Guide to Expanding Mitigation

MAKING THE CONNECTION TO ELECTRIC POWER

FEMA

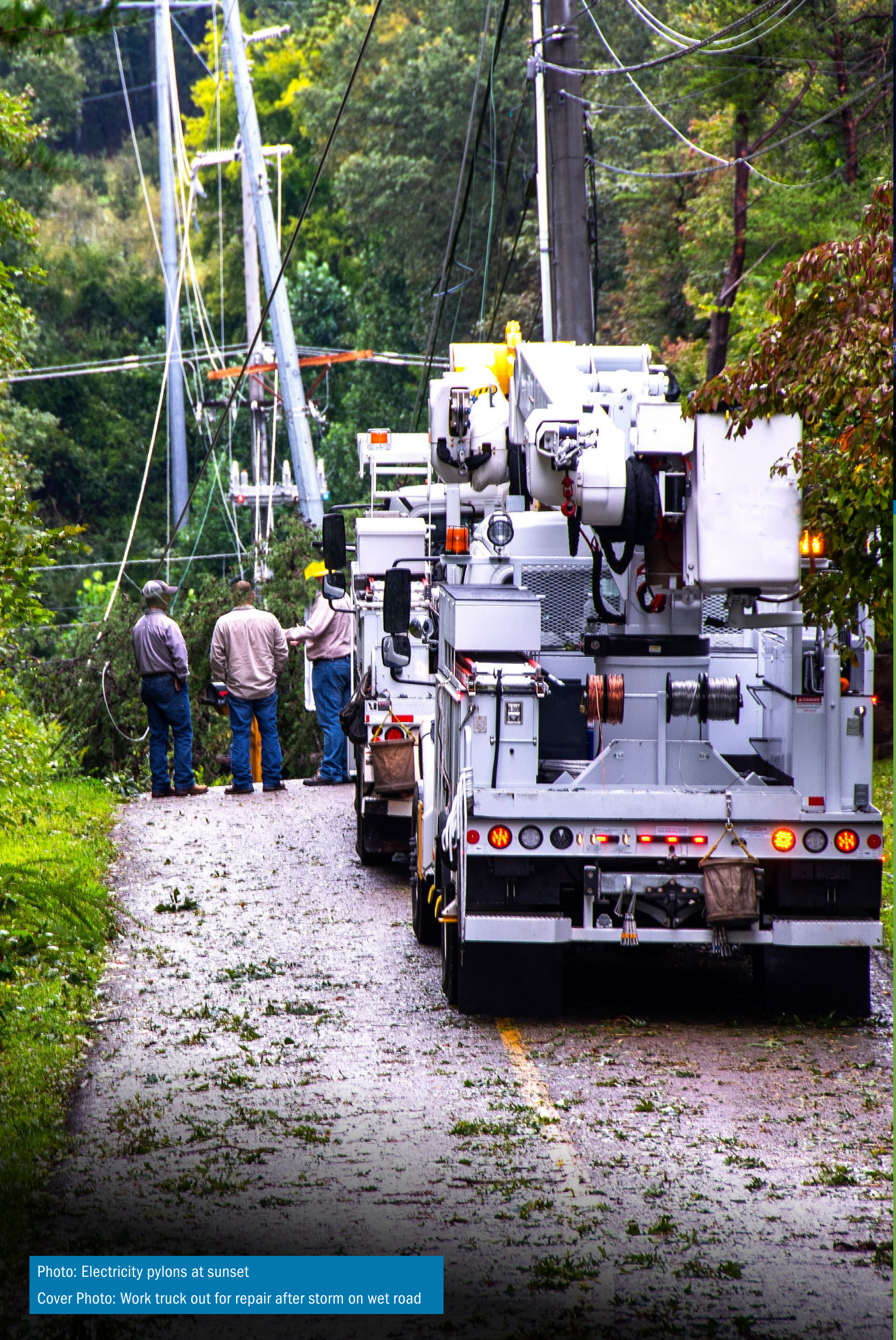

Photo: Electricity pylons at sunset

Cover Photo: Work truck out for repair after storm on wet road

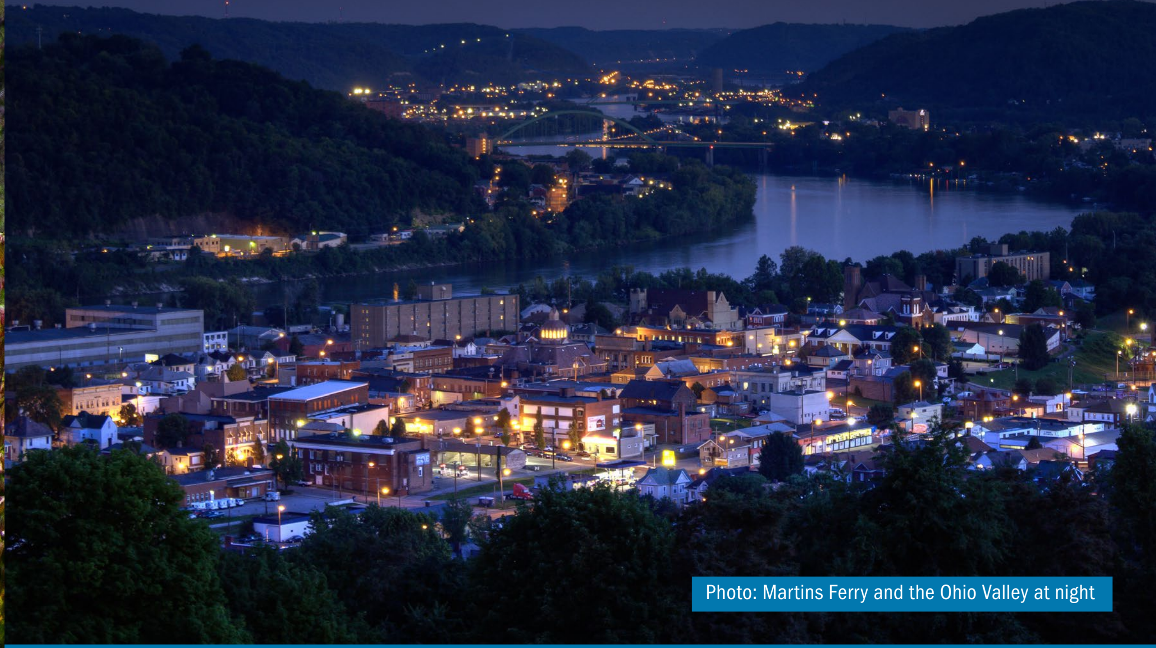

Photo: Martins Ferry and the Ohio Valley at night

Electric power is essential for modern society to function. In addition to powering the lights in our homes and the technology we use, electricity is necessary for water, transportation and communications systems. Reliable electric power systems are paramount in an emergency, as they keep communities connected and sustain essential services. Despite the need for a reliable supply of electricity, the electric power sector is not typically engaged when communities plan for hazards.

Disasters such as hurricanes, earthquakes, floods and wildfires pose a tremendous risk to power supplies by compromising a community's electric infrastructure. Communities must consider such impacts in their hazard mitigation plan and projects to reinforce and reimagine their electric power systems now, before the next disaster. Regional power authorities, regulators, renewable energy advocacy organizations and industry experts should be engaged during the hazard mitigation planning process to share their insights on energy efficiency, renewable energy and resilience challenges.

This *Guide to Expanding Mitigation* can help community officials work with the public and private sectors to support hazard mitigation, especially in the planning process and project development. This guide can help community officials initiate a conversation about mitigation investments that will make electric power systems more resilient.

This *Guide to Expanding Mitigation* is part of a series highlighting innovative and emerging partnerships for mitigation.

