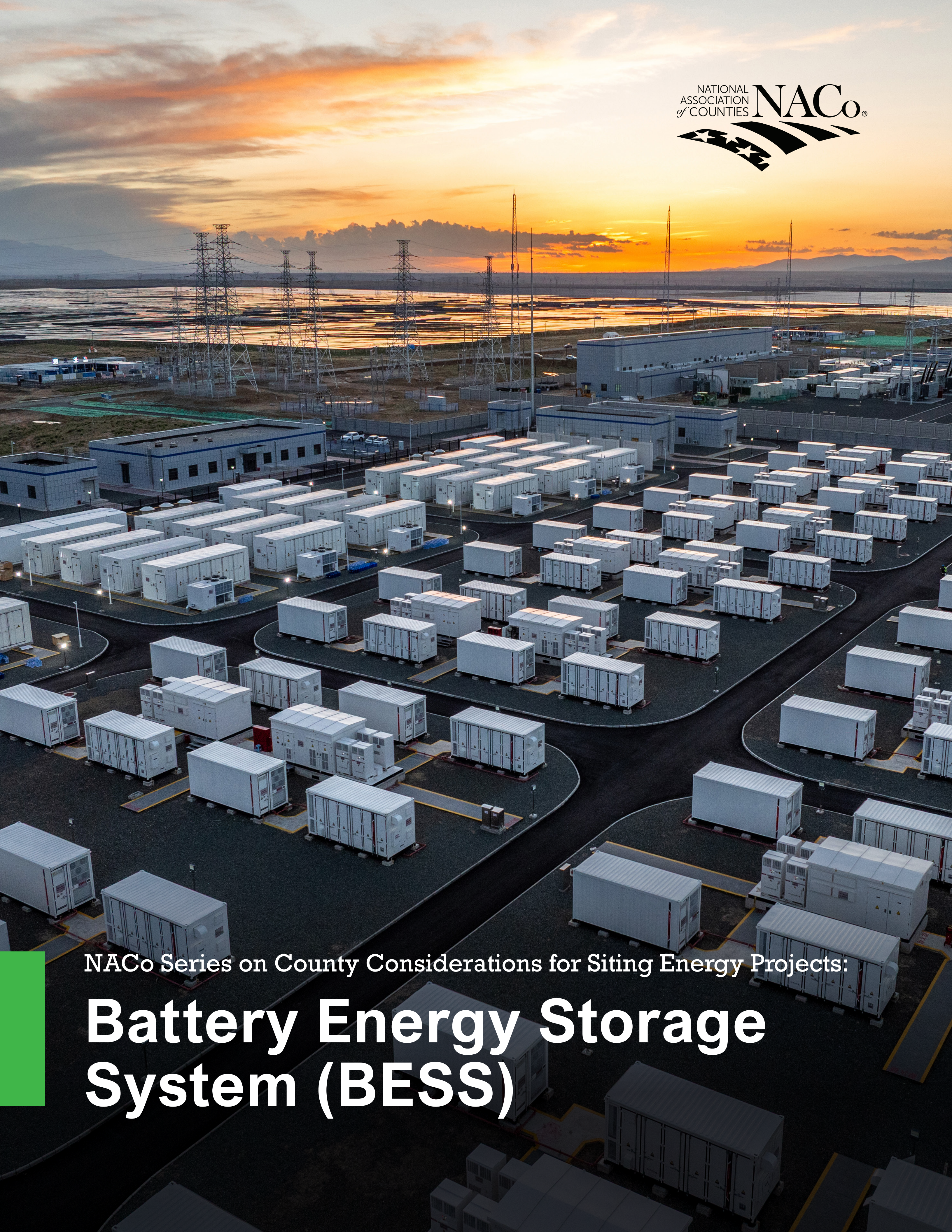


NACo Series on County Considerations for Siting Energy Projects:

Battery Energy Storage System (BESS)

