NARUC
National Association of Regulatory Utility Commissioners

Technology Brief: Microgrids as Resilience Investments

Part 1 – Introduction

Regulators, utilities, and communities are under increasing pressure to ensure continuous access to electricity, particularly for critical infrastructure. Grid hardening strategies such as undergrounding and hardening are important but often expensive or difficult to implement. In certain scenarios, microgrids may offer a more flexible resilience solution instead. Microgrids can operate independently from the main grid, sustain essential services during outages, and help reduce strain on transmission and distribution infrastructure. This technology brief explores the role of microgrids as targeted resilience investments, clarifies how they differ from traditional backup power systems, and illustrates their real-world impact through both rural and urban case studies.

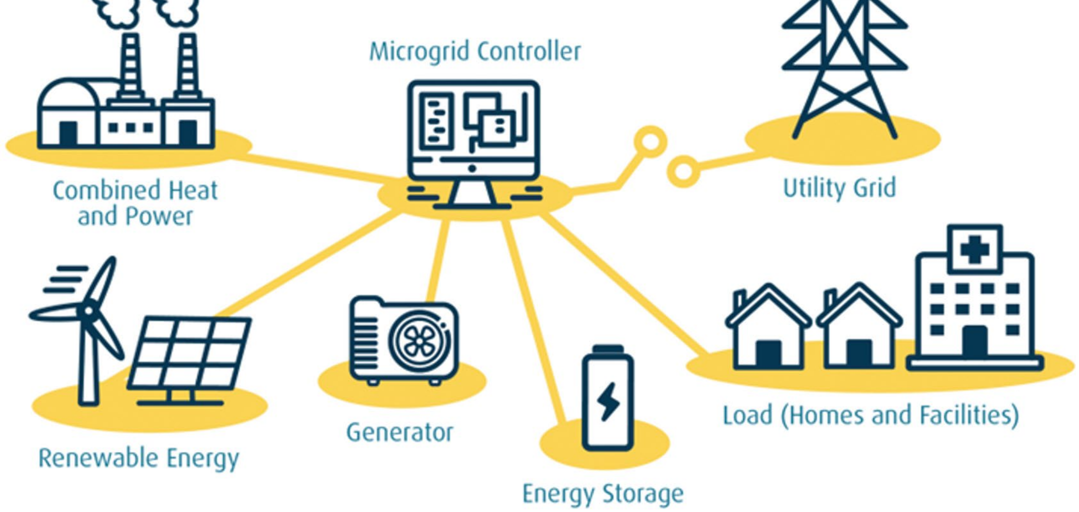
Part 2 – What is a Microgrid?

The Department of Energy's (DOE) Microgrid Exchange Group developed a broadly accepted definition of a microgrid in 2012[1]:

[A microgrid is] a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

A microgrid generally operates while connected to the distribution grid, but when the electric grid fails or is resource-constrained due to a natural disaster or system conditions, the microgrid can operate on its own to provide power for the facility(ies) connected to it. Microgrids also have the added flexibility of being able to operate with a variety of generation sources, not limited to combined heat and power systems (CHP), or distributed energy resources (DERs), such as solar and energy storage, and other generation sources suited for the task. A visual aid of this concert of technology is available in **Figure 1**.

Figure 1: Example Microgrid



While DOE's definition is useful, it does not include discussion of how many customers or facilities might be connected to a microgrid, an important consideration during an initial evaluation of a proposed system. The New Jersey Board of Utilities (NJ BPU) has developed a classification system for microgrids according to the number of customers and other factors (**Figure 2** and **Figure 3**)[2]. The classification system is as follows:

- **Level 1 or single customer microgrid:** This is a single DER system such as a photovoltaic solar (PV) system, CHP, or fuel cell (FC) system that is serving one customer through a single meter. This microgrid class is connected to and can island from the distribution grid.
- **Level 2 or single customer/campus setting:** Also referred to as the partial feeder microgrid, this classification includes either single or multiple DER systems connecting multiple buildings but controlled by one meter at the point of common coupling. This microgrid class is connected to and can island from the distribution grid.
- **Level 3 or multiple customers/advanced microgrid:** Also referred to as the full feeder microgrid, this system consists of one or more DERs that serve several different buildings orcustomers that are not on the same meter or on the same site as the DER. An advanced microgrid has one point of common coupling (PCC). The individual buildings or customers may be independently connected to the larger distribution grid and through the microgrid PCC.

