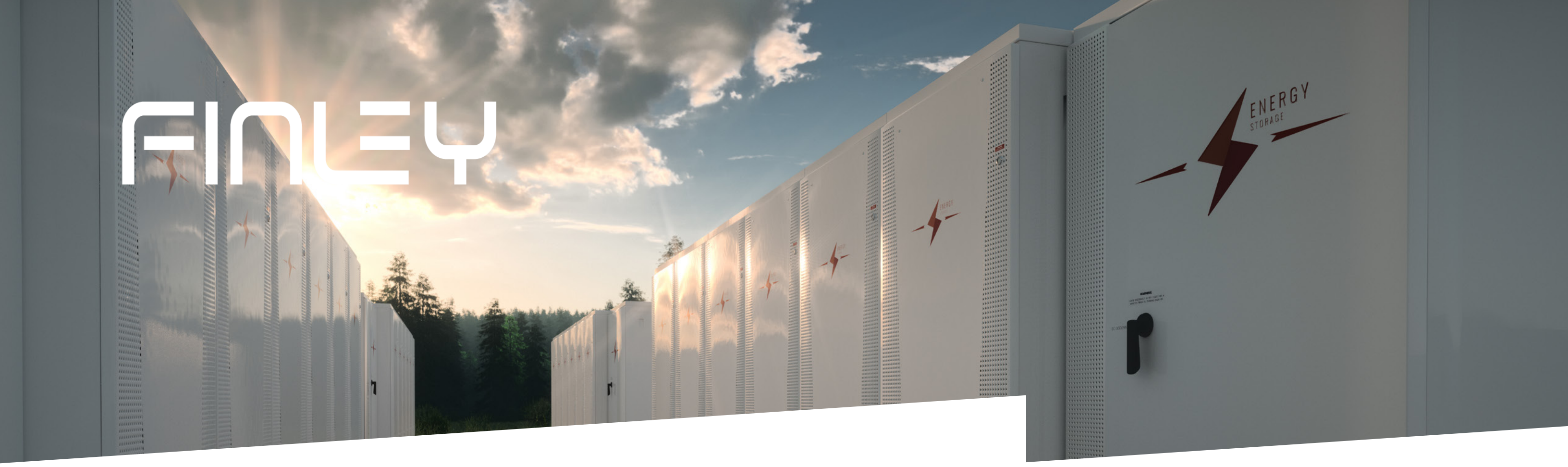


INTEGRITY INTO EVERYTHING

THE OPPORTUNITIES FOR GROWTH IN UTILITY-SCALE STORAGE

INTRODUCTION

As various technologies advance, they pose not only some challenges for electric utilities, but also some opportunities. One such technology is battery energy storage, which typically involves lithium-ion (Li-ion) batteries often combined with solar, but also with other sources of generation (which will be discussed further on).

RENEWABLE ENERGY BATTERY STORAGE

There are generally three system sizes of battery energy storage: home and small business units, community units, and utility-scale storage (USS) units. Here, we look at utility-scale storage and the opportunities that this technology (and its expected continued growth) along with some additional considerations for USS, has for readers.

What kind of growth is being projected? In the short term, a March 2022 report from the U.S. Energy Information Administration noted that, in the next two years, power plant developers and operators expect to add 10 GW of battery storage capacity, and that more than 60 percent of this capacity will be paired with solar facilities. "In 2021, 3.1 GW of battery storage capacity was added in the United States, a 200% increase," said the report. "Declining costs for battery storage applications, along with favorable economics when deployed with renewable energy (predominantly wind and solar PV), have driven the expansion of battery storage."

FUTURE GROWTH

In the longer term, a 2021 report from the National Renewable Energy Laboratory (NREL) noted that, across all scenarios in its study, utility-scale diurnal energy storage deployment is expected to grow significantly through 2050, totaling over 125 gigawatts of installed capacity in the modest cost and performance assumptions. This represents a more than five-fold increase from today's total. Depending on cost and other variables, deployment could total as much as 680 gigawatts by 2050, said the NREL.

WHY USS GROWTH IS OCCURRING

By introducing more flexibility into the grid, energy storage can help integrate more solar, wind, and distributed energy resources. It can also improve the efficiency of the grid – increasing the capacity factor of existing resources – and offsetting the need for building new pollution-emitting "peak power" plants.

Unlike conventional storage systems, such as pumped hydro storage, battery storage systems have the advantage of geographical and sizing flexibility and can therefore be deployed closer to the locations where the additional flexibility is needed and can be easily scaled.

Deployment of pumped hydro storage, on the other hand, requires specific geological conditions (e.g, mountains and water).

