Smart Electric Power Alliance

The Microgrid Playbook: Community Resilience for Natural Disasters

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About SEPA

The Smart Electric Power Alliance (SEPA) is dedicated to helping electric power stakeholders address the most pressing issues they encounter as they pursue the transition to a clean and modern electric future and a carbon-free energy system by 2050. We are a trusted partner providing education, research, standards, and collaboration to help utilities, electric customers, and other industry players across four pathways: Transportation Electrification, Grid Integration, Regulatory Innovation and Utility Business Models. Through educational activities, working groups, peer-to-peer engagements and custom projects, SEPA convenes interested parties to facilitate information exchange and knowledge transfer to offer the highest value for our members and partner organizations. For more information, visit www.sepapower.org.

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About SEPA's Microgrids Working Group

SEPA's Microgrid Working Group seeks to identify new business models, explore regulatory and financial innovations, address gaps in standards, define use cases that drive new system requirements, and share experiences and best practices to help the energy industry stakeholders. SEPA convenes the working group at industry events and over monthly meetings. For more information on how to get involved, visit www.groups.sepapower.org.

Executive Summary

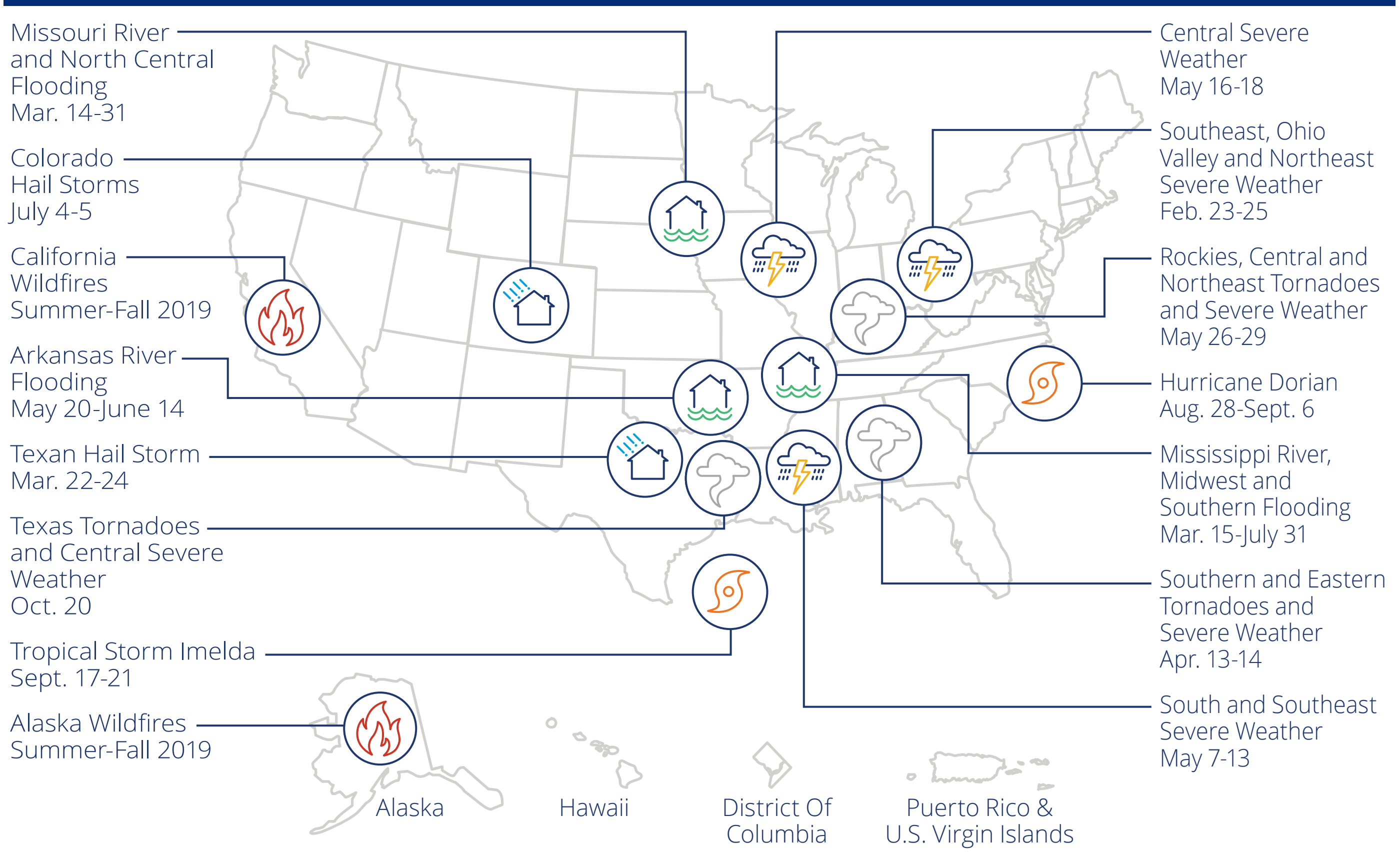
Utility customers, utilities and other communities are exploring options to be more resilient in the wake of recent extreme weather events in the Pacific, Gulf coast and Caribbean, and fires in California. In 2019, 14 natural disasters caused damages of over $1 billion each. These disasters included severe weather events, hail storms, wildfires, flooding, tornadoes, tropical storms, hurricanes and earthquakes, all of which can threaten the reliability and stability of the electric power system. In response, some utilities and government entities are turning to microgrids as one tool to provide solutions to power critical systems and facilitate the integration of distributed energy resources (DERs).

