INDUSTRY CURRENT

Energy Storage: Clearing the Path for a Breakthrough

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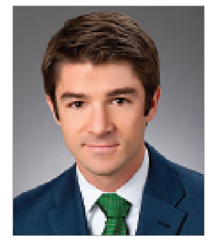

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Numerous energy storage technologies have now reached technological maturity and are being deployed in various electricity market segments. Competing new technologies are also in research and development. Barriers nonetheless persist at the state and federal levels and within the organized wholesale power markets, preventing energy storage providers from commercializing their products and services in a way that attracts necessary investment capital at acceptable rates of return and at costs that are fair to ratepayers.

The U.S. **Federal Energy Regulatory Commission**, various state public utility commissions (most notably in California and Texas), regional system operators, and state and federal legislatures and agencies are attempting to address these barriers. Some utilities, independent transmission and generation developers, and regional system operators have placed energy storage systems in use despite the absence of clear market regulations and even guaranteed cost recovery. The immediate need for such systems is acute and their deployment cannot be deferred until the market and regulatory rule-makers catch up with the technical demands of the grid. This article describes energy storage applications and recent changes in energy storage regulation, and makes recommendations as to how to remove legal and market barriers to foster full commercial implementation of energy storage systems.

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What is Energy Storage?

Energy storage means many different things to different industry stakeholders depending on where and how it is used in the electricity value chain. Sensitive to the many uses of the term, the **California Public Utilities Commission** formally adopted the definition of an energy storage system contained in the California Public Utilities Code in its "Decision Adopting Proposed Framework for Analyzing Energy Storage Needs" issued on Aug. 6, 2012 (the August 2012 Rulemaking). The code defines an energy storage system as a commercially available technology that is capable of absorbing energy, storing it for a period of time and thereafter dispatching the energy. The system must be cost-effective and accomplish one of the following purposes: reduce greenhouse gas emissions, defer or replace generation, transmission or distribution assets, or improve the reliability of the grid. The system must also meet at least one of the following characteristics: 1) use mechanical, chemical or thermal processes to store energy that was generated at one time for use at a later time, 2) store thermal energy for direct use for heating or cooling at a later time in a manner that avoids the need to use electricity at that later time, 3) use mechanical, chemical or thermal processes to store energy generated from renewable resources for use at a later time, or 4) use mechanical, chemical or thermal processes that would otherwise be wasted for delivery at a later time. In the absence of an industry-standard definition of "energy storage" California's definition is reasonably comprehensive, but does not include research-stage and emerging technologies, which should also be considered.

There are numerous energy storage technologies in various stages of commercial development and use. Generally, they break down into mechanical or electrochemical technologies. Mechanical energy storage technologies include pumped hydro, compressed air and flywheels. The advantages of mechanical systems are that they are long established, proven (and therefore bankable) technologies, and many have been in commercial operation for decades. Pumped hydro, for example, constituted approximately 22,000 MW of the 23,250 MW of installed energy storage capacity in the U.S. in 2011. The downsides of mechanical systems for certain applications are low energy efficiencies and slow response times. In addition, pumped hydro and compressed air systems have geographical and geological constraints, long construction lead-times, and high capital costs.

There are several types of electrochemical technologies (*i.e.,* batteries) for large-scale energy storage that are either commercially available or close to commercialization. Lithium-ion has been the battery technology of choice in recent years due to its high energy density, high efficiency, and relatively long lifecycle. However, lithium-ion batteries are expensive and present safety issues. Traditional flooded or sealed lead-acid battery technology has high energy density and is currently the lowest-cost battery technology, but it has relatively low efficiency. Moreover, the batteries need to be charged at low temperature, requiring an HVAC system that results in higher balance of plant and operating costs than certain other battery technologies. Advanced lead-acid batteries, also known as lead-carbon batteries, which use a hybrid technology that is part lead-acid battery and part supercapacitor, have lower energy density than traditional lead-acid batteries, but have lifecycles estimated at 5 to 10 times that of traditional lead-acid batteries. Lead-carbon batteries are fast charging, with charge acceptance rates estimated at 10 to 20 times that of earlier generation lead-acid technologies. Sodium sulfur batteries have an energy efficiency of approximately 89%, but must be kept at 300°C, are expensive, and also present safety issues. Flow battery technology, which is a cross between a conventional battery and a fuel cell, has an energy efficiency of approximately 80%. Flow battery chemistries include zinc-bromide and all-vanadium redox.

