quoting Gunderson), *available at* http://www.greentechmedia.com/articles/read/vc-cmeas-gunderson-on-utility-scale-storage/.
13. *See* Electricity Storage Association, http://www.electricitystorage.org/images/uploads/static_content/technology/technology_resources/capital-cost_large.gif (viewed Aug. 6, 2012).
14. CPUC White Paper at 5.
15. Fed. Energy Regulatory Comm'n, Office of Energy Projects, Energy Infrastructure Update for June 2011 at 3, *available at* http://www.ferc.gov/legal/staff-reports/06-11-energy-infrastructure.pdf.
16. *Stephentown Regulation Servs. LLC*, 138 FERC ¶ 62,193 (2012) ("*Stephentown*"); Notice of Consummation, Docket No. EC12-68-000 (filed March 8, 2012).
17. *AES ES Westover, LLC*, 131 FERC ¶ 61,008 (2010) ("*Westover EWG order*"); Notice of Change In Status in Ownership or Control of Generation and Transmission Facilities, Docket Nos. ER10-3142-003, *et al.*, Appendix B at 1 (filed Dec. 23, 2011); *AEE2, L.L.C.*, 134 FERC ¶ 61,096 at P 4 (2011).
18. *AES Energy Storage Projects*, Laurel Mountain, *available at* http://www.aesenergystorage.com/projects.html (viewed Aug. 3, 2012). *See also* AES Laurel Mountain, LLC, Docket No. EG11-10-000, Notice of Self-Certification as an Exempt Wholesale Generator (filed Nov. 9, 2010).
19. Pike Research, *Energy Storage Tracker 2Q12 Global Energy Storage Projects by World Region, Market Segment, Technology, and Application* (published 2Q 2012).
20. CleanBiz Asia, *Japan to follow clean energy push with advances in storage* (quoting the Ministry of Economy, Trade and Industry) (July 11, 2012), *available at* http://www.cleanbiz.asia/story/japan-follow-clean-energy-push-advances-storage.
21. CPUC White Paper at 2.
22. *Western Grid Dev., LLC,* 130 FERC ¶ 61,056 at P 2 (2010) ("*Western Grid*").
23. *Id.* at P 43.
24. *Id.* at PP 19, 45-46.
25. *Western Grid* at P 16.
26. 16 U.S.C. § 824s. Significantly, however, FERC's grant of the incentives was contingent on Western Grid's project being approved by CAISO in its transmission planning process. In 2011, FERC denied Western Grid's complaint against CAISO for failing to include the projects in the CAISO's 2009-2010 transmission planning process. *Transmission Tech. Solutions, LLC & Western Grid Dev., LLC v. Cal. Indep. Sys. Operator Corp.*, 135 FERC ¶ 61,077 (2011).
27. *Western Grid* at P 44.
28. *AES ES Westover, LLC,* Docket ER10-712-000, Application for Acceptance of Market-Based Rate Tariff and Granting of Waivers and Blanket Authorization, at 3 (filed Feb. 5, 2010).
29. *AES ES Westover, LLC*, Docket Nos. ER10-712-000, *et al.* (unpublished delegated letter order issued Apr. 23, 2010).
30. *Stephentown*, 138 FERC ¶ 62,193; *Stephentown Spindle*, LLC, Docket No. ER12-1260-000, Letter Order (issued Apr. 16, 2012) (accepting market-based rate tariff name change to Stephentown Spindle).
31. *Frequency Regulation Compensation in the Organized Wholesale Power Markets*, Order No. 755, 137 FERC ¶ 61,064, FERC Stats. & Regs. ¶ 31,324 (2011).
32. *Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies,* 139 FERC ¶ 61,245, FERC Stats & Regs. ¶ 32,690 (2012).
33. CPUC Energy Storage Decision at 26.

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