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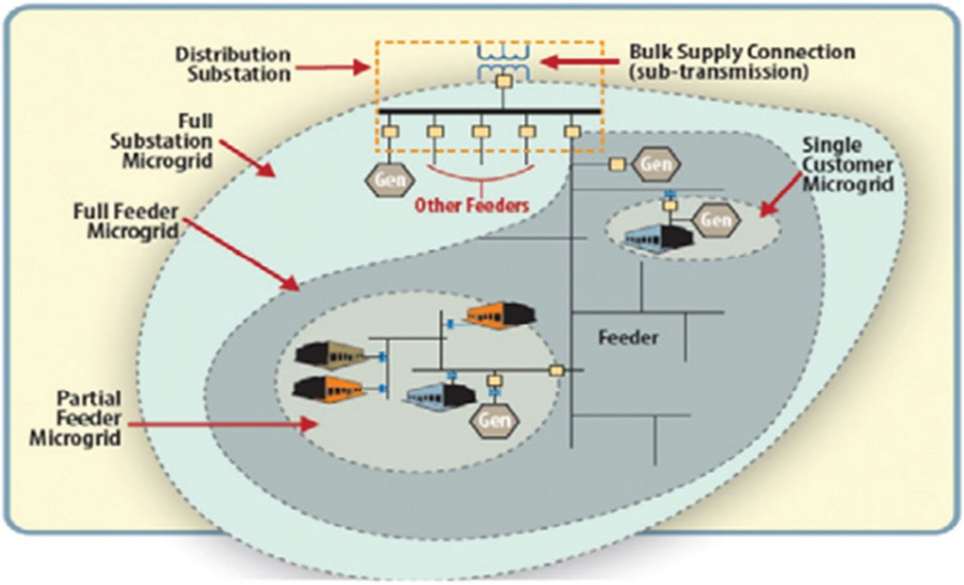
1 Dan Ton and Merrill Smith. October 2012. The U.S. Department of Energy's Microgrid Initiative. The Electricity Journal, 25(8), 84-94. doi:10.1016/j.tej.2012.09.013 (energy.gov)

2 NJBPU. (n.d.). Microgrid. Board of Public Utilities. https://www.nj.gov/bpu/about/divisions/opp/microgrid.html

Figure 2: NJ BPU Microgrid Classification

Microgrid Type	DERs	Facilities	Meters	PCC
Level 1	1	1	1	1
Level 2	1+	1+	1	1
Level 3	1+	2+	2+	1

Figure 3: Types of Microgrids



Part 3 – Microgrids as a Resilience Investment

Resilience is defined by the Federal Energy Regulatory Commission (FERC) as "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."[3] Microgrids can be a resilience investment because they enable critical facilities and communities to have continued access to electricity when the main grid goes down. If a wildfire, storm, or cyberattack compromises the wider electric system, a microgrid can disconnect to keep powering essential services like hospitals[4], water facilities[5], or emergency shelters[6]. This helps limit the impact of outages, maintain public safety, and accelerate recovery, thus bolstering resilience.

Resilience assessments include not only the analysis of potential disruptive events, but also post-event analysis (e.g., recovery). A frequently cited visualization of this objective is the 'resilience trapezoid' (**Figure 4**)[7] that highlights the return to normal operations after a disturbance in a baseline system compared to a more resilient system.

Because microgrids reduce reliance on distant transmission infrastructure, they can be a practical way to strengthen grid resilience at the local level by ensuring service while reducing reliance on distant transmission infrastructure.