There are many more energy storage technologies in the research and development stage that may eventually prove more cost-effective for certain applications. The U.S. **Department of Energy**, through its **Advanced Research Projects Agency-Energy**, provided $43 million in funding to 19 new projects in 2012 to advance national policy goals of improving the efficiency and reliability of the grid, advancing electric vehicle technology, and promoting energy security. The projects focus on the development of new battery chemistries and designs and battery sensing and control technologies. For example, in a project at the **University of Southern California**, which received earlier ARPA-E funding, researchers are developing an iron-air battery. This battery can store the same amount of energy as a lithium-ion battery, but at an estimated 10% of the cost. If successfully developed, this technology would result in a low-cost, environment-friendly, high energy density battery capable of 5,000 deep charge/discharge cycles.

The "End-Use" Approach to Defining Energy Storage

California Assembly Bill 2514, which was signed into law in September 2010 by then Governor **Arnold Schwarzenegger**, requires the CPUC to determine appropriate targets, if any, for mandating energy storage for load-serving entities by Oct. 31, 2013. In December 2010, the CPUC issued an order instituting rulemaking outlining the first of two phases designed to implement AB 2514. The first phase focused on overall policies and guidelines for energy storage systems. This phase concluded in July 2012 and is summarized in the August 2012 Rulemaking. The second phase, which began in December 2012, will address the costs and benefits of energy storage and establish how they should be allocated. Various stakeholders collaborated to develop "use cases" which were filed with the CPUC for its consideration in connection with the goals of AB 2514.

In the August 2012 Rulemaking, the CPUC used an "end-use" approach to adopting a framework for analyzing the state's energy storage needs. This approach is helpful in understanding the "big picture" of energy storage, its various uses in the organized electricity markets, the multitude of governmental and quasi-governmental agencies which regulate or influence the uses and potential uses of energy storage, and how certain energy storage technologies are best suited to particular applications at various points in the electricity value chain. The end-uses are summarized in the following chart contained in the August 2012 Rulemaking:

Category	**Storage End Use**	
Describes at what point in the value chain storage is being used	*Describes what storage is being used for, i.e., its application.*	
ISO/Market	1	Ancillary services: frequency regulation
	2	Ancillary services: spin/non-spin/replacement reserves
	3	Ancillary services: ramp
	4	Black start
	5	Real time energy balancing
	6	Energy price arbitrage
	7	Resource Adequacy
Generation	8	Intermittent resource integration: wind (ramp/voltage support)
	9	Intermittent resource integration: photovoltaic (time shift, voltage sag, rapid demand support)
	10	Supply firming
Transmission/ Distribution	11	Peak shaving
	12	Transmission peak capacity support (upgrade deferral)
	13	Transmission operation (short duration performance, inertia, system reliability)
	14	Transmission congestion relief
	15	Distribution peak capacity support (upgrade deferral)
	16	Distribution operation (voltage/VAR support)
Customer	17	Outage mitigation: micro-grid
	18	Time-of-use (TOU) energy cost management
	19	Power quality

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Who Are the Stakeholders in Energy Storage?

As ratepayers, of course, we all are. In California, for example, retail electricity consumers are represented by the CPUC **Division of Ratepayer Advocates**. Other key stakeholders in the uses, valuation, cost recovery and return on investment in energy storage systems are the independent system operators and regional transmission operators which operate the regional grids and the organized power markets, other balancing area authorities, utilities, independent power producers, independent transmission providers, distribution companies, ancillary services providers, energy storage technology companies, "technology agnostic" energy storage system suppliers, and state and federal policymakers, lawmakers and regulators. Additional interested parties include energy storage trade associations, consumer advocacy groups and environmental protection organizations.

There has been some mischaracterization of AB 2514 in the media, some of which have reported that AB 2514 will or is likely to result in energy storage mandates similar to the renewable portfolio standards or goals in place in 40 states, Washington, D.C. and 4 U.S. territories. AB 2514 directs the CPUC to determine appropriate targets, *if any*, for each load-serving entity within California to procure viable and cost effective energy storage systems. To date, the California investor-owned utilities and the Division of Ratepayer Advocates, as well as many other stakeholders, are unified in their opposition to RPS-like energy storage mandates. Certain other stakeholders, such as the **California Energy Storage Alliance** and the **Sierra Club**, support energy storage procurement targets for the reasons set forth in the next section.

Commercialization of Energy Storage and the Regulatory and Market Barriers to Its Economically Feasible Deployment

For each of the "end-uses" for energy storage, there is a market driver creating demand for that use. The challenge for regulators and stakeholders is to figure out the relationships among energy storage uses, the optimal technology for the particular use, the cost of the technology, and the market value of that use.

