

# What a "good" energy storage system would look like to a large utility

Allan Ingram [<sup>1</sup>]

Bonneville Power Administration

The Race is on and Energy Storage systems are positioned to compete in the profitable deployment of distributed generation. While the ongoing restructuring of the electric industry complicates customer identification, attractive markets are developing.

Economic signals emerging from California over the past three months indicate substantial opportunities for new power technologies and applications. Now, we have to match products with customers at prices that will close sales.

When utilities were vertically integrated, it was easy to knock on the correct door. The parties responsible for service and reliability were clearly identified. Response to new ideas was slow and uneven. Prior to FERC mandated deregulation, utilities managed and coordinated generation, transmission and distribution assets. A monolithic utility was an easily visible, if slow moving, target. Regardless of the pace of new technology adoption, vendors could identify appropriate target markets for new electrical equipment and technology.

The current definition of utility includes the functions of the old integrated structure along with new independent players. In states that have implemented retail open access residential, commercial and industrial end users have joined the ranks of utilities in the supply and management of electricity.

To a large integrated utility, "good" energy storage looks like an easily dispatchable, cheap to fuel, flexible output generator. Mobility, along with the ability to provide real or apparent power at a variety of voltage levels would increase the number of applications.

Under deregulation, the same characteristics are valuable. The economic and regulatory landscape is much different. Business is now separated into generation, transmission and distribution units. Each presents unique profit opportunities and requires a tailored perspective.

Implementation of Regional Transmission Organizations (RTO's) under FERC Order 2000 adds another layer of complication for potential storage providers. Under this order utilities are directed to turn over operation and marketing of transmission capacity and services to an independent operating agency. California's Independent System Operator (ISO) is an operating example of the issues and problems that arise during this transition. As with any period of rapid change, new business opportunities are created by these problems. Storage providers, along with the distributed generation competition, need to position their products to meet the needs of the new players.

Traditionally separated from the utility business, the deregulated end user may choose to participate in the utility business through generation, energy storage or energy management techniques. Opportunities with larger consumers are likely to go beyond traditional co-generation and conservation approaches.

The major characteristic of unbundled power and transmission products is assignment of system costs to low load factor end uses. The costs assigned to these loads drive the economics of end-user market applications of electric storage.

Small and medium sized end users will be faced with the unbundled costs of their load peaks. First, they will seek regulatory relief. That is occurring in California right now, in response to the recent residential price spike in San Diego. Distributed resources and storage will be adopted next, to the extent economic incentives remain.

Applications for Larger "utilities".

Regardless of the absolute market price of power, the reliability and power quality needs of larger end users will present opportunities for energy storage applications.

---

<sup>1</sup> Author may be contacted at [aeingram1@bpa.gov](mailto:aeingram1@bpa.gov)

Energy storage applications will fill different needs and face significantly different economics on the generation and transmission sides of the meter. Storage used in conjunction with larger generators can be used to improve output characteristics and provide a more marketable product.

Opportunities also exist for storage where non-power issues limit installations of new thermal facilities. By shifting off peak energy to high value periods, storage can provide additional market opportunities.

Storage strategies are less workable in the absence of demand charges or retail access laws. In California, a well-developed Power Exchange pays high prices for hourly deliveries. Grid connected storage has economic strength in current California markets compared with the more regulated Pacific Northwest.

Smaller (<50 kW) modular/portable storage units should find initial markets in residential or commercial users in application complimenting small solar and/or wind systems.

Units should be capable of connecting low voltage generation (220/480V AC or 3-12V DC) to distribution level voltages to minimize losses. The integrated solution should have a high side inverter that is capable of connecting to the grid at distribution voltages to accommodate net metering sales of the energy.

At the smallest capacities (25kw and lower) energy storage units should accommodate input voltages that are flexible and matched to the output characteristics of the connected

The value added by storage may be largest in areas experiencing shortages of generation reserves, where output from larger storage units may have a very high market value in the short term or reserve marketplace. Transmission system operating requirements mandate specific minimum reserve levels. Satisfying these markets may be lucrative during 100 or 200 hours per year.

Projects able to support large storage capacities need to move energy and capacity from hour to hour. The ability to move energy to subsequent hours increases the value of the project output on the power market.

On-peak energy, preferably delivered via cheap non-firm transmission access is a preferred business.