3 Order 162 ¶ 61,012 – FERC, 2018: https://cms.ferc.gov/sites/default/files/2020-05/20180108161614-RM18-1-000_3.pdf

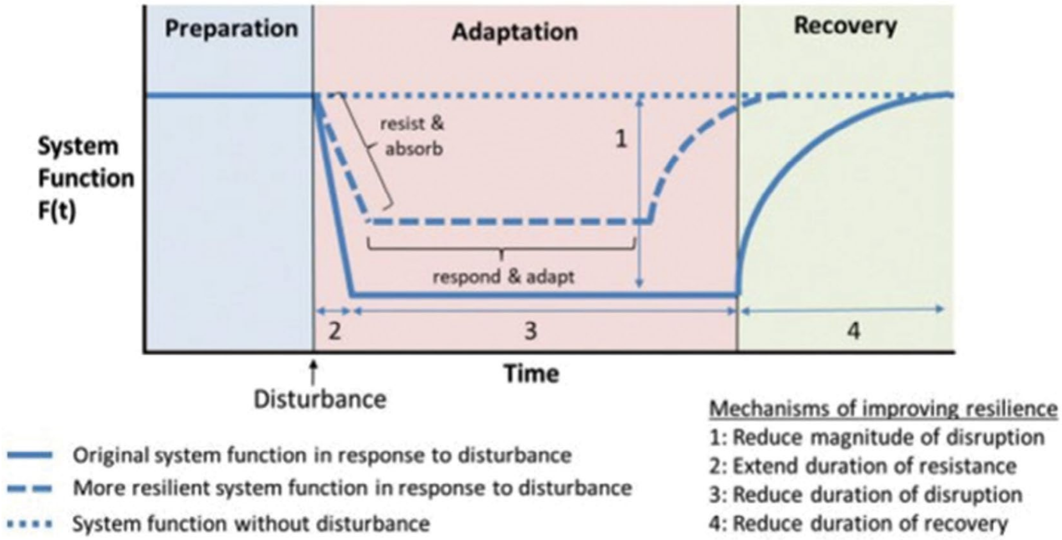
4 Cohn, L. (2023, April 21). New ruling allowing microgrids for health care facilities is "Seismic shift." Microgrid Knowledge. https://www.microgridknowledge.com/healthcare-hospitals/article/33003827/healthcare-microgrids-new-federal-ruling-marks-seismic-shift

5 Microgrid Knowledge. (2022, November 15). Why microgrids for water and Wastewater Facilities. Microgrid Knowledge. https://www.microgridknowledge.com/commercial-microgrids/article/21437936/microgrids-for-water-and-wastewater-facilities

6 GovTech. (2022, July 26). Frostburg state to build microgrid for emergency shelter. GovTech. https://www.govtech.com/education/higher-ed/frostburg-state-to-build-microgrid-for-emergency-shelter

7 McCurry, W., & Nethercutt, E. (2023, February). Energy Resilience Reference Guide Chapter Two: Developing a Shared Framework to Value Resilience Investments. NARUC. https://pubs.naruc.org/pub/458600D2-913F-CBF6-B8F3-BBF1A796F00E

Figure 4: Resilience Trapezoid



Microgrids can improve reliability for customers at the grid edge who experience frequent outages[8] and help maintain essential services in isolated communities during emergencies. Depending on the costs of enhancing or expanding transmission or distribution infrastructure, particularly for remote communities or areas that experience frequent severe weather events, microgrids can be an attractive resilience investment.

When microgrids power public buildings—such as schools or community centers—they can serve as resilience hubs[9], offering shelter, power, and communication access during extended outages. Such public benefits may further justify the investment in appropriate settings. Microgrids are an alternative to traditional backup generators, which can fail during acute weather events involving hurricanes and flooding. For example, CrescentCare[10], a community health center in New Orleans, Louisiana serving over 13,000 patients annually, uses a solar PV generation system with a battery to create a microgrid (referred to as a solar + battery microgrid) that maintains resilient power and protects operations during natural disasters or other weather events. Kickstarted from a partnership with the Together New Orleans Community Lighthouse Project[11], CrescentCare invested in a 128-kilowatt solar array paired with a 220-kilowatt-hour lithium-ion battery storage system and a 500-kilowatt natural gas generator for their St. Roch location. During low solar generation periods, such as cloudy days or nighttime, a natural gas generator charges the batteries. With battery storage providing 9 hours of backup power, the combined system with their generator averages 10 days of backup power, supporting the entire facility including their vaccine storage, pharmacy, IT infrastructure, and patient care areas.