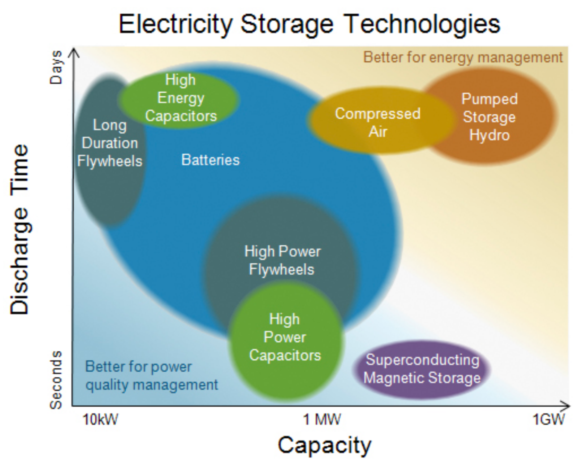
For example, the increased penetration of renewable energy – an intermittent, variable resource – creates stress on the grid. When a cloud passes over a solar photovoltaic power plant, the sudden disparity between supply and load must be balanced by injecting additional energy into the grid, a process known as "frequency regulation." There is value for the rapid and accurate frequency regulation promised by certain energy storage technologies, but this value must be quantified, choices need to be made about what technology will best meet the need for frequency regulation, who can or should own that particular energy storage solution, and who makes these decisions.

With effective storage, energy can also be generated and stored off-peak (for example, at night when wind assets are most productive but electricity demand is low) and scheduled and discharged at peak demand times of day. This energy shifting to reduce generation costs (energy arbitrage) has a very different value than frequency regulation. Other end-uses present separate market demand and potential value to stakeholders. At the transmission level, energy storage that is used for peak capacity support can be valued at the deferred cost to add or upgrade transmission facilities. In a nodal pricing market such as California's, energy storage located in a constrained part of the transmission system will have a higher market value than energy storage located in a less congested area. At the distribution level, energy storage systems can be used for many purposes, but can be particularly valuable for automatic islanding during a grid outage, for example, in severe weather conditions or in the event of an intentional attack on the grid. Growing electric vehicle market acceptance will put more stress on the distribution system as cars are charged primarily at night, although smart-grid technologies may allow the grid operator to remotely control charging and discharging of electric vehicles and home appliances to meet system needs.

Most of the policy debate among stakeholders has focused on whether an energy storage procurement mandate should be implemented. Given the complexity of the analysis required to value energy storage systems, most utilities and ratepayer advocates oppose such mandates. They argue that mandates will fail to remove legal and regulatory barriers to cost-effective energy storage and distort the market, creating short-term profit incentives for investors and long-term dependency on those incentives. Such policies would result in a misallocation of resources to regulatory affairs rather than research and development—better, they argue, to implement policies that create a level playing field and a competitive market. On the other hand, proponents of procurement mandates argue that a statutory requirement for procurement is the best way to ensure effective implementation. Some of these proponents, including the California Energy Storage Alliance, favor mandates as a policy tool analogous to RPS targets. Others, including the Sierra Club, argue that mandates need not be based on a specific quantity of energy storage to be procured by load-serving entities, but could use other criteria such as reduction in peak load or certain air pollutants. Opponents counter that renewable energy provides non-monetary benefits to society (air pollution reduction) that justify a subsidy policy to promote the industry, even though renewables may be uneconomic when compared to fossil fuels. They argue that, unlike renewables, energy storage has location and technology-specific value, which a mandate would not capture. Parties on all sides of the debate seem to agree that the need for energy storage is here and growing. Estimates of the California ISO's storage needs to safely operate the grid in 2020 range from 3,000 to 4,000 MW (not including pumped hydro) – more than 450 times the current installed capacity of 6.5 MW.

FERC's Role in Energy Storage Regulation

FERC has jurisdiction over the sale at wholesale and transmission of electricity in interstate commerce, including the provision of energy storage services into the bulk power grid. Among other things, FERC must determine that the rates and terms and conditions under which jurisdictional services are provided are "just and reasonable." While FERC has taken a number of steps over the past few years to address the unique regulatory issues posed by energy storage, in particular with respect to the appropriate compensation mechanisms for providing storage services, it has yet to formulate a comprehensive policy. Indeed, given the multiple storage technologies and the differing benefits they provide to the grid, it is unlikely that a single comprehensive policy is



Source: Akin Gump

warranted. FERC's efforts thus far have been in large part focused on evaluating the appropriate ratemaking treatment for energy storage projects given that the historic regulatory paradigm for the electricity industry was designed around the three traditional business functions in the industry: production, transmission, and distribution. Storage does not fit neatly or exclusively within one of those distinct business models.

In 2006, FERC deferred ruling on a request by **Nevada Hydro** to treat its proposed Lake Elsinore Advance Pump Storage project as a transmission asset for rate recovery purposes, a request that presented an issue of first impression. FERC subsequently granted a request by **Western Grid Development**, an independent developer, to treat its proposed energy storage projects in California as wholesale transmission facilities, thereby making them eligible for the incentive ratemaking treatment made available pursuant to the Energy Policy Act of 2005 to encourage investment in transmission infrastructure. FERC announced in the Western Grid order that a determination of whether a particular storage project would be categorized as a transmission asset, at least for purposes of determining eligibility for transmission incentive rates, would be made on a case-by-case basis after evaluating the facts of a particular project.