The objective of this playbook is to provide utilities, local and state government entities and relevant stakeholders with:

- An overview of microgrid services and value streams based on utility, community and customer perspectives
- A comprehensive set of microgrid and resilience strategies against natural disaster
- An integrated approach to identifying and evaluating potential microgrid deployment to increase community resilience against natural disaster

A holistic approach to evaluating microgrids as a tool to increase resilience against natural disaster threats can be broken down into three components, general microgrid planning & deployment, hardening microgrid systems, and increasing building resilience. The natural disaster use-cases covered within this playbook are hurricanes, earthquakes and wildfires.

Figure 1. U.S. 2019 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the **14 separate billion-dollar weather and climate disasters** that impacted the United States **during 2019**.

Source: National Oceanic and Atmospheric Administration (NOAA).

Within that approach are four key microgrid and resilience strategies against natural disaster:

- Identifying potential microgrid candidates to provide **community resilience in areas vulnerable to natural disasters**
- Identify customers and sites who already have **existing or are exploring on-site DERs and build in microgrid capability**
- Identifying **critical infrastructure site resilience needs**
- Identifying innovative business models and customer incentives to **successfully integrate microgrids into disruption-prone areas**

A critical component of this holistic approach is a thoughtful methodology for planning and deploying microgrid sites throughout the community. SEPA lays out a 5-step approach that can be used by utilities and local and state government entities to develop their microgrid proposals and to socialize those plans with external stakeholders and regulators. This approach is based on SEPA's work engaging with utility and government entities exploring plans for microgrids to increase resilience against natural disaster. These five steps include:

1. Identify Critical Customers and Public/Community Sites
2. Define Areas of Highest Risk of Power Outages Due to Natural Disaster
3. Identify Critical Customer and Public/Community Sites Served by Circuits Within Disaster-Prone Areas
4. Evaluate Critical Sites' Load Profiles and Develop Microgrid System Sizing Scenarios
5. Evaluate Strategic Microgrid Deployment Scenarios

Microgrids are one tool to provide resilience for the community, however, this playbook does not cover many other non-microgrid strategies that utilities are using to increase resilience to the grid. These strategies include, but are not limited to, insulating transmission and distribution lines, building transmission system redundancy, hardening substations and feeders, and managing vegetation.

This playbook covers microgrid planning for community resilience in six sections (outlined in Table 1). Additional information about utility and developer case studies can be found in The Microgrid Case Studies: Community Resilience for Natural Disasters.

Table 1. Playbook Roadmap	
Overview of Microgrid Services and Values for Resilience	Defines microgrids and resilience and provides an overview of the different stakeholder perspectives of microgrid services and values of resilience
Natural Disaster Use Cases: Earthquakes, Hurricanes and Wildfires	Provides several sets of unique considerations and strategies for deploying microgrids and keeping them online during different natural disaster use cases.
SEPA Approach for Planning and Deploying Microgrids for Community Resilience Against Natural Disaster	Outlines an adaptable 5-step approach for utilities and local/state governments planning as they consider opportunities to deploy microgrids for resilience against natural disasters and compares this approach with other industry resilience planning processes.
Conclusion	Highlights key recommendations for utilities and local and state governments to consider for microgrid resilience strategies and mitigating risk against threats of natural disaster in their service territories or jurisdictions.
Appendix A: SEPA Preliminary Microgrid Design Considerations	Provides SEPA's Preliminary Microgrid Design Consideration framework to illustrate additional questions to consider when developing microgrid projects and strategy.

Source: Smart Electric Power Alliance, 2020

Overview of Microgrid Services and Values for Resilience

Developing a strategy around microgrid planning for community resilience relies on a common understanding of 1) microgrid and resilience definitions and 2) all microgrid services, values and resilience benefits to the customer and utility—in addition to the community.

Defining Microgrids and Resilience

The U.S. Department of Energy (DOE) defines a microgrid as "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act 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." While several industry definitions exist, all collectively describe microgrids as having multiple loads, DERs, and islanding capabilities. Another key characteristic is that microgrids are defined as a single controllable entity that are grid-tied when not operating in islanded mode. This contrasts to systems where the building or campus may never connect with the grid and always operate in island mode.

The value of these systems come from the ability for a microgrid to disconnect from the grid and operate independently if the grid goes down. This characteristic provides resilience to connected buildings, systems, and customers. The value of microgrids varies depending on the purpose for which it is built. Examples include the owner of a campus building a microgrid to provide power to systems critical for the company, a homeowner so that their residence has power during an outage, or by cities to provide resilience to key assets. This playbook focuses on microgrids that provide resilience to the community and critical infrastructure sites. These types of microgrids are often referred to as public purpose microgrids because they serve a societal need, often creating electrified places of refuge for the community during a crisis.

In 2009, the Department of Homeland Security defined resilience as "the ability to resist, absorb, recover from, or successfully adapt to adversity or a change in conditions."[1] Similarly, in a 2013 Presidential Policy Directive (PPD), resilience was defined as "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions." The PPD expands on this, pointing out that resilience "includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."[2] In comparison to reliability, resiliency has more to do with a system's response or behavior when subjected to largely unavoidable events not intrinsic to the system itself.

Microgrid Services for Customer, Community and Utility Resilience Benefits

Although community resilience is the primary focus of this playbook, all perspectives of resilience are discussed in this section, including an expansive view of how microgrid services can benefit end-use customers, utilities and communities. This understanding of the breadth of microgrids and resilience facilitates the understanding of how microgrids can serve community resilience and the related strategies within this playbook.