In addition, USS systems have a typical storage capacity ranging from around a few megawatt hours (MWh) to hundreds of MWh. Different battery technologies, such as lithium-ion (Li-ion), sodium sulfur, lead acid, and flow batteries, can be used for grid applications. However, in recent years, most of the market growth has been in Li-ion batteries.

TYPES OF USS SYSTEMS

As noted, the most common combination of USS technology currently is "solar & battery." However, wind with battery storage technologies is gaining traction.

In addition, "black start," which typically involves gas or combined-cycle turbines, is also a very important and viable application, especially for "short duration" (power) applications.

Utility companies typically charge much more money for connecting 'spinning reserve' to the grid. Battery energy storage can be used to replace 'spinning reserve' with what is now starting to be called 'rapid reserve' and reduce the amount of fossil-fueled generation that needs to be kept running on standby. USS systems also reduce wear and tear on generation units that are started up and then subsequently not required to go on-line.

CONSIDERATIONS IN INTRODUCING USS SYSTEMS

Ability to raise capital (from investors) and the amount of renewable generation that is available in their service territories are a couple of important things for utility companies to consider for introduction of USS systems. Consideration of benefits related to 'spinning reserve' were discussed previously.

The ESA cites four benefits for utilities in introducing energy storage systems in general, including USS systems:

1. It can save money. Energy storage can save operational costs in powering the grid, as well as save money for electricity consumers who install energy storage in their homes and businesses. Energy storage can reduce the costs associated with providing frequency regulation and spinning reserve services, as well as offset the costs to consumers by storing low-cost energy and using it later, during peak periods at higher electricity rates.

   By using energy storage during brief outages, businesses can avoid costly disruptions and continue normal operations. Residents can save themselves from lost food and medicines, and the inconvenience of not having electricity. In addition, there is an option for both businesses and residential consumers to participate in demand-response programs when available.

Storage provides flexibility for the grid, to ensure uninterrupted power to consumers, whenever and wherever they need it. This flexibility is critical to both reliability and resilience.

2. It can improve reliability and resilience. Energy storage can provide backup power during disruptions. The same concept that applies to backup power for an individual device (e.g., a smoke alarm that plugs into a home but also has battery backup), can be scaled up to an entire building, or even the grid as a whole.

   Storage provides flexibility for the grid, to ensure uninterrupted power to consumers, whenever and wherever they need it. This flexibility is critical to both reliability and resilience. As the cost of outages continues to rise, the value of enhanced reliability and improvements in resilience also increases.

3. It can integrate diverse generation resources. Energy storage can smooth out the delivery of variable or intermittent resources, such as wind and solar, by storing excess energy when the wind is blowing and the sun is shining, and then delivering it when the opposite is happening.

   In addition, storage can support the efficient delivery of electricity for inflexible, baseload resources. When demand changes quickly, and flexibility is required, energy storage can inject or extract electricity as needed to exactly match load – wherever and whenever it is needed. As such, energy storage is an enabling technology. When the sun isn't shining or the wind isn't blowing, energy storage can be utilized. When demand shifts and baseload resources can't react quickly enough, energy storage can meet the needs for power.

4. It can reduce environmental impacts. In simplest terms, energy storage enables electricity to be saved for a later time, when and where it is most needed. This creates efficiencies and capabilities for the electric grid—including the ability to reduce greenhouse gas (GHG) emissions.

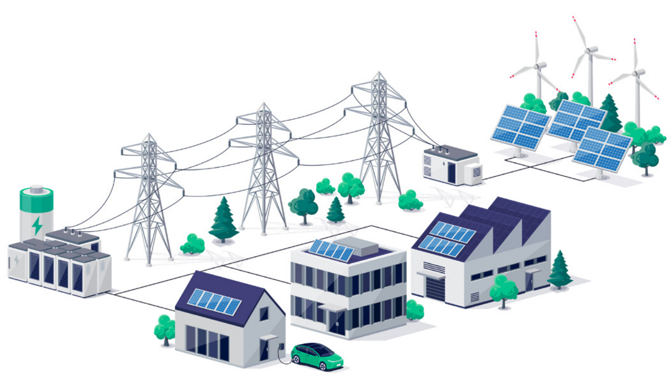
   By introducing more flexibility into the grid, energy storage can help integrate more solar, wind and distributed energy resources. It can also improve the efficiency of the grid – increasing the capacity factor of existing resources – and offset the need for building new pollution-emitting "peak power" plants.

As the nation's energy supply mix becomes cleaner with low- and no-carbon resources, energy storage will help that supply mix evolve more easily and reliably.

HOW TO DETERMINE THE NUMBER OF USS SYSTEMS

Under what circumstances would it make sense for utilities to build just one, versus building two or more USS systems in different locations in their service territory?

