

White paper

How BESS is Powering the Future of Microgrids and Energy Independence



Executive summary

In a world increasingly impacted by more frequent natural disasters, escalating cybersecurity threats, and rising energy demand, resilience is no longer optional—it's essential. Blackouts can occur when the load demand is greater than the power supplied. For instance, Spain and Portugal recently experienced the [largest blackout](#) in European history, losing [15 GW](#) in five seconds—60% of Spain's national demand—and leaving [55 million](#) without power.

Battery energy storage system (BESS)-supported microgrids offer a powerful solution for utilities and organizations to protect against catastrophic events like these.

By providing greater visibility and control over distributed energy resources (DERs), BESS microgrids efficiently manage peak loads, optimize energy usage, and strengthen local grid resilience to meet growing demands.

For mission-critical facilities—such as hospitals, airports, schools, and data centers—uninterrupted power is non-negotiable. Traditional diesel generators, which are obligated to start weekly and generate greenhouse gases solely for compliance testing purposes, may not be the most efficient solution for long-duration, multi-day outages. Diesel gensets also take precious minutes to activate—a delay that can cause significant financial losses.

In addition to emergency power, BESS provide vital ancillary services like load shifting, voltage control, frequency regulation, and black start capability—all while reducing reliance on fossil fuels and driving down energy costs to transition to a modular, more sustainable energy future.

This white paper will explore how BESS-powered microgrids offer a more resilient and cost-effective alternative to diesel generators, with enhanced flexibility and functionality that goes beyond backup power.



Introduction

According to a recent [report](#) from Guidehouse Insights, U.S. consumers across all sectors are increasingly exploring microgrids as a response to rising electricity costs, frequent grid outages caused by extreme weather, and ambitious decarbonization targets.

While early adopters of microgrids were primarily healthcare facilities, data centers, military bases, and other facilities where power reliability is critical, their use-case has expanded to a wide array of applications including college campuses, smart cities, and commercial real estate.

Traditionally, backup power relied almost entirely on emergency diesel generators (EDGs). However, with the steep decline in photovoltaic (PV) and BESS costs, these technologies are now being considered as alternatives or supplements to conventional EDG-based systems. When coupled with other sources—such as solar, wind, and diesel gensets—energy storage maximizes microgrids' flexibility and efficiency.

A few years ago, advanced microgrids that performed multiple services in addition to supplying backup power was a trend. Now value-stacking is a necessity to remain competitive. As a result, BESS-powered microgrids have emerged as the go-to solution for organizations looking to generate their own power, improve resilience, and benefit from additional revenue streams that accelerate ROI.

Demystifying microgrids: Beyond rural communities

Microgrids have traditionally been seen as lifelines for remote or isolated areas, delivering resilient power during emergencies and outages. However, today's microgrids are far more versatile—and just as valuable in urban and industrial settings.

What is a microgrid?

A [microgrid](#) is a self-contained network of DERs, energy storage systems, and loads that can generate and manage its own electricity. Microgrids typically operate in grid-connected mode, running parallel to the main grid, strengthening grid stability and power quality. When disruptions occur, most microgrids can also seamlessly switch to islanded mode, disconnecting from the grid to maintain uninterrupted power for critical operations.

It's important to distinguish a true microgrid from simpler energy systems. Rooftop solar panels alone cannot maintain power during an outage without additional infrastructure. Likewise, backup generators activate only during emergencies, while microgrids operate 24/7/365, continuously managing loads and supporting grid stability.

Microgrid applications

Microgrids are especially valuable for remote communities that rely on diesel generators for power, which are costly to operate and harmful to the environment. By integrating Battery Energy Storage Systems (BESS) into a microgrid, these communities can significantly reduce their dependence on imported fuels, lowering both energy costs and CO2 emissions while improving resilience.

However, microgrid applications are not limited to off-grid or rural applications. They are increasingly being deployed in places with strong grid connections to protect critical facilities such as university campuses, hospitals, airports, industrial complexes, and energy-intensive data centers. By ensuring continuous, flicker-free power to essential loads, microgrids safeguard operations during grid failures.

Advantages of a BESS-powered microgrid

Modern microgrids incorporate a variety of DERs, including solar PV, combined heat and power (CHP) systems, thermal storage, wind power, fuel cells, and, notably, BESS. Microgrids equipped with BESS deliver faster, more efficient energy management, reducing reliance on traditional diesel generators that lack responsiveness and require manual operation. This advanced capability establishes BESS as a critical component of modern energy strategies, providing utilities and IPPs with a robust solution to handle the complexities of a dynamic and low-carbon energy future.