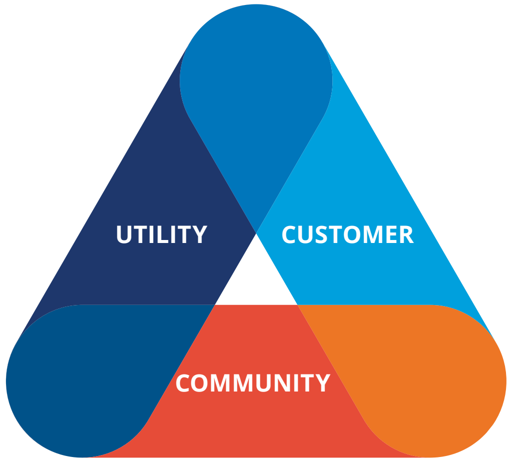
There are three main perspectives of resilience and potential beneficiaries of microgrid services.

- **Customer:** The customer values the ability to avoid power interruption and outages to maintain critical operations and economic production.
- **Utility:** The utility values the ability to maintain safe and efficient operations with highly reliable service (limited and shorter duration outages).
- **Community:** The community values the ability to avoid power interruption and outages and to assure the provision of power to critical services—such as public safety, communications, water treatment and health care.

1 Department of Homeland Security, National Infrastructure Protection Plan: Partnering to Enhance Protection and Resiliency, 2009.

2 "Presidential policy directive—Critical infrastructure security and resilience," White House, Washington, DC, USA, Feb. 2013, https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Figure 2. Microgrid Services by Customer, Utility, and Community Perspectives



Utility Service

- **Utility Operations:** Utility microgrid serving a utility operation center to ensure data centers are kept running and so that personnel can effectively restore the grid.
- **Grid Reliability:** Utility microgrid serving multiple customers to reduce the number of customers not being served energy and experiencing outages in the service territory.
- **Community Resilience:** Utility program offering for customers to install and incent on-site microgrids to provide resilience services for customers.

Customer Service

- **Agriculture:** Ex) Farming microgrid serving the operations of a farm to sustain crop and food production.
- **Residential:** Ex) Residential microgrid providing lighting air conditioning, heating, refrigeration and other critical loads.
- **Industrial:** Ex) Manufacturing facility microgrid providing critical power to ensure production and to avoid economic loss.
- **Commercial:** Ex) Grocery store facility microgrid providing critical power to avoid spoilage of products and loss of business.
- **University Campus:** Ex) University campus microgrid providing critical power to ensure continuity of studies and essential services of the university.
- **Military Campus:** Ex) Microgrid serving a mission-critical base to ensure a successful mission for national security.

Community Service

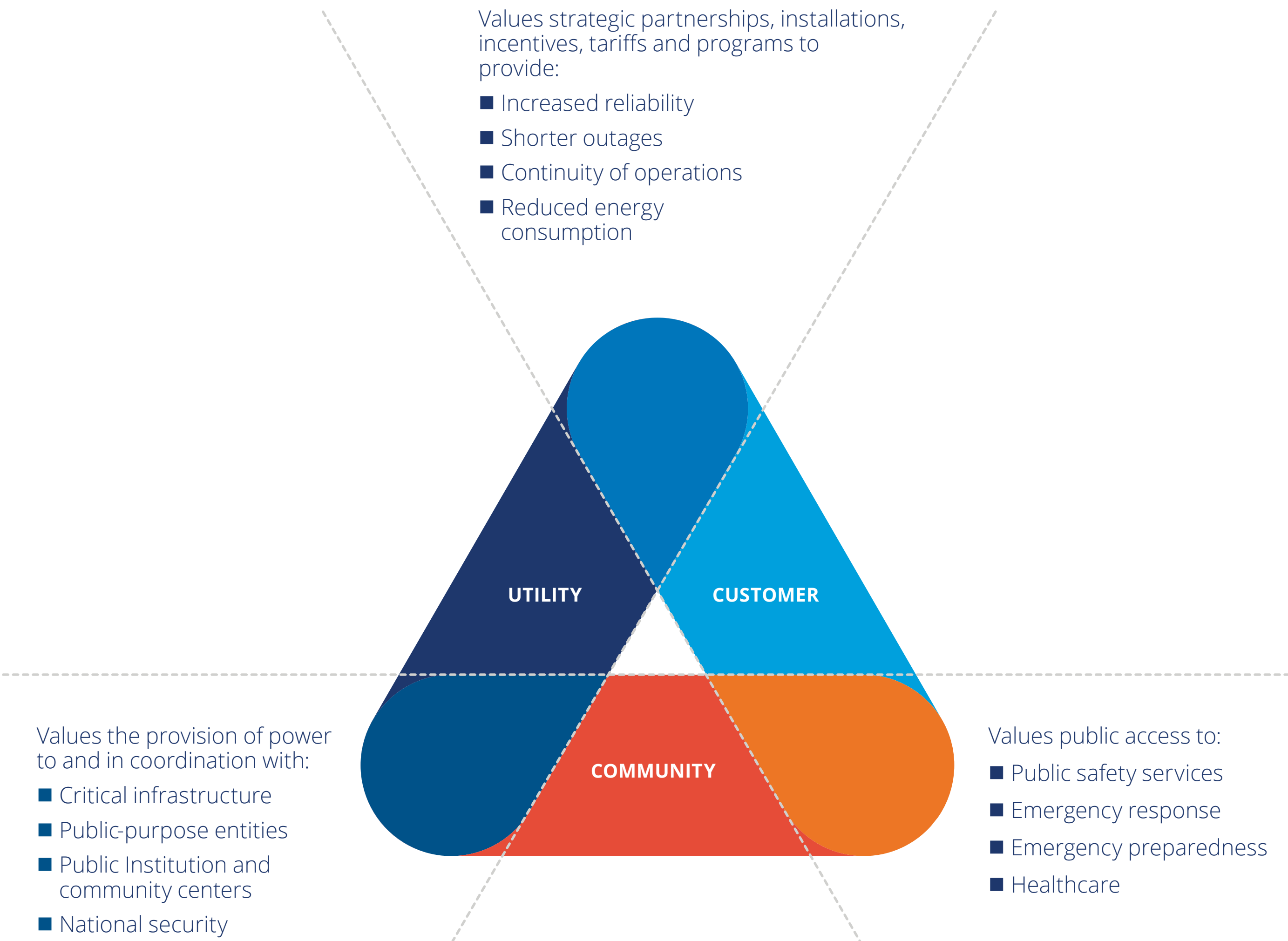
- **Public Safety:** Microgrid serving fire and police headquarters, stations and dispatch centers to ensure emergency response services as part of emergency preparedness for the community.
- **Radio Tower:** Microgrid serving critical communication sites to ensure continuity of communications during an outage event.
- **Water/Wastewater Treatment:** Microgrid providing critical power to water treatment facilities to ensure continued access to clean drinking water and the continued processing of wastewater.
- **Public Institution:** Microgrid serving gas stations, grocery stores and electric vehicle charing infrastructure to ensure access to food and transportation fuel for the community.
- **Health Care/Hospital:** Microgrid serving the critical operations of the facility to ensure access to health care facilities and continuity of emergency services for the community.