Introduction

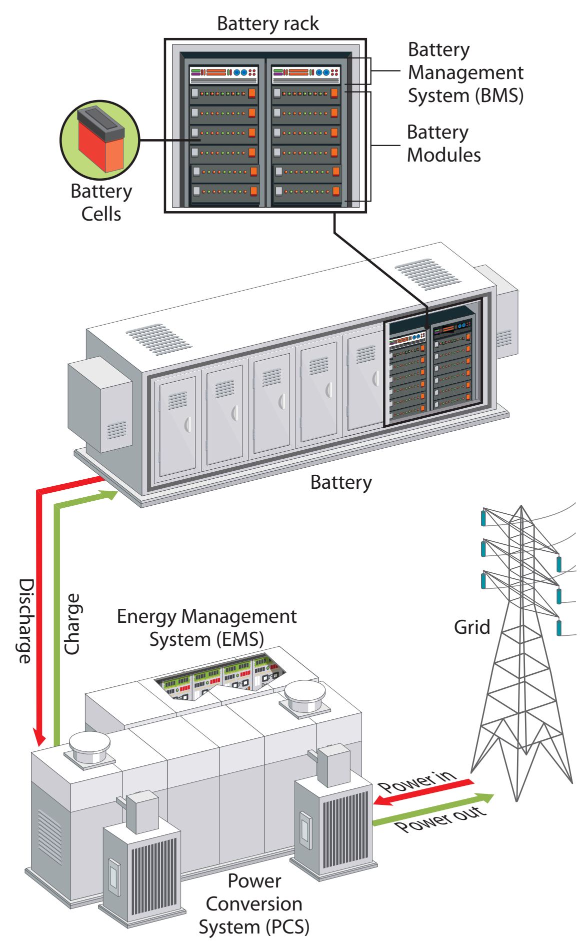
Battery Energy Storage System (BESS) is a technology that stores electrical energy from a power generator to be used when the energy is needed. Capable of being charged from either conventional or non-conventional energy sources, BESSs can balance energy generation and demand in real time. In the United States, cumulative utility-scale battery storage capacity exceeded 26 gigawatts (GW) in 2024 representing a 66 percent increase in capacity over the prior year.[1] This surge in investment has been fueled by technology advancements, cost reductions, incentives and increasing utility and developer familiarity with the technology. While energy storage comes in many forms, this technology brief focuses on the fastest growing technology with the most immediate relevance to county leaders. For more county insights on energy topics, visit NACo's Energizing Counties Resource Hub.

Battery Technology

The fundamental unit of a BESS is a rechargeable **battery cell**. Each cell has two electrodes and an electrolyte that allows charged particles to move between them. Applying voltage across the electrodes causes a chemical reaction that stores the energy (**charging**). The energy can later be released as electricity to power connected loads (**discharging**). This charge-discharge cycle can be repeated thousands of times throughout the cell's useful life. Multiple cells are connected to build systems of the desired power and energy ratings.

Battery cells charge and discharge using direct current (DC) and rely on two key systems to work with the electric grid (grid) that uses alternating current (AC) for energy distribution – a ***Power Conversion System (PCS)*** to convert DC to AC and an ***Energy Management System (EMS)*** to optimize battery use. ***Balance of System (BoS)*** components such as monitoring, thermal management and electrical systems, allow interconnection to the grid.

Energy performance – such as energy density, cycle life and duration – varies by material used to make the cells and can be tailored to different applications. **Lead-acid batteries** are improved versions of car batteries, while **lithium-ion batteries** offer higher energy density, longer life and lower lifetime costs, making them suitable from consumer devices to utility-scale projects. **Long-duration energy storage (LDES)** technologies, including **flow batteries** and emerging technologies like **high-temperature** and **solid-state batteries**, are typically designed to deliver energy for eight hours or more, often trading higher upfront costs or lower energy density for scalability, safety or longer cycle life.



BESS Components

BESS Project Types

BESS projects can be scaled from a few wall-mounted units powering a home to acres of containerized systems for utility scale projects.

	RESIDENTIAL	COMMERCIAL	UTILITY	RENEWABLE INTEGRATED
ELECTRIC GRID CONNECTION	Customer side of meter/off-grid	Customer side of meter	Transmission level	Co-located with solar and/or wind
COMMON CAPACITY	< 10s – kWh	<10s – 100 kWh	>100s kWh to 10s MWh	100s kWh to 10s MWh
TYPICAL SIZE	4' X 2.5' X .5' Wall or ground mounted	8' X 5' X 5' trailer to 20' container	Many 20 – 40' container(s)	Many 20 – 40' container(s)
MARKET VALUE	Backup power during power outage	Backup power, peak shaving, grid support	Energy sales, grid decongestion, dispatchable capacity, arbitrage	Dispatchable capacity, islanding, grid support
OWNERSHIP	Homeowner	Business, farmer / rancher, municipality	Utility or independent power producing company	Renewable energy developers
AVAILABLE TECHNOLOGY	Lead Acid/Lithium	Lithium	Lithium / Flow	Lithium / Flow

Residential and commercial projects can use lead-acid batteries, although lithium-ion batteries are now more common. Often designed as part of a hybrid system or microgrid charged by a small wind and/or solar PV system, these systems are designed for complete grid independent operation *(off-grid)* and/or with the grid to provide back-up power during a power outage in island mode. In commercial applications like data centers and other large loads, systems are also designed to reduce the power purchased from the grid during the busiest times (called *peak shaving*) to avoid high demand charges.