Lac-Mégantic Microgrid

Beyond backup, microgrids combined with BESS provide additional grid services—helping customers optimize their energy use, lower electricity costs through load shifting, and contribute ancillary services to the grid like frequency and voltage support.

Common challenges with microgrids

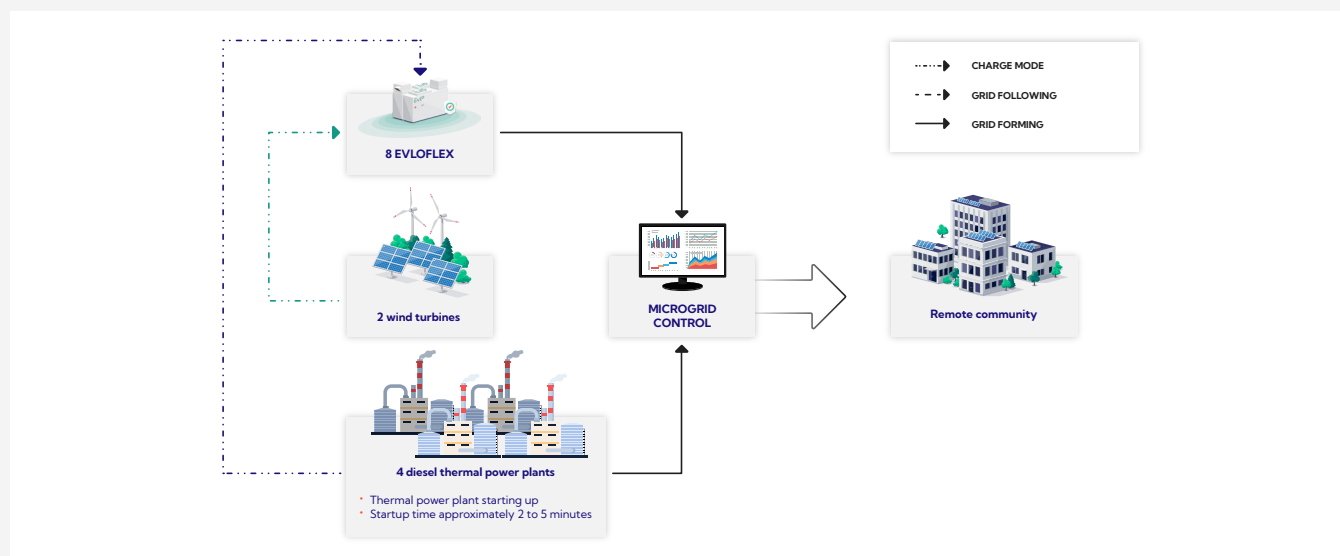
Microgrids deliver strong resilience benefits, but they also come with technical and operational complexities. Integrating diverse DERs, managing system stability, and coordinating protection and control systems demand sophisticated design and oversight.

Traditional diesel generators—commonly used for backup—take minutes to start, often requiring a manual reset for IT systems, increasing downtime and operational risk. These diesel gensets are typically underused, running for only a few hours every couple of years, making them an inefficient use of capital as a stranded asset while also not being designed to withstand extended outages.

In contrast, BESS-powered microgrids offer instant, always-on support, reducing operational complexity and minimizing downtime compared to traditional generators.

How BESS powers next-gen microgrid performance

BESS is transforming microgrid design by maximizing clean energy production, providing flexible electricity dispatch, and lowering energy costs. In grid-following mode, BESS synchronizes with the main grid, adjusting output to support voltage and frequency—critical for integrating renewables and maintaining stability during fluctuations. In grid-forming mode, BESS sets and regulates voltage and frequency, providing a stable supply of power independent of the grid during outages or in off-grid applications. This enables reliable, resilient power systems capable of adapting to both everyday needs and unexpected disruptions.



The image above shows how a BESS can be integrated into a microgrid to support a remote community. Excess energy from the wind turbines and diesel power plants is stored by the BESS, providing instant and continuous power to the rural community.