Source: Smart Electric Power Alliance and Cadmus, 2020.

The above stakeholders utilize microgrids as a tool to solve a problem, and the siting and application is dependent on the problem it is trying to solve. For example, commercial and industrial customers can look to build microgrids to avoid loss of production, cut energy costs and increase sustainability. Utilities can look to build microgrids to maintain and improve service reliability. Communities can look to build microgrids to ensure continuity of public access to critical services. Despite the distinct microgrid services provided for each stakeholder, there is overlap between each perspective when evaluating the value of resilience.

Figure 2 lists the different types of microgrid applications, and details the microgrid services for each stakeholder viewpoint by outlining specific examples for each of the applications.

Figure 3. Microgrid Resilience Value Stacking



Source: Smart Electric Power Alliance and Cadmus, 2020.

Each of the microgrid services listed above provide a certain level of utility value for grid resilience, community value for critical infrastructure resilience, and/or customer value for end-user resilience. Figure 3 complements Figure 2 by listing compatible value streams of resilience across different stakeholders. The intersection points of the triangle indicate where stakeholders jointly value resilience and microgrid benefits.

While specific microgrid applications are meant to serve different stakeholder needs, stacking the community, utility and customer values of resilience can increase the financial viability of microgrid projects. As seen in Figure 3, the commonalities between utilities and communities can be leveraged to explore potential public-private partnerships. The commonalities between communities and customers can be leveraged to explore how individual customer microgrids can have dual commercial-public function (i.e., university campus functioning as an emergency shelter during a natural disaster).

Natural Disaster Use Cases: Earthquakes, Hurricanes and Wildfires

Earthquakes, hurricanes, and wildfires each present unique threats, stakeholder needs, and required technical solutions. Threat-specific strategies for microgrid deployment are illustrated in Table 2 through three natural disaster focused use-cases. For each natural disaster (Earthquake, Hurricane, Wildfire), the resilience and microgrid strategies framework includes the following elements:

- **Planning & Deployment:** See "SEPA 5-step Approach for Planning and Deploying Microgrids for Community Resilience against Natural Disaster" in the following section of this playbook.
- **Microgrid System Hardening:** This includes strategies on hardening microgrid systems against physical threats.
- **Increase Building Resilience:** This includes strategies on increasing the resilience of the buildings served by the microgrid.
- **Case Studies:** This references case examples from utilities and developers and their strategies for resilience and microgrids. Full case studies are included in The Microgrid Case Studies: Community Resilience for Natural Disasters.

Table 2. Microgrid and Resilience Strategies by Natural Disaster Threats

Earthquake	
Planning & Deployment	▪ See SEPA 5-Step Approach for Planning & Deploying Microgrids for Community Resilience against Natural Disaster
Microgrid System Hardening	▪ Utilize shock-mount system enclosures for battery storage to maintain the integrity of individual system components
	▪ Maintain industry standards for all microgrid assets sited near seismic activity
	▪ Ensure solar roof mount design meets American Society of Civil Engineers (ASCE) building code for seismic areas
	▪ Look into purchasing earth-quake resistant and certified equipment
	▪ Store enough fuel onsite for standby generators to avoid delivery issues
Increasing Building Resilience	▪ Design for structural loads
	▪ Address for soil characteristics, water drainage, site grading, and foundation to avoid subsidence and to mitigate seismic risk
	▪ Secure appliances (i.e., water heaters) to help prevent them from separating or falling and causing fires due to gas leaks or severed electrical connections
Case Studies	▪ Portland General Electric (PGE) Resilience and Microgrid Strategy against Earthquakes
	▪ Snohomish County Public Utility District (PUD) Resilience and Microgrid Strategy against Earthquakes, Wind and Ice Storm