The project established CrescentCare as an early success in Louisiana's Community Lighthouse Project, a coalition which seeks to establish "lighthouses" - places of refuge for nearby residents to access necessities during disasters. Following Hurricane Ida[12], many of Louisiana's backup diesel generators broke down or ran out of fuel, revealing a weakness in local energy resilience during emergency events. This resilient power application elevates the potential of a community center into a resilience cornerstone.

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8 Wood, E. (2022, December 19). Microgrid benefits: Eight ways a microgrid will improve your operation ... and the world . Microgrid Knowledge. https://www.microgridknowledge.com/about-microgrids/article/11430613/microgrid-benefits-eight-ways-a-microgrid-will-improve-your-operation-and-the-world

9 Resilience hubs support communities across the U.S.: Homeland security. U.S. Department of Homeland Security. (2024, June 20). https://www.dhs.gov/archive/news/2024/06/20/resilience-hubs-support-communities-across-us

10 Walker, A. (2025, February 27). Crescentcare Community Health Center will become the Gulf Coast's first solar and battery-powered Resilience Hub. NACHC. https://www.nachc.org/crescentcare-community-health-center-will-become-the-gulf-coasts-first-solar-and-battery-powered-resilience-hub/

11 Community Lighthouse. Together New Orleans. https://www.togethernola.org/community-lighthouse

12 Beven II, J. L., Hagen, A., & Berg, R. (2022, April 4). Hurricane Ida. NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT . https://www.nhc.noaa.gov/data/tcr/AL092021_Ida.pdf

Both traditional backup generators and microgrids supply power, but microgrids are more advanced systems that can function on their own or with the main grid, while generators are usually simpler devices that provide temporary backup power during distribution grid outages.

Microgrids may have higher upfront costs than backup generators, and many projects depend on federal grants, state programs, or public-private partnerships to get started. However, microgrids can offer meaningful value in certain contexts, especially as targeted alternatives to large-scale resilience investments.

Microgrids may be more appropriate than undergrounding distribution lines in areas where geography, wildfire risk, or population density make undergrounding impractical or prohibitively expensive. This is often the case in remote or rural areas with long feeder lines that are costly to bury, or where the infrastructure serves a small number of customers, which can potentially inflame the cost-per-customer of undergrounding and challenge cost-effectiveness.

In wildfire-prone areas, microgrids help maintain power to communities when utilities de-energize lines due to fire conditions[13]. They can also reduce ignition risk[14] by enabling the retirement of long overhead lines, particularly when paired with distributed generation. Further, if a microgrid allows a utility to defer or avoid an expensive capital upgrade, it can be a non-wires alternative[15] that saves money for ratepayers in the long term.

Part 4 – Case Study A: Rural Application of a Microgrid

Our first case study brings us to the Tahoe National Forest. The Sagehen Creek Field Station, located within the Tahoe National Forest, is the largest privately operated experimental research forest in the United States, managed by the University of California, Berkeley in conjunction with the United State Forest Service. At an elevation of 6,390 feet in the Sierra Nevada Mountains approximately 10 miles north of Truckee, California, this station is serviced by Liberty Utilities. Liberty Utilities is an investor-owned, regulated utility that provides water, wastewater, natural gas, and electric services across thirteen states. It serves approximately 800,000 customers and operates with a local management model, focusing on small and mid-sized communities[16]. Facing multi-million-dollar grid hardening costs, Liberty Utilities partnered with BoxPower to deploy a containerized microgrid (technology resides inside a standard shipping container) to reduce wildfire risk while maintaining reliability during fire season[17]. BoxPower is a microgrid solutions provider that designs and deploys modular solar and battery systems for rural and remote areas[18].