There are three considerations here. One is the size of the utility's service territory. The larger the territory, the more sense it may make to build more than just one USS system. A second is the cost to install, gain governmental approvals, and maintain units in different states within the utility's service territory. The third, of course, is the size and availability of capital for investment in USS.



CRITERIA IN DETERMINING USS UNIT LOCATIONS

What are some of the important criteria in determining where to locate USS systems? Battery storage systems have the advantage of geographical and sizing flexibility and can therefore be deployed closer to the location where the additional flexibility is needed.

USS systems are often located at existing generation facilities and even inside old abandoned generation / turbine buildings. In such cases, the utility will already have the permits for some quantity of MW generation, so it is can then just be a matter replacing the old fossil-fuel generation with new USS technology.

Another consideration is where renewable generation is situated or planned to be installed. For example, USS systems are often located near large PV farms for obvious reasons.

Finally, larger urban areas have typically been reluctant to allow "ugly" energy storage "containers" to be installed. Because of this and other issues like high property values, installing USS systems in urban areas typically drives up costs.

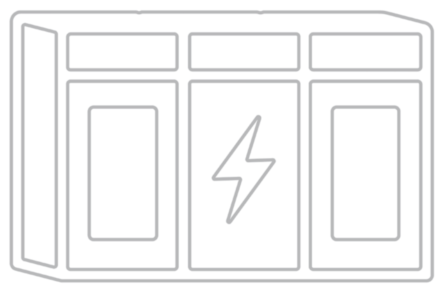
PLANNING FOR THE LONG TERM

Does it make sense to start out building a small or medium sized USS system, and then add capacity on to it later if needed? Or does it make more sense to build a larger one from the start?

All things equal, it makes more sense to install one or more large USS systems from the start. One reason is that the cost per kWh for Engineering, Procurement, and Construction (EPC) should decrease as the initial USS size increases. It should be noted, one mistake that has been made by investors and others is use of the assumption that the cost of (installed) kWh will be the same in different locations. Construction labor costs are variable, based on supply of labor, unions, remoteness of the site and other factors. In addition, site preparation and construction costs are highly variable based on condition of the land (soils, rock, etc.), local EPA requirements, etc.

Probably the biggest adaptation by battery energy storage system suppliers in recent years has been the modularization of the battery storage product to reduce weight of the individual modules (or containers) to be connected in the field and simplification and reduction of the cabling interconnections required to assemble systems at site.

Also of concern is the "big gamble" in terms of speculation on how much and how fast battery prices will decrease, especially the costs of Li-ion batteries, which are still the most common type of batteries being installed for USS systems.



Other issues with initially installing smaller battery energy storage units and adding capacity later are uncertainty of the future availability of the same type of battery modules, compatibility, and rapid changes in battery technologies.

LOOKING AT MAINTENANCE REQUIREMENTS OF USS SYSTEMS

Battery energy storage systems may appear on the surface to be very low maintenance. However, maintenance of USS systems is not insignificant. Maintenance is required and critical for reliable and safe operation, and the costs should be determined (or estimated) and factored in as part of the investment.

What are the most salient / important maintenance requirements for a USS system? There can be several, but here are seven of the most important:

1. Safety, of course, is the first and most important priority.
2. Site inspections including thorough equipment and battery inspections.
3. Availability of original batteries and compatibility for augmentation to maintain MWh capacity over time and for incremental MWh capacity expansion.
4. Thorough diagnostic software from the battery manufacturer, down to the cell level.
5. Proper integration of the battery manufacturer's diagnostic software at the next level by the systems integrator.

6. Filter cleaning on a regular basis, as well as filter replacement as required. HVAC maintenance is also crucial.

7. A formal process for safely disposing of (or recycling) old batteries.

CONCLUSION

The last decade has seen rapid growth of USS. There were large deployments in 2021. All indications are that growth for USS is expected only to continue at an ever-increasing rate.

There are many things to consider related to investing in introduction of new USS systems including available capital for investment, future costs of batteries, new and evolving battery technologies, geographic placement, short and long-term utility growth plans (capacity), and the mix of renewable generation.

For more information on this topic and other services, contact Finley Engineering at 800-225-9716 and ask for Dennis Wright, or visit FinleyUSA.com.

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Dennis Wright, P.E., recently joined Finley Engineering's Energy Division as a Distribution Engineering Manager in the Overland Park, KS, location. Dennis came to Finley with more than 25 years of experience, most recently working as a Senior Application Engineering Manager for Battery Energy Storage Systems.

An experienced professional engineer and manager, Dennis is highly skilled and has extensive experience in High Voltage Substations, Protection & Controls, Substation Physicals, Battery Energy Storage Systems, Power Plants, Chemical Plants, Smart Grid, SCADA, Electric Power, and Electrical Wiring.

RESHAPING EVERYDAY