Table 2. Microgrid and Resilience Strategies by Natural Disaster Threats	
Hurricane	
Planning & Deployment	▪ See SEPA 5-Step Approach for Planning & Deploying Microgrids for Community Resilience against Natural Disaster
Microgrid System Hardening	▪ Do not locate microgrids within flood plains and areas of high risk to flooding without proper safeguards
	▪ Elevate all equipment above flood and storm surge levels
	▪ Avoiding siting solar ground mount PV in flood zones and design solar rooftop PV systems and framing for easy runoff and drainage
	▪ Use National Electrical Manufacturers Association (NEMA) rated enclosures to minimize exposure to debris and to protect against water damage
	▪ Design Emergency Management System (EMS) or protection system to shutdown at harmful wind speeds or conditions
	▪ Store enough fuel onsite for standby generators to avoid delivery issues
	▪ Maintain American Society of Civil Engineers (ASCE) standards for solar rooftop systems based on expected wind loads
	▪ Use flexible solar racking and anchoring systems
Increasing Building Resilience	▪ Follow the International Building Code (IBC) provisions of structural strength including wind and rain loads
	▪ Follow IBC provisions associated with the protection of openings from flying debris
	▪ Elevate structures to mitigate flooding and storm surge and to prevent water intrusion into storm shelters
	▪ Follow IBC provisions for building enclosures to help maintain integrity (i.e., nail patterns for roof decks, wall sheathing, wind-resistant exterior materials – shingles, metals, tiles, siding, stucco, and masonry)
	▪ Cover flood loads and elevate of structures to reduce impacts of flooding
	▪ Include provisions of overall structural strength to withstand hydrostatic forces of water and wave action.
	▪ Coordinate with IBC's requirements and National Flood Insurance Program (NFIP)/ Community Rating system (CRS) for flood mitigation
	▪ Grade the building site to reduce the impacts of floods
	▪ Follow IBC provisions for flood-resistant design
Case Studies	▪ North Carolina Electric Membership Corporation (NCEMC) and Tideland Electric Membership Corporation (EMC) Resilience and Microgrid Strategy against Hurricanes, Flooding, and High Winds
	▪ Blue Planet Energy Resilience and Microgrid Strategy in Puerto Rico

Table 2. Microgrid and Resilience Strategies by Natural Disaster Threats	
Wildfire	
Planning & Deployment	▪ See [SEPA 5-Step Approach for Planning & Deploying Microgrids for Community Resilience against Natural Disaster]()
Microgrid System Hardening	▪ Undergrounding electrical systems and facilities
	▪ Store enough fuel onsite for standby generators to avoid delivery issues
	▪ Minimize damage for follow-up repairs and replacements post-evacuation
	▪ Deploy built-in fire suppression systems for any battery storage on-site
	▪ Site solar PV in open areas away from flammable material (i.e., trees, shrubs, etc.)
	▪ Increasing Building Resilience:
	▪ Follow International Building Code (IBC) and International Wild-land Urban Interface Code (IWUIC)
Case Studies	▪ Southern California Edison (SCE) Resilience and Microgrid Strategy

Source: Smart Electric Power Alliance Microgrids Working Group and Resilience Task Force, 2020.

Public Safety Power Shutoff Microgrid Strategy

In 2019, utilities in California conducted Public Safety Power Shutoff (PSPS) events by proactively turning off power in high risk areas to reduce the threat of wildfires. When potentially dangerous weather conditions occur in fire-prone areas, the utilities turn to PSPS as a mitigation tactic to reduce the risk of wildfires.

Utilities considering microgrids to reduce the negative impacts of PSPS are beginning to evaluate ideal locations for deploying microgrids, centered around two key considerations: managing wildfire risk of the microgrid while maintaining geographic proximity to the impacted area, and how geographic proximity of critical facilities impacts electrical location of the point of common coupling for the microgrid (behind or in-front of meter).

Factoring in the geographical proximity of the critical infrastructure and community sites to the impacted area allows utilities to weigh the risk of damage in a wildfire versus the benefits of resilience of a particular asset. In order to determine the appropriate strategy, utilities can weigh the safety and physical vulnerability of sites within the high-risk zones versus the effectiveness of sites outside the zones. In certain circumstances, siting microgrids in low to moderate risk wildfire areas can significantly decrease the risk of the microgrid being damaged by wildfire, while still being effective in providing power to critical loads within communities impacted by PSPS. For example, instead of having microgrids deployed within areas of high risk, it could be beneficial to deploy microgrids in a neighboring community to provide power to community centers and emergency shelters for those in the high risk areas.

Factoring in geographical proximity of critical infrastructure and community sites to each other allows utilities to consider the most effective electrical location for a microgrid — either behind-the-meter at a customer site or in-front-of-the-meter to serve a group of customers. For instance, if the critical facilities are near each other and served by the same circuit, the utility may develop an in-front-of-the-meter microgrid to serve all the critical loads. In other situations, critical facilities are not situated nearby others, so the better solution may be a site-specific microgrid behind-the-meter.

SEPA Approach for Planning and Deploying Microgrids for Community Resilience Against Natural Disaster

SEPA has developed a proven approach that utilities and local and state governments can take to jointly plan for the deployment of microgrids. This approach is based on SEPA's work engaging with utility and government entities exploring plans for microgrids to increase resilience against natural disaster. Stakeholders should use this microgrid planning tool in coordination with all other system and emergency response planning activities—including energy assurance planning, emergency response strategies and energy restoration strategies.