Sierra Nevada Mountains, California

13 Public safety power Shutoffs explained. PSE Healthy Energy. (n.d.). https://www.psehealthyenergy.org/public-safety-power-shutoffs-explained/

14 Taylor, S., Setyawan, G., Cui, B., Zamzam, A., & Roald, L. (2023, June 16). Managing wildfire risk and promoting equity through optimal configuration of networked microgrids | proceedings of the 14th ACM international conference on future energy systems. The ACM Digital Library. https://dl.acm.org/doi/10.1145/3575813.3595196

15 Cohn, L. (2019, June 21). What are non-wires alternatives?. Microgrid Knowledge. https://www.microgridknowledge.com/about-microgrids/article/11429614/what-are-non-wires-alternatives

16 Liberty Utilities. (2017, January). Liberty Utilities completes acquisition of The Empire District Electric Company. https://libertyutilities.com/liberty-utilities-completes-acquisition-of-the-empire-district-electric-company.html

17 Sagehen Creek Field Station Microgrid. BoxPower. (n.d.-b). https://cdn.prod.website-files.com/670d01fbeb728f367fca2449/67ab3a2e73add009d86ea890_BoxPower_Sagehen-Case-Study_03-05-21.pdf

18 BoxPower. (n.d.). About us. https://boxpower.io/about-us

Like many utilities in the region, Liberty Utilities faces increasing risks to its infrastructure as wildfires become fiercer, more frequent, and more widespread. Grid hardening is imperative in this new era of wildfire risk. One option for grid hardening is installing insulated conductors and extensively clearing trees and brush from around transmission and distribution lines. This is effective yet can be expensive for remote areas since pricing is often billed per mile of circuit regardless of density[19], which can be a conflict for prudent and reasonable capital expenditures. The more remote the customer, the more expensive the project, since these sites are served by longer distribution lines.

Liberty Utilities estimated the grid hardening costs of a non-microgrids solution for the Sagehen Creek Field Station to be $3 million. As discussed earlier, microgrids offer an alternative to expensive grid hardening efforts, particularly in remote locations like Sagehen, where undergrounding long feeder lines is not cost-effective. In such cases, utilities may opt to de-energize high-risk lines altogether during wildfire season to reduce ignition risk, a practice known as a Public Safety Power Shutoff (PSPS). But while this approach helps mitigate wildfire threats, it also cuts power to the end user. For a critical research facility like Sagehen, the question then becomes: how can operations continue during PSPS outages each year?

Liberty Utilities contracted BoxPower to install an islandable microgrid capable of powering the field station so that Liberty Utilities can de-energize their service line for fire season. The system consists of 20 kW of solar PV, 68.4 kWh of Lithium Iron Phosphate (LiFePO4) battery storage, a 14 kW bi-directional inverter, site controller, and a 35 kW prime-power propane generator, all prefabricated inside of a climate-controlled 20-foot shipping container. Rather than rely on backup generators alone, the Sagehen microgrid's hybrid system of solar, storage, and propane provides more robust, renewable, and controllable power, all key attributes of a resilience investment. Additionally, the system includes a remote monitoring and control system that allows for both autonomous operation and complete remote control and diagnostic capabilities.

After being built in 2020, the capital balance of this collaboration was included in the 2022 general rate case with the California Public Utilities Commission, which granted approval for rate recovery[20].

Emerging microgrid technology can further adjust to evolving weather conditions. BoxPower's installation at the Sagehen Field Station can endure over 8 feet of snow due to container reinforcements and a tilt-adjustable solar array. To ensure year-round reliability, the system includes utility-grade monitoring and control through SCADA (Supervisory Control and Data Acquisition) and DERMS (Distributed Energy Resource Management System) integration. This allows for remote operation, diagnostics, and switching between grid-connected and off-grid modes. These features support resilience by enabling autonomous operation during fire season and efficient reintegration once grid conditions stabilize.

The Sagehen case study demonstrates how microgrids can serve critical facilities in rural areas, maintaining essential functions during extended outages and high-risk fire seasons. It also illustrates how utilities can deploy microgrids as a targeted, cost-saving alternative to traditional infrastructure investments that aligns with broader resilience planning goals.