FERC's most recent attempts to clarify the ratemaking treatment of energy storage assets have been in the context of generic rulemaking proceedings. On June 11, 2010, FERC staff requested comments from the industry on the rate treatment of services provided by storage technologies. Staff initially noted that, while the traditional functions of generation, transmission and distribution assets within the electric grid are well understood and their cost recovery mechanisms well established, the same was not necessarily true for energy storage, especially given that storage technologies are often deployed by independent developers rather than vertically-integrated load-serving entities. Staff concluded that, "[u]nder appropriate circumstances, storage can act like any of the traditional asset categories, and also like load."

Based on the comments submitted in response to the FERC staff's request and to a subsequent FERC Notice of Inquiry, FERC issued a Notice of Proposed Rulemaking on June 22, 2012. The NOPR's primary focus is on fostering the development of competitive markets for the supply of ancillary services, which are generally defined as those services necessary to support the transmission of electricity from resources to loads while maintaining the reliability of system operations. As noted by the California Energy Storage Alliance, FERC's proposals would help reduce barriers to new market entrants, including energy storage technologies, that can provide ancillary services. The NOPR also proposed to revise FERC's Uniform System of Accounts to better account for and report transactions associated with energy storage assets. FERC's current accounting regulations and related reporting requirements were developed to capture financial and operational information aligned with the industry's traditional production, transmission and distribution functions. Because storage has operational characteristics of each of these distinct functions, and can provide multiple types of services simultaneously, FERC's proposed accounting and reporting revisions would potentially enable developers of storage assets to seek multiple methods of cost recovery for their investments.

On the same day it issued the NOPR, FERC issued a Final Rule in a rulemaking proceeding on the integration of variable energy resources into the grid. The increased deployment of generation resources that do not consistently produce power in relation to demand, such as solar and wind resources, has further underscored the system benefits to deploying storage assets that can be used to "bank" renewable energy for use during peak periods when demand, and prices, are highest. While the scope of the Final Rule was limited and not focused on the use of storage to firm up variable resources, it is nonetheless significant for advancing the regulatory discussion as to the optimization of such resources. The California Energy Storage Alliance commented in the proceeding that FERC should initiate a separate rulemaking dedicated exclusively to the use of energy storage to further integrate variable resources.

Of particular significance, FERC issued a Final Rule in October 2011 in a rulemaking proceeding regarding the compensation mechanism for the provision of frequency regulation in the electricity markets administered by RTOs and ISOs. Frequency regulation is generally provided by generators that respond to an RTO/ISO's automatic generator control signal, but can also be provided by storage providers that have the capability of ramping production up and down quickly. The Final Rule requires RTOs/ISOs to pay higher rates to companies that provide the fastest and most accurate frequency regulation service. While storage providers will not be the only beneficiaries of the Final Rule, FERC's policy is anticipated to play a significant rule in further encouraging the deployment of storage technologies.

While FERC has been formulating general policy with respect to the appropriate regulatory treatment of energy storage technologies to reduce the barriers to their market entry, the RTOs and ISOs and their stakeholders have been developing market rules and other structures to operationally integrate storage into their respective regions. For example, in May 2009 FERC accepted a proposal by the New York ISO to permit a new class of resources, referred to as Limited Energy Storage Resources, to participate in the day-ahead and real-time regulation services markets. In May 2010, the New York ISO issued a White Paper to further evaluate integration efforts given the statue of maturing storage technologies. Similarly, PJM, the independent administrator of the Mid-Atlantic regional grid, is currently evaluating the use of storage technologies to meet NERC reliability standards.

Another policy measure to promote energy storage at the federal level is the planned re-introduction of a bill in Congress that would allow a 20% investment tax credit for energy storage projects connected to the grid. According to recent media reports, the goals of the tax credit are to manage peak load needs more efficiently and to encourage the continued growth of renewable energy.

Conclusion

The regulatory and policy regimes that will determine the future of energy storage in the U.S. are just beginning to take shape. At this point, active participation of all stakeholders—public *and* private—is critical: given the numerous applications, evolving technologies, competing market interests and complex analysis required to optimize energy storage implementation, a flexible and holistic strategy that combines bottom-up and top-down approaches, accounts for the interests of all stakeholders, and incorporates inter-agency knowledge sharing is necessary. Such a strategy would include the use of pilot projects, coordinated multi-agency rulemaking and market and stakeholder feedback based on real-world experience. Using a flexible approach in which regulations can be adjusted based on operational experience and cost-effectiveness would avoid the pendulum effect of unilateral decision-making and provide the highest and best value for all energy storage market participants and consumers.