Mapping SEPA Approach to Other Industry Resilience Planning Processes

SEPA's 5-step approach for planning microgrids for community resilience against natural disaster is specifically designed towards understanding natural disaster outage risk and the ability for strategic deployment of microgrids to provide enhanced resilience to critical infrastructure within the community. It includes a step-by-step approach for analyzing critical infrastructure, vulnerable areas, and potential microgrid deployment scenarios. Within each step, it also provides key questions to consider.

The SEPA framework coexists with existing resilience planning frameworks. Sandia National Laboratories,[3] Argonne National Laboratory,[4] and National Renewable Energy Laboratory (NREL)[5] have developed planning processes for resilience. Figure 4 illustrates SEPA's step-by-step approach alongside other resilience planning processes developed by national labs within the energy industry.

Each process focuses on identifying threats, assessing vulnerabilities and laying out solutions. SEPA's process focuses specifically on microgrids for critical infrastructure to build resilience within the community, and includes key considerations around microgrid deployment and design for resilience. In contrast to other industry processes, SEPA's approach takes a solution—microgrid—and threat—natural disaster—specific approach.

SEPA 5-Step Approach for Planning and Deploying Microgrids for Community Resilience Against Natural Disaster

#1—Identify Critical Customers and Public/Community Sites

Identify critical customers and public/community sites to ensure the energy needs of critical infrastructure and life-safety facilities and sites that could serve as community resilience centers and maintain continuous operation through natural disaster events.

Key Questions to Consider

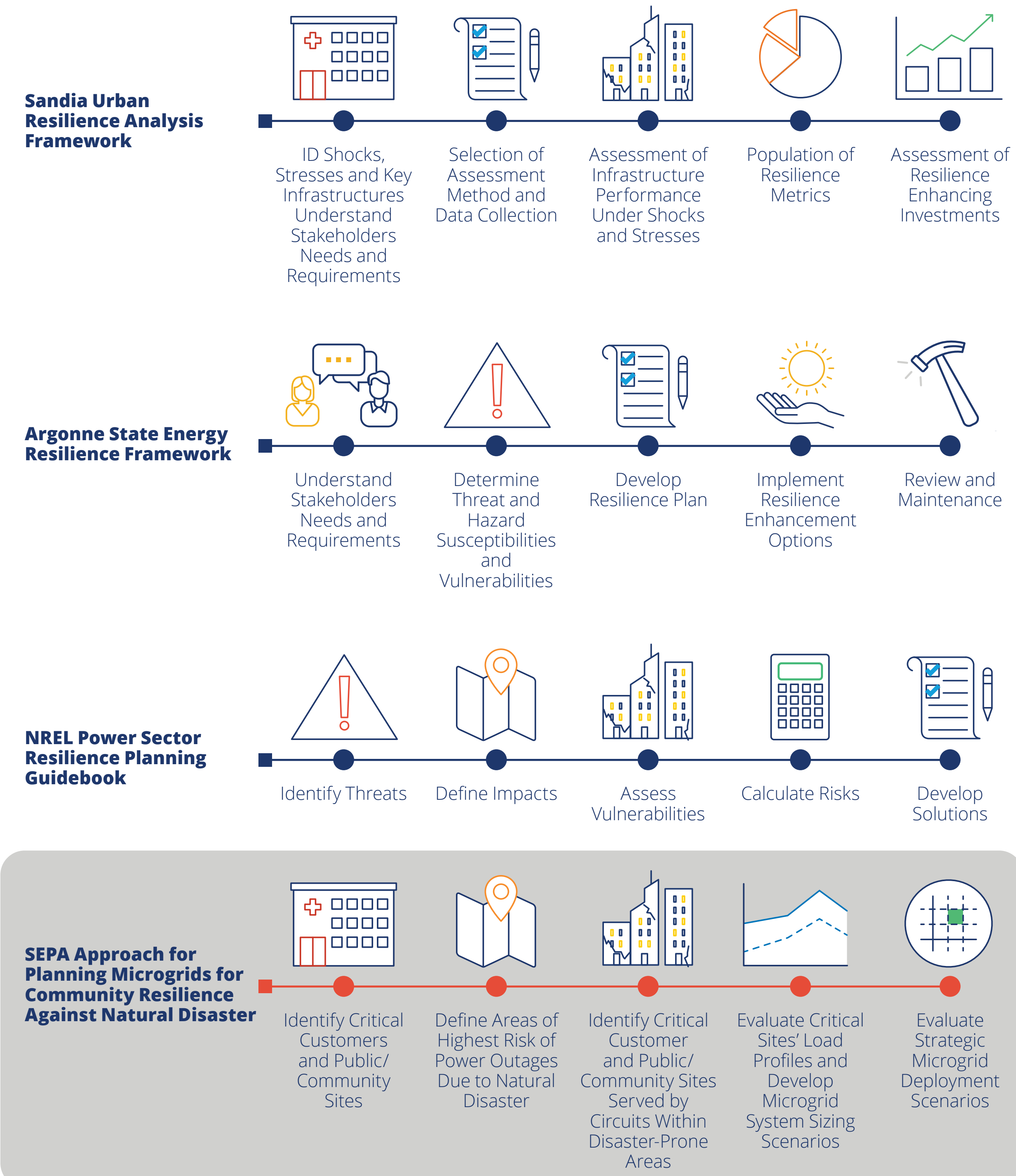
- What are the critical facilities or customer types to target for microgrid installations?
  - Ex) hospitals, correctional facilities, water/wastewater treatment facilities, healthcare facilities, schools, fire and police stations, radio towers, designated shelters or evacuation sites, etc.