Utility scale storage projects range from one to many 20-to-40-foot containerized systems. They can provide grid congestion relief by storing energy when demand or cost is low and discharging it during periods of higher demand or cost *(arbitrage)*. In rural grids with capacity constraints, these systems can also help defer infrastructure upgrade projects.

Renewable integrated BESSs play a vital role in smoothing out the intermittent nature of solar and wind power. BESSs store excess energy during high production periods and deliver it when generation drops, ensuring a more consistent power supply. When paired with appropriate controls, they can form a microgrid to power communities during a power outage *(islanding)*. This can improve the value of renewable energy projects and strengthen the grid.

Authority

Utility scale projects that interconnect at transmission voltages fall under the purview of the Federal Energy Regulatory Commission (FERC) and independent system operators (ISOs). Interconnections to the distribution system are handled by the electric services provider and regulated by the state and/or Public Utilities Commission (PUC). Close coordination can ensure county interests are preserved.

Siting BESS Projects

Utility scale BESS developers prospect for project locations across the country and select sites to maximize project returns. These developers consider factors that include:

Land – Smaller, distribution scale projects are often sited on or adjacent to distribution substations and require as little as 4,000 sq. feet. Larger BESS projects may require 0.5 to 1.5 acres for 1 MW of capacity depending on technology used. Developers prioritize clear flat land with few landowners, in proximity to existing electric grid infrastructure. They typically prefer existing zoning ordinances but will pursue conditional use permits if necessary.

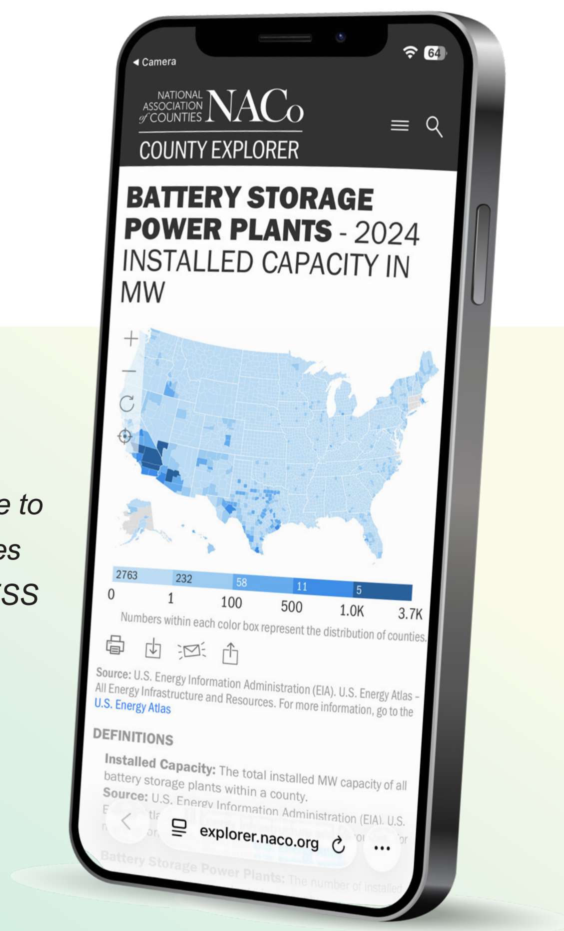
Interconnection – BESS projects are connected to either distribution or transmission grids based on grid capacity and/or needs as identified by the electric service provider. BESS can be collocated with wind or solar projects to simplify grid interconnection.

Incentives – Developers target local, state or federal incentives and tax credits to meet investment hurdles. Some utilities incentivize BESSs to reduce development and ownership risks for third parties or cooperatives. The value of energy and demand needs vary with location and utility and are often an influencing factor in site selection.