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19 Zeiss, G. (2019, February 12). Between the Poles: Lidar changes the cost structure for utility distribution vegetation management. Between the Poles: All About Infrastructure. https://geospatial.blogs.com/geospatial/2019/02/lidar-changes-the-cost-structure-for-utility-distribution-vegetation-management.html

20 Liberty Utilities (CalPeco Electric) LLC. (2021). Application of Liberty Utilities (CalPeco Electric) LLC (U 933-E) for authority to, among other things, increase its authorized revenues for electric service, update its Energy Cost Adjustment Clause billing factors, establish marginal costs, allocate revenues, and design rates, as of January 1, 2022 (Application No. A.21-05-017). California Public Utilities Commission.

Part 5 – Case Study B: Urban Application of a Microgrid

Our second case study shifts from a rural forest station to an urban center, highlighting how microgrids can fortify critical infrastructure in cities. As wildfire threats[21] rise in Oregon, grid resilience becomes increasingly vital for emergency response facilities. Portland's Fire Station 1[22] is among the first resilience hubs in the city to implement a solar + battery microgrid with a project led by Generac. This system was active from 2019-2021.

Like many emergency facilities, Fire Station 1 originally relied solely on a diesel generator to sustain operations during outages. However, diesel generators are dependent on onsite fuel storage, which limits their longevity and flexibility in longer-duration outages, and require regular testing and maintenance. A more reliable solution was needed.

To address this, Portland's Bureau of Planning and Sustainability (BPS), Portland General Electric (PGE), and Portland Fire & Rescue (PF&R) partnered with Generac. As the lead designer of the project, Generac designed and delivered a fully integrated microgrid system, bringing together solar PV, battery storage, intelligent controls, and diesel backup generation into a cohesive and resilient solution. This system serves as an example of energy sufficiency for critical facilities cities like Portland.

Microgrids can be complex, often requiring coordination between multiple components and stakeholders. In this case, Generac orchestrated the full system integration, ensuring that all pieces worked together to support Fire Station 1. Generac brought in several project partners to support design, installation, and operation. The system includes integrated solar PV and battery storage to provide ongoing renewable power and reduce reliance on the utility grid. It also incorporates a control system to manage real-time energy flows, optimize solar and battery performance, and ensure compliance with PGE's network grid requirement prohibiting backfeeding. Backfeeding is when excess energy generated by DERs is sent back into the main grid.

In addition to meeting those utility requirements, the microgrid could operate autonomously during power outages. When grid power is lost, the control system modulates solar and battery output to reduce generator runtime and fuel use. The system also includes a sophisticated power converter that links the solar array to the battery and keeps it fully charged, ensuring that backup power is available even when solar generation is limited.

This project highlights how a complex set of technologies and partners can be choreographed to deliver a reliable and resilient microgrid. The outcome is a replicable model that other jurisdictions can adopt to harden emergency services, enhance grid flexibility, and reduce vulnerability during major outages.

21 Dake, L. (2025, July 16). Oregon governor declares statewide emergency with intense wildfire threat looming. opb. https://www.opb.org/article/2025/07/16/oregon-governor-statewide-wildfire-emergency/

22 Generac Power Systems. (n.d.). Portland fire station: Generac industrial energy. Generac. https://www.generac.com/industrial/microgrid-solutions/about/projects/portland-fire-station/

Part 6 - Conclusion

The design of a microgrid is an important consideration, as different use cases may require different configurations, such as the hybrid solar-propane-battery system at Sagehen Field Station versus the solar-plus-battery-only system at Portland Fire Station 1. Microgrids represent an adaptable tool for strengthening local resilience in the face of growing resilience and reliability challenges. Whether in a remote forest facility or a downtown emergency hub, microgrids enable critical operations to continue when the grid is compromised. The Sagehen Field Station and Portland Fire Station 1 demonstrate how microgrids can reduce wildfire risk, improve reliability, and provide value as non-wires alternatives. While upfront costs and technical complexity can be barriers, strategic investment in microgrids, especially when supported by partnerships or public funding, can deliver long-term benefits to communities, utilities, and the overall grid.

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