3 Sandia National Laboratories (2016), Development of an Urban Resilience Analysis Framework with Application to Norfolk, VA, https://www.sandia.gov/cities/_assets/documents/Urban_Resilience_Norfolk_SAND2016_2161.pdf

4 Argonne National Laboratory (2016), State Energy Resilience Framework, https://www.energy.gov/sites/prod/files/2017/01/f34/State%20Energy%20Resilience%20Framework.pdf

5 National Renewable Energy Laboratory and United States Agency for International Development (2019), Power Sector Resilience Planning, https://www.nrel.gov/docs/fy19osti/73489.pdf Guidebook

Figure 4. SEPA Approach vs. Other Industry Resilience Planning Processes



Source: Smart Electric Power Alliance, 2020.

- What customers already have on-site generation or interest in installing and have the existing infrastructure space amenable to microgrids?
  - Ex) public institutions such as high schools or universities
- What federal, state or local laws require back-up power of certain facilities to consider?
  - Ex) California code requires hospitals to be equipped with permanently installed on-site generation.[6]
  - Ex) Texas code encourages all critical government facilities, hospitals and wastewater treatment facilities to be equipped with 14 days of back-up generation during an outage event.[7,8,9]
  - Ex) Army directive requires all mission-critical bases to be equipped with 14 days of energy and water security to power and sustain critical missions.[10]
  - Ex) Air Force directive requires critical infrastructure providing mission essential functions to be equipped with enough off-grid power capabilities to power the base for either 7 days or enough time to relocate the mission.[11]
- Which facilities or customer types are more critical than others? Are there different tiers of criticality for potential microgrid sites?
- Are there existing emergency response or outage response plans around critical infrastructure and/or customers to coordinate with?

#2—Define Areas of Highest Risk of Power Outages Due to Natural Disaster

Identify the natural disaster threats and the areas that are most vulnerable and at high-risk to outage caused by natural disaster threats. Depending on the geography, different natural disaster threats, such as high winds and flooding, can cause damage to electricity infrastructure. This playbook also covers high risk from wildfires and earthquakes.

Key Questions to Consider:

- Are there existing county, city, state or federal emergency preparedness maps that identify vulnerable areas to natural disaster?
- What are the areas that have the highest probability of being impacted by a natural disaster?
- What are the areas that have the highest magnitude of negative impact due to a natural disaster?

#3—Identify Critical Customer and Public/Community Sites Served by Circuits within Disaster-Prone Areas

Identify the critical customer and public/community sites collected from Step 1 that fall within disaster-prone areas identified in Step 2. The result is a list of potential sites in areas that are susceptible to power outages due to natural disasters that could benefit from a microgrid.

Key Questions to Consider:

- How many of these sites already have on-site generation assets to leverage for microgrid retrofits?
- Do these circuits have sufficient hosting capacity to support a microgrid interconnection?
- How do the disaster-prone areas compare with other locational constraint areas with respect to capacity and reliability?[12]

#4—Evaluate Critical Sites' Load Profiles and Develop Microgrid System Sizing Scenarios

Once sites have been identified through Steps 1-3, collect pertinent information on these sites, including facility information (i.e., critical services, square footage, number of employees, etc.), energy usage, electricity consumption, cost of electricity, fuel usage, cost of fuel and estimated outage cost. It also may be necessary to conduct site assessments to determine critical load. Then, determine the appropriate asset mix and size of microgrids

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6 State of California Office of Statewide Health Planning and Development (2016), Electrical Guide for Health Facilities Review, https://oshpd.ca.gov/ml/v1/resources/document?rs:path=/Construction-And-Finance/Documents/Building-and-Construction-Projects/Comments-and-Activities/2016-Electrical-Requirements.pdf.

7 Texas House of Representatives (2009), H.B. 1831 2009, https://capitol.texas.gov/tlodocs/81R/billtext/html/HB01831F.HTM.

8 Texas House of Representatives (2009), H.B. 4409 2009, https://capitol.texas.gov/tlodocs/81R/billtext/html/HB04409F.HTM.

9 Texas House of Representatives (2013), H.B. 1864 2013, https://capitol.texas.gov/tlodocs/81R/billtext/html/HB04409F.HTM.

10 United States Department of Defense (2017), Army Directive 2017-0726 (Installation Energy and Water Security Policy), https://www.asaie.army.mil/Public/ES/doc/Army_Directive_2017-07.pdf.

11 United States Department of the Air Force (2016), Air Force Policy Directive 90-17 (Energy and Water Management, https://www.safie.hq.af.mil/Portals/78/documents/IEN/afpd90-17.pdf?ver=2017-06-27-213545-467.

12 Although this playbook primarily is an approach for evaluating the opportunities microgrid solutions offer for resilience, microgrids also could be leveraged and packaged together as a value-stacked solution providing grid reliability and management services.

(i.e., capacity of generation and storage assets) based on the critical load to be served.

Key Questions to Consider

- How much of the total load profile should the generation assets be sized for? (i.e., load duration curve design 95%) This is directly impacted by the breakdown of the site's critical load vs. total load.
- How much of the microgrid generation can be renewable? Depending on the load to be served and the duration desired, non-renewable resources may be necessary.
- What is the necessary size of the microgrid to meet the application?
  - Ex) The Energy Information Administration (EIA) OpenEI Open Source Database[13] can be used for modeling load profiles.
  - Ex) The SEPA Preliminary Microgrid Design Framework (see Appendix A) can be used for preliminary microgrid design.
  - Ex) The Sandia National Laboratories Microgrid Design Toolkit[14] can be used for detailed microgrid design and modeling.

