AMERICAN PUBLIC POWER ASSOCIATION
Powering Strong Communities

Energy Storage for Public Power Resilience

In utility-scale applications, energy storage systems have primarily been used for managing peak loads. However, energy storage is playing an increasing role in resilience planning. This shift is particularly significant as weather-related outages increase and intermittent renewable generation sources become a bigger portion of the supply mix. The array of potential uses for energy storage in fortifying resilience efforts, thus preventing power outages, can help fortify support for storage as an economical pathway for public power communities.

Use Cases for Energy Storage in Support of Resilience

Key applications for energy storage in support of grid resilience include supporting islanded sections of the grid that lack redundancy or tie-lines, providing microgrid services to critical facilities and areas, and quickly balancing energy supply and demand in the face of large and unexpected swings in energy supply or demand.

Use Case	Description	Notes
Facility-level islanding capabilities	Energy storage continues facility operations when the grid becomes unavailable or power quality is insufficient.	Used in data centers, hospitals, and other critical facilities to support full facility operations or critical loads.
Multi-facility islanding capabilities	Energy storage is integrated into a microgrid, using power electronics and control systems.	Used in campuses, military bases, and communities to support essential services during emergencies.
Area microgrid services	Energy storage supplies an islanded distribution feeder or line section when upstream power becomes unavailable.	Typically connected to distribution substations or feeders to protect downstream operations.
Dynamic grid-balancing services	Energy storage injects large amounts of energy into the grid to stabilize wide areas in response to sudden changes in power supply or power demand.	Utility-scale installations, often interconnected at the transmission level.
Black start services for local generation	Beyond preventing outages in a particular area, energy storage assets can also restore generation services for broader areas affected by outages or service reductions.	Generator and distribution system coordination required.
Firming renewable generation sources	In areas with high penetration of renewable generation, combining energy storage with these assets can prevent outages if renewable resources quickly become unavailable.	Operating characteristics and scale must be closely coordinated with generation facilities

Applicable Energy Storage Technologies

Different types of energy storage technologies are suitable for the use cases described.

Type	Description	Applications	Unique Attributes	Maturity
Pumped Storage Hydro	Dual water reservoirs, separated by an elevation	Grid balancing, firming renewables, black start	High capacity, long duration	Fully mature
Lithium-Ion Batteries	Ions move through an electrolyte solution, between an anode and cathode.	Equipment- and facility-level backup power, microgrids, utility-scale application	Scalable deployment at equipment, facility, and grid levels	Fully mature
Flywheels	A large rotating mass spins with minimal friction, providing on-demand power.	Equipment- and facility-level backup power	Long lifetime, no degradation	Fully mature
Flow Batteries	Large-volume liquid electrolyte solutions are mechanically pumped across a specialized membrane	Grid balancing, firming renewables	Decoupled power rating and discharge time	Demonstrations and early deployments in progress
Gravity-Based Storage Systems	Large weights are lifted using excess energy. Weights are lowered to turn generators when power is needed.	Grid balancing, firming renewables	Long-duration energy storage	Demonstration phase

Deployment Considerations for Public Power

Public power utilities face a unique set of challenges when attempting to use energy storage systems to support grid resilience. These challenges range from financial constraints to workforce development needs and regulatory hurdles.

Cost

Deploying energy storage requires significant capital investments and activities, including engineering and financial analyses, permits, approvals, studies, reviews, construction, equipment purchases, installation, testing, and commissioning. For this reason, utilities have mainly deployed energy storage in applications that offer a clear return on investment, such as peak shaving. It may be difficult to economically justify using storage for resilience alone, therefore utilities have explored the concept of "value stacking," which involves managing multiple use cases using a single energy storage system. This can present operational challenges, as utilities would need to balance competing needs, such as dispatching storage to cover peak demand periods with ensuring sufficient storage reserve capacity to effectively respond to a resilience event. Achieving this balance requires robust analysis and modeling capabilities that include weather forecasting, integrated planning, and peak demand prediction. When analyzing the costs and benefits associated with a storage project, reliability metrics (like SAIDI, SAIFI, CAIDI, and CAIFI) should be considered, as lost revenue due to poor reliability could prove an economic justification for storage projects.

Scale and Scope

Public power utilities may serve smaller communities or operate within specific geographic areas that may limit the scale and scope of potential energy storage projects. This limitation can affect the economic feasibility and impact of storage solutions, as larger-scale projects often benefit from economies of scale. For instance, gravity-based storage and pumped-storage hydro systems may not be possible to site in every municipal district within the U.S., preventing a barrier to deploying cost-effective, long-duration energy storage.

Ownership and Financing Models

The choice between various business models or ownership structures for energy storage systems, such as owning, leasing, or financing through power purchase agreements, can be complex and daunting. Choosing the right approach involves evaluating financial implications in the context of a utility's budget constraints and funding availability. Ownership may offer control and potential long-term savings but requires significant upfront capital. Leasing can mitigate initial capital outlay but might result in higher overall costs. Power purchase agreements allow utilities to avoid direct investment while benefiting from energy storage, but involve complex negotiations and dependency on third-party providers. Furthermore, each option carries different regulatory, financial, and operational risks that must be carefully assessed to ensure they align with the utility's strategic goals and comply with local, state, and federal regulations, making the decision-making process intricate and critical.

Operational and Maintenance Expertise

Operating and maintaining diverse energy storage systems requires specific technical expertise. Public power utilities may not have staff with the necessary skills and experience, necessitating investments in training or hiring of new personnel. While costly, these personnel investments can produce long-term net savings through improvements to system resiliency and reliability.

Community Engagement and Support

Gaining community support for energy storage projects can be challenging, especially if there are concerns about environmental impact, land use, or aesthetics. Public power utilities must effectively engage with stakeholders, communicate the direct benefits of storage to communities, and incorporate feedback and learnings to promote successful implementation of energy storage projects.

Other Resources

Other American Public Power Association publications offer a focused examination of energy storage technologies from the perspective of public power providers.

- **Understanding Energy Storage** explores technology fundamentals, application areas, and the economics of storage.
- **Behind-the-Meter Energy Storage: What Utilities Should Know** outlines benefits and challenges for both utilities and customers.
- **The Public Power Energy Storage Tracker** summarizes public power energy storage projects.
- **The Public Power Energy Storage Guidebook** contains case studies from municipal utilities that have deployed energy storage projects.

APPA's **Energy Innovation** page provides quick access to these publications and more.