Community acceptance – Developers often seek to site projects in jurisdictions where residents are accepting of BESS development on private or public land and may engage residents prior to input from local leaders. County leaders, elected to speak and act on behalf of their constituents, are well-suited to coordinate outreach and facilitate the discussion needed to assess and potentially foster community acceptance.

As these factors can influence developers' desire to site in one location over another, counties may wish to assess each of them independently to make siting more attractive to developers. However, the current nationwide surge in energy demand may make even non-ideal land, interconnection and incentive structures economically viable to developers, opening up more opportunities for counties that may have discounted their resources.

Scan the QR code to see which counties have the most BESS installed capacity



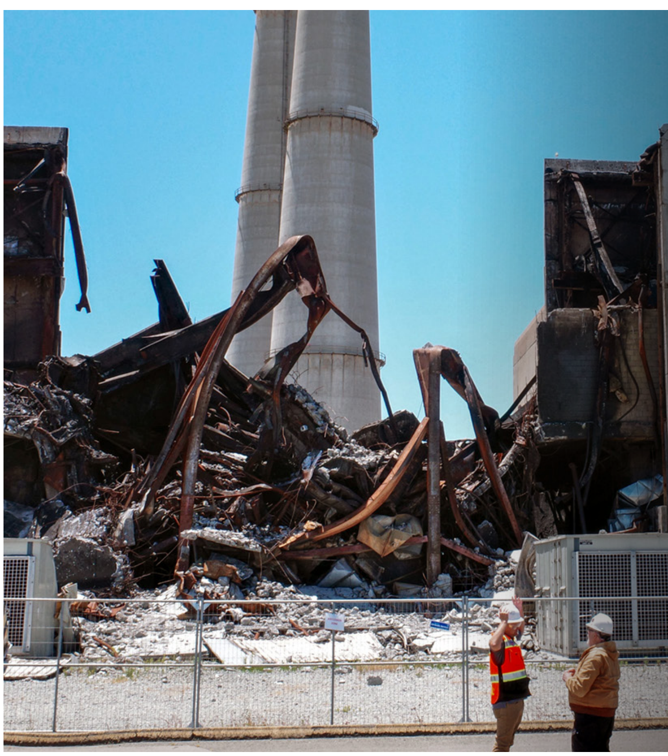
BESS Safety

A small number of BESS-related fires and explosions have occurred in recent years due to thermal runaway. Thermal runaway is a phenomenon in BESS that occurs when heat generation exceeds heat dissipation, leading to catastrophic failures such as fires or explosions. The risk of this phenomenon is higher in BESS using older lithium chemistries such as nickel manganese cobalt (NMC). Newer chemistries like lithium iron phosphate (LFP) have significantly more thermal stability. Modern battery management and monitoring systems track temperature, voltage and other indicators to detect abnormal cell behavior and provide early warning signs before unsafe conditions develop. Containerized BESSs include fire-resistant separators and engineered venting systems – such as blow-out panels – to safely relieve pressure in case of internal explosions or rapid gas release. Finally, cooling systems help keep batteries within safe operating temperatures and some designs include active fire suppression within the unit to minimize risk.

As BESS technology and safety standards have improved, the rate of failure incidents – including fires – at utility scale projects has dropped by about 98 percent from 2018 - 2024, relative to deployed capacity.[2] Requiring a detailed site-specific safety plan can help counties be better prepared to support projects and address community concerns.

Scan the QR code to access the Battery Energy Storage: Blueprint for Safety from American Clean Power

> *"There are no perfect energy solutions - every option has risks. Working together, with rigorous oversight and commitment to continuous safety improvements, we can ensure that renewable energy solutions are effective and safe as we transition to a sustainable future."*
>
> ***Supervisor Wendy Root Askew**, Monterey County, Calif*



The Moss Landing Battery Energy Storage System is a large scale facility located at the retired Moss Landing Power Plant site in Monterey County, Calif. With 750 MW / 3,000 MWh installed across three phases, it was once the world's largest battery energy storage facility. In January 2025, a fire occurred within a Phase 1 battery building. The incident resulted in localized damage and prompted precautionary emergency response measures, including evacuations and temporary road closures. There were no injuries, and the event did not propagate to other battery systems or phases on site. The incident has informed updates to industry best practices and state level safety requirements.

Scan the QR code to review the Western Electricity Coordinating Council's report detailing the incident and lessons learned.