Fast-acting, flicker-free power

Unlike traditional diesel generators, which require several minutes to start, BESS microgrids offer continuous, flicker-free power, maintaining operations while backup generators or alternative power sources come online. This uninterrupted power flow is crucial for avoiding financial losses and operational disruptions in sensitive environments. Integrated with SCADA and EMS systems, BESS operates with full 24/7 monitoring and offers seamless functionality, even during grid transitions.

Maximizing efficiency and sustainability with hybrid solutions

When connected to various DERs, BESS-powered microgrids create a hybrid solution that allows users to access multiple power sources. This flexibility optimizes renewable energy use, reduces reliance on fossil fuels, and improves operational efficiency, providing a more dynamic and cost-effective alternative to diesel generators.

Full functionality and multi-service capabilities

By integrating BESS with microgrids, developers can take advantage of load shifting, synthetic inertia support, and other market opportunities to reduce costs. BESS also maximizes self-consumption of renewable energy and contributes to decarbonization efforts.

Intelligent, transparent energy management

By utilizing one or more BESS, businesses can manage their energy assets in an intelligent, transparent manner that idle diesel generators simply can't match. This advanced microgrid enables businesses to not only maintain continuous power but also optimize consumption for efficient energy use management.



Value-stacking: Maximizing grid services beyond backup power

BESS-powered microgrids boost ROI through “[value-stacking](#)”—delivering multiple grid services simultaneously to maximize asset utilization, reduce costs, and create new revenue streams. Value stacking reduces the microgrid’s cost by utilizing renewable generation, generation shifting, frequency and voltage regulation, or other market opportunities during nonemergency periods—and, as a result, are less expensive to operate than diesel gensets.

Some grid services, like black start or spinning reserves, are used infrequently—limiting overall battery utilization when designed for a single function. By stacking multiple services, BESS microgrids can maximize performance and value. For instance, stored energy can meet peak demand during high-load periods, deferring costly transmission upgrades. During off-peak hours, the same BESS can generate revenue by providing operating reserves, all while remaining on standby for seamless 24/7 backup.

Grid services by BESS-powered microgrid

- **Frequency droop regulation:** Automatically balances supply and demand in milliseconds, preventing blackouts during sudden demand spikes.
- **Voltage and active/reactive power control:** Adjusts active and reactive power near-instantaneously to maintain grid stability, protecting vital equipment and ensuring high-quality power.
- **Black start capability:** Restores power during a complete outage without grid power, avoiding the reliance on diesel-powered black-start generators.
- **Regulation and spinning reserves:** Provides fast-response backup power—minimizing generator cycling, improving fuel efficiency, and stabilizing the grid during sudden fluctuations in demand or renewable output.
- **Generation shifting:** Captures excess energy when generation is high and demand is low, then discharges stored energy when demand increases—helping balance load and optimize energy use.
- **Network investment deferral:** Meets growing electricity demand by shifting load during peak hours to defer costly grid upgrades for years or even decades.
- **Islanded operation capability:** Seamlessly transitions from grid-following (i.e., responding to the grid) to grid-forming (i.e., regulating voltage and frequency independent of the grid) modes during outages or in remote microgrids.
- **Maximized renewable usage:** Stores excess solar or wind generation to minimize curtailment, reduce reliance on diesel gensets, and support decarbonization targets.
- **Synthetic inertia support:** Provides synthetic inertia through fast-response inverter technology.

Case study: North America's first fully automated BESS for transmission-level backup power

In 2021, EVLO deployed a [4-MW / 20-MWh BESS in Parent, Québec](#)—a remote community dependent on a single transmission line for electricity. The goal: complete critical grid upgrades without disrupting power to residents and businesses.



As the largest energy storage system in Québec, the Parent BESS provided seamless backup during the transmission line work. Today, the microgrid continues to bolster grid resilience, serving as a primary electricity source during outages and helping offset peak demand. By reducing reliance on diesel generators, the system also cuts greenhouse gas emissions and noise pollution.

The Parent BESS microgrid can switch from grid following to island mode without manual intervention—making it the first fully automated, utility-scale battery system for transmission-level backup power in North America.

During outages, the BESS not only maintains uninterrupted supply but can also detect, withstand, and provide feedback on faults—a unique capability rarely seen in transmission-connected systems.