#5—Evaluate Strategic Microgrid Deployment Scenarios

Once all potential microgrid sites have been evaluated, the next step is to layout different microgrid deployment scenarios. This is an iterative process based on the microgrid's architecture in relation to the distribution system and its location in relation to the disruption-prone areas. Since there may be several potential sites identified in Steps 1-4, it's important to prioritize based on geography (i.e., mountainous, rural, urban, etc), population density, and proximity to additional critical loads or communities.

Key Questions to Consider:

- Are there cities, communities or neighborhoods that have higher population density than others and should be prioritized for microgrid deployment?
- Are there physical barriers, such as mountains, that should be considered when deploying multiple microgrids?
- Where on the electrical distribution system should the microgrid be deployed?
  - Ex) Site-specific microgrid. This would be a microgrid behind the customer's meter.
  - Ex) Transformer-level microgrid. This would require the aggregation of load profiles at the transformer level to determine proper sizing and resources for the microgrid.
  - Ex) Community-level microgrid. This would require more evaluation of system-level data to determine if this architecture would be feasible. This approach may also be feasible if there is a geographical cluster of potential sites that could be served by a single microgrid.
- Where within the natural disaster risk areas should the microgrid be deployed?
  - Ex) Inside the disruption-prone areas to serve as an accessible and immediate resilience solution.
  - Ex) Outside the disruption-prone areas to avoid physical damage from the natural disaster while still serving as a designated resilience solution for those within the disruption area.

Conclusion

Microgrids are a tool that utilities, communities and customers are exploring to solve outage problems due to natural disasters. This playbook provides an overview of microgrid services and value streams, based on different stakeholders, to put community resilience into perspective. This comprehensive set of microgrid and resilience strategies provides threat-specific techniques that stakeholders can leverage to build resilience into their microgrid projects and plans. SEPA's integrated approach to identify and evaluate potential microgrid deployment offers utilities and government entities a starting point for developing holistic microgrid and resilience planning.

13 Energy Information Administration (2020), OpenEI Open Source Database, https://openei.org/datasets/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states.

14 Sandia National Laboratories (2020), Microgrid Design Toolkit (MDT), https://energy.sandia.gov/download-sandias-microgrid-design-toolkit-mdt/.

The key takeaways from the strategies and approaches outlined within this playbook are:

- Evaluating microgrids by looking at the problems they are trying to solve and the services they are providing, is a beneficial way to understand different stakeholder perspectives—utility, customer and community—on the value of resilience.
- Extracting the maximum resilience benefits of microgrids is dependent on early and often coordination between utilities, customers and government entities, who each have specific roles and responsibilities as it relates to the operation and planning of the electric system as well as the development of emergency preparedness plans.
- Increasing community resilience not only involves a holistic approach to microgrid planning and emergency preparedness, but also involves constructing microgrids and facilities that can withstand natural disaster threats.
- Identifying potential microgrid sites for community resilience requires a combination of determining critical infrastructure, defining vulnerable areas, and evaluating preliminary site load profiles and microgrid scenarios

This playbook can help stakeholders understand the variety of benefits, services and value streams microgrids can provide for communities, individual customers and the overall grid. The playbook also highlights the importance of conducting a highly coordinated planning effort between utilities, regulators, local and federal government officials, and energy and emergency response planning organizations.

Appendix A: SEPA Preliminary Microgrid Design Considerations

These are six common components of preliminary microgrid design. Table 3 below lists all of the potential considerations within each design component to discuss with stakeholders when initiating microgrid design. It also lists the potential options to address these preliminary design consideration questions. The framework can be used to facilitate stakeholder discussions and develop a preliminary microgrid design.

Table 3. SEPA's Preliminary Microgrid Design Framework

Common Components	Considerations	Options
Fuel Mix Approach	▪ What is the preferred fuel mix? ▪ Is there preference or mandates for renewables?	▪ Primarily Fossil Fuel (<10% Renewable) ▪ Moderate Renewables (20-40% Renewable) ▪ Aggressive Renewables (40-60% Renewable) ▪ 100% Renewable
Microgrid Assets	▪ Given the microgrid's application and fuel mix approach, what newly created or exiting assets should be deployed? ▪ What existing energy infrastructure in on-site?	▪ Solar PV ▪ Wind ▪ CHP ▪ NG Generator ▪ Diesel Generator ▪ Energy Storage ▪ Microgrid Controller ▪ Distribution Assets
Value Stacking	▪ What are the different streams of the microgrid system? ▪ Do you plan on operating the microgrid to provide internal customer services and external grid services?	▪ Performance and Reliability ▪ Fixed Long-Term Contracts ▪ Demand Management ▪ NWA to Grid Investment ▪ Resiliency Benefits ▪ Wholesale Participation
Primary Operating Modes	▪ What is the preferred operation scheme? ▪ How critical are the loads the microgrid intends to serve? ▪ How reliable is the utility service at the location of the microgrid?	▪ ___% of operation in grid-connected mode ▪ ___% of operation in islanded mode
Built Capacity	▪ Based on the preferred operation scheme, how much on-site generation capacity should be installed (v. imported electricity)?	▪ ___% of its total consumption
Imported/ Exported Electricity	▪ In the microgrid capacity built less than its total annual consumption? ▪ What is the cost of fuel for on-site electricity and cost of electricity imports?	▪ ___% On-site Generation ▪ ___% Imported Electricity

Source: Smart Electric Power Alliance, 2020

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