Source: *U.S. Environmental Protection agency; www.epa.gov*

County Considerations for Siting BESS Projects

Like any infrastructure project, large BESS projects create a variety of positive and negative impacts on surrounding communities. A comprehensive ordinance can ensure project benefits are shared equitably and negative impacts are minimized. This task can be challenging for counties without zoning authority, but county leaders can still promote a healthy relationship between the developer and residents through active collaboration with state and federal regulators. Key issues for county officials in collaborating with developers and drafting BESS development ordinances include:

Economic Impact – Behind-the-meter and off-grid projects benefit local consumers by providing grid independence, resilience and cost control, especially in markets wherein utilities employ time-of-use energy pricing. For front-of-the-meter projects, landowners receive land lease payments (which are often higher than farming revenues in rural areas) and project owners receive capacity and potential tax credits. Large BESS projects provide an income source for counties through negotiated host community agreements or payments in lieu of taxes. County leadership can support residents by ensuring the appropriate benefit-sharing mechanisms are chosen.

Land Use – Large scale BESS projects alter land use. While the actual project footprint can be small, local setback requirements may increase the impacted land. The impact can be minimized by co-locating with existing grid infrastructure or other energy projects and with careful planning.

Visual Impact – Large scale BESS projects resemble container yards and blend in with surroundings in commercial areas. County leaders can address visual impacts in rural landscapes by promoting public input, identifying optimal development zones and by requiring visual barriers to minimize the impact on neighboring property owners.

Workforce Development – In the short term, on-site construction labor provides opportunities for local tradespeople. The modular nature of BESS projects equates to fewer on-site jobs compared to solar or wind projects. Most on-site work is civil or low voltage electrical work, roles that can usually be filled by existing local workforce.

End of Project Life – Battery power projects are designed to operate for at least 20 years or more with potential multi-year extensions through cell replacement or augmentation. Depending on project scale, requiring a decommissioning bond or other financial instrument is built into the project budget can ensure the land is returned to its original condition at the end of the project.

Public Perspective – Active community engagement with accurate information can help address misinformation and ensure equitable community growth.

Local Infrastructure – BESS project components do not typically need unique transportation accommodations or permits. Still, county leaders can require a detailed transportation study to minimize impacts on the community for larger projects during the construction phase and negotiate with project developers to ensure that any necessary road upgrades or repairs are made by the developer.

Wildlife Impact – Larger BESS projects can affect the local ecosystem both during and after construction. In addition to compliance with federal environmental regulations, coordination with local and state wildlife agencies and programs is essential to address impacts to native species and develop appropriate mitigation measures.

Frequently Asked Questions

How long do batteries last, and can they be recycled after use?

Lithium and other modern batteries are typically designed for 15-20 years of operation, often with periodic augmentation or cell replacement to maintain performance. This is significantly longer than traditional batteries which last 5-10 years. After initial use, some BESS can be repurposed for less demanding application like back up power, and once fully depleted, they can be recycled. Modern recycling processes can recover 80-90 percent of valuable materials depending on the technology used.

How much power does a BESS provide and for how long?

A battery system's operating time depends on the size of the load it serves, which is why BESS are rated by both power (MW) and duration (hours), together defining total energy capacity (MWh). For example, a 60 MW, four-hour BESS has a total energy capacity of 240 MWh. It can deliver 60 MW for four hours, 30 MW over eight hours or longer at lower power levels. Most commercial systems are sized to supply energy for 4-6 hours to meet typical needs without oversizing the system.

What are some other types of energy storage?

Other energy storage systems include:

- Mechanical systems: pumped hydro, flywheels and compressed air energy storage that store in the form of potential or kinetic energy
- Thermal systems: direct sunlight or electricity converted to heat is stored in a material and then released, either to heat a building or to re-generate electricity
- Chemical systems: electrical energy is stored within the bonds of a fuel like hydrogen, methane or ammonia and released as electricity through a fuel cell or as heat when burned

The U.S. Department of Energy (DOE) Energy Storage Handbook[3] is a good resource to learn about various current and emerging storage technologies.

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For official NACo positions, please refer to the American County Platform

[1] U.S. Energy Information Administration, Preliminary Monthly Electric Generator Inventory, January 2025. https://www.eia.gov/todayinenergy/detail.php?id=64705

[2] EPRI BESS Failure Incident Database. Accessed 03/06/2026.

[3] U.S. DOE Energy Storage Handbook – DOE Office of Electricity Energy Storage Program

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May 2026

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