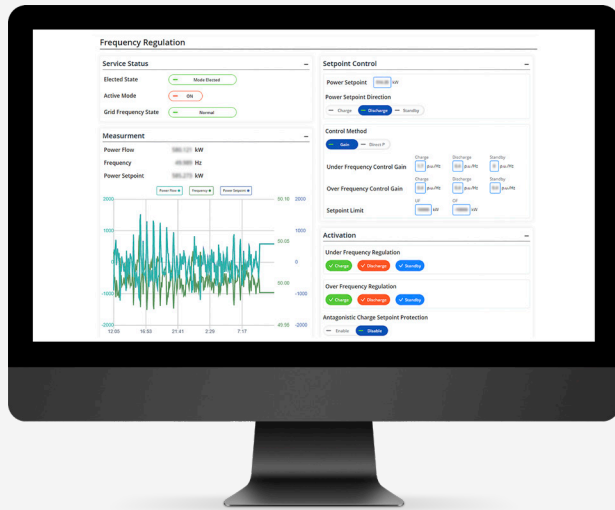
This innovative project required meeting the stricter regulations and standards of transmission systems, which was validated through rigorous real-world testing at EVLO's [state-of-the-art test line](#).

Recognized for its ingenuity and impact, the Parent BESS microgrid earned the [2023 Landmark Application of Energy Storage Award](#) from Energy Storage Canada and the [2024 Environment+Energy \(E+E\) Leader Top Project of the Year Award](#) for setting a new standard in the energy industry.

The future of microgrids

By [2035](#), microgrids are projected to become integral 'building blocks' of the electric grid, driving resilience, sustainability, and affordable energy. These modular systems help the grid recover faster from disasters, faults, and manmade attacks, while accelerating the shift toward a more distributed and flexible energy architecture. As DERs are expected to supply [30–50%](#) of total generation capacity, BESS microgrids will play a critical role in their integration and aggregation, ensuring secure and equitable access to clean energy.

Advanced controls and cybersecurity



Future microgrids will rely on sophisticated control systems and embedded [cybersecurity](#) protections to maintain optimal performance and reliability. EVLO's security-by-design approach, built into the proprietary [EVLOGIX](#) energy management system (EMS), ensures encrypted communications and multi-layered SCADA-level cybersecurity to defend against costly and disruptive cyber threats.

For more information, download our white paper [Why Cybersecurity in Energy Storage is More Crucial Than Ever](#) to learn about how EVLO ensures BESS security at every level.

Innovative business models

Battery systems can provide certain grid services—such as frequency regulation—much faster and more precisely than conventional power plants. Markets are beginning to reflect this advantage by aligning compensation schemes with service quality, ensuring BESS-powered microgrids are fairly rewarded for more rapid and accurate performance—making BESS microgrids more competitive with traditional grid investments and further accelerating their adoption.

Microgrids in cities

While once associated mainly with remote or rural areas, microgrids are now increasingly being deployed in urban settings to improve energy resilience and sustainability across commercial, municipal, and residential sectors. As cities face increasing energy demands and climate challenges, microgrids are emerging as critical infrastructure—delivering local, efficient, and reliable power that supports the transition to more sustainable urban energy systems.

Conclusion

BESS-powered microgrids are becoming the leading solution for building resilient, sustainable, and cost-effective energy systems. Their true value lies not in a single feature, but in their ability to deliver multiple benefits—from keeping mission-critical operations running during outages to enabling cost-saving strategies like synthetic inertia support and generation shifting. By intelligently managing energy use, storage, and generation, BESS microgrids help optimize operational costs, maximize renewable energy integration, and enhance reliability by providing energy independence. Whether deployed in urban centers or remote communities, EVLO's BESS microgrids, backed by Hydro-Québec's utility expertise, offer unmatched flexibility, performance, and security for a sustainable and resilient energy future.

Ready to upgrade from outdated backup?

EVLO's BESS microgrids aren't just a backup—they're a smarter, cleaner, and more cost-effective way to power your facility 24/7. [Contact us](#) today to find the right solution for your site and future-proof your power supply with an intelligent, always-on BESS microgrid.



About EVLO

EVLO Energy Storage Inc. (EVLO) is a fully integrated battery energy storage systems and solutions provider and subsidiary of Hydro-Québec, North America's largest producer of renewable energy. EVLO's utility-scale battery energy storage systems and controls software deliver superior safety and reliability backed by decades of R&D. Our advanced modelling and testing and comprehensive approach to BESS integration streamline project development to accelerate the transition to a cleaner, more reliable grid.

To learn more: evloenergy.com/en/

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