Power reliability and quality issues outrank kilowatt-hour costs for high tech and Internet businesses. Modern storage can provide quiet, vibration free substitutes for back up generation and other existing un-interruptable power supply (UPS) technology. These attributes are key for server farms and chip fabrication facilities.

#### Renewable Generation Applications

Larger Renewable (>1 MW) energy projects could effectively use clean, cheap, reliable and easily scaleable energy storage systems. Storage costs would be traded off against the extra integration and transmission costs imposed on non-dispatchable generation. Wind projects typically demonstrate plant factors of 30 to 40 percent depending on the site. Solar generating plant factors can be significantly lower depending on the location.

To reach the market, renewable project power also faces the cost of grid based transmission rights and losses. Annual purchases of transmission capacity sufficient to meet the annual peak facility output will improve marketability but will add significant costs to power generated during the remainder of the year. Of course this assumes that the renewable project site has sufficient transmission capacity available. Larger renewable projects are often located at the end of long, skinny transmission lines little or no, available capacity during high load hours (HLH).

Energy Storage systems can provide renewable developer with several positive options. First, The storage system can provide on-site shaping. Within each operating hour, the resource developer could fill valleys and shave output peaks to flatten the projects output shape. Flatter output means reduced exposure to the mandatory ancillary service charges imposed by transmission system operators.

Available transmission line capacity and the costs of substation interconnections can limit the economic prospects of renewable projects. Since HLH hour deliveries command premium prices, high efficiency energy storage systems of adequate size could contribute to system and operational reliability. For more traditional hydro-based projects, positive impacts from energy storage include improved nighttime operation where minimum flows must be maintained.

Clean, cheap, reliable, energy storage systems featuring transfer and paralleling equipment packaged in modular/portable units would enable renewable projects to fit into market niches currently occupied by small and mid sized gas and diesel powered generation. Pairing a remote project with storage located on site with the end user would help optimize renewable resource reporting and use. This arrangement would provide the usual benefits of onsite storage and generation with the ability to receive the renewable power on the hour it is generated, regardless of load. One stop financing would sweeten the package for the end user.

Gaining Access to high priced spot power markets requires that the developer purchase sufficient ancillary services to guarantee forecasted within hour generation levels. This key step turns the variable output of a wind plant, or any other variable resource into a known, marketable power quantity. The site energy availability and sales strategy would likely determine the unit size and output capabilities to optimize returns based on the rules of the ISO/RTO or pool operator

### Transmission System Applications

The latest addition to the utility industry is the Regional Transmission Organization or RTO. These entities are being developed to serve 18 regions in the US. RTO's are charged with operating and maintain transmission service under FERC rules. In practice, the RTO's presents a new complicated structure. Power providers will depend on scheduling coordinator services to successfully interact with their RTO. For storage suppliers, these players are new customers. Storage is well placed to provide new supplies of specific transmission and ancillary service products.

For example, an energy storage system could be focused on transmission system stability improvement.

1. Use for "redispatch" of power —i.e. near or at a large customer facility (load center) to be used at peak load times for relief of transmission line congestion, peak shaving — to net out loads for four hours or longer, to offset winter load peaks and would likely be used for periods up to two weeks in emergency conditions. . It should be easily and inexpensively increased in capacity and output size so that future load growth could be accommodated, expanding to eight hours use, at higher power levels in the future. Start-up time would need to be about one minute if its variable cost is high, so it only is used after a rare contingency. If variable cost is low, then start up time can be one hour and the operation would come on in the absence of a transmission contingency.
2. Storage could be applied to increase transfer capability over lines in use, if the energy storage device automatically kicked in within milliseconds and stayed on for several seconds, if needed.
3. Storage could be sited to specifically provide reactive support to a transmission or distribution system.

Such installations could allow a transmission operator to consider a storage facility rather than build new transmission. Non-cost, NIMBY, issues in new line siting; such as environmental and visual impacts would be avoided. Also the lead-time required to site or upgrade a new line could be more than three to five years.

What cost might be acceptable to overcome siting issues? Storage costing twice conventional system per kW for an energy storage system could be attractive. Applications priced above that may not be selected. Operational alternatives such as load curtailment and load management may be cheaper and easier to implement at those price levels.

In addition, large mobile storage units might be competitive if it was able to mitigate long replacement lead times for power transformer replacements

Energy storage has the potential to compete and contribute to the economic and reliable delivery of electricity. Realization of that potential will require providing products that fit in with the operational needs of a wide variety of customers.