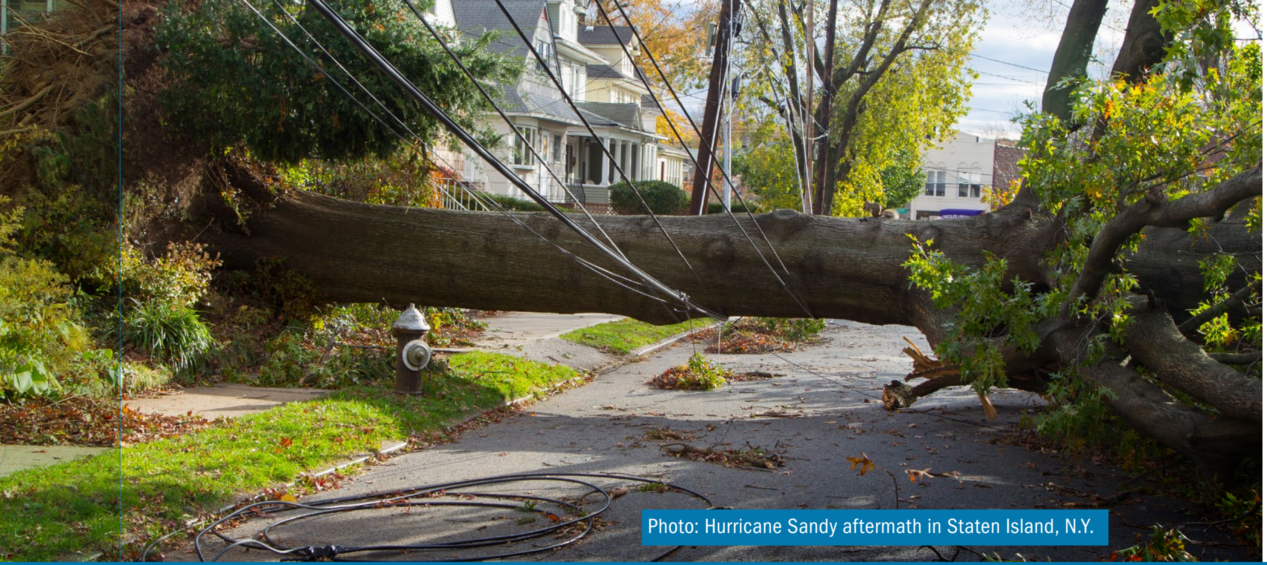

Photo: Hurricane Sandy aftermath in Staten Island, N.Y.

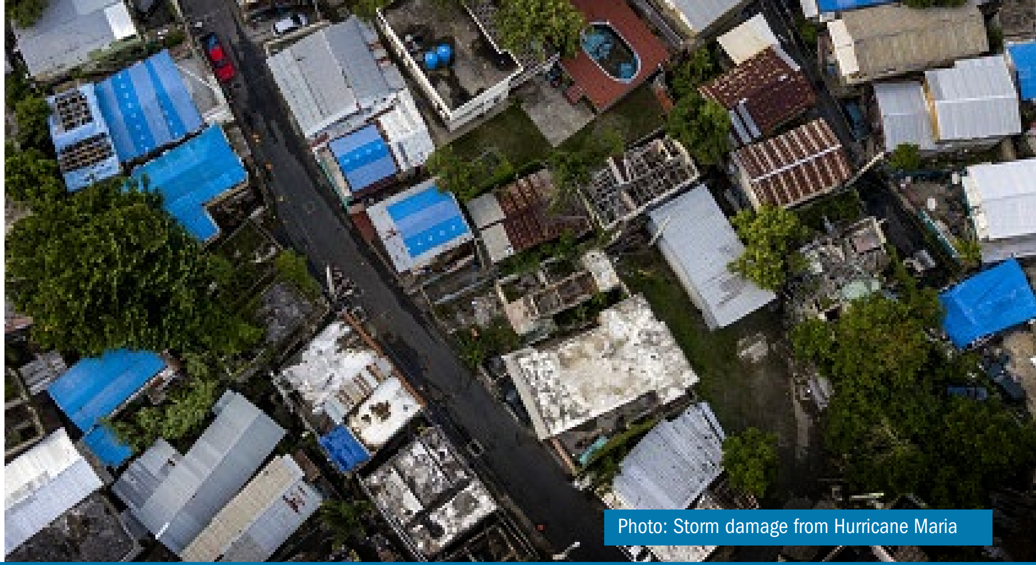

Photo: Storm damage from Hurricane Maria

HOW NATURAL DISASTERS AFFECT ELECTRIC POWER SYSTEMS

The most immediate and significant impact on the electric power sector during a disaster is loss of power. This is especially true for communities with aging or poorly maintained infrastructure. The impact on electric power systems depends on the scale and condition of the system — transmission, distribution and generation — as well as the severity of the event. During adverse weather events, like hurricanes, typhoons, floods, tornados or snowstorms, transmission and distribution networks are often disrupted; power cannot get from point A to point B. Inefficient delivery systems can result in congestion and poor service. Impacts on power generation units and substations can cause additional problems. Water damage is especially difficult to recover from, particularly from coastal flooding because prolonged exposure to saltwater causes corrosion.

Maintaining a stable and efficient electric power system is key to creating a resilient community. Maintaining resilient electricity infrastructure minimizes the extent of power downtime a community experiences after a disaster. A resilient power system is less likely to experience the catastrophic effects of a natural disaster and is more easily repaired.

WHAT IS “THE GRID”?

Power grids connect homes, businesses and other buildings to central power sources. The grid is interconnected, meaning that any disruption to the grid has the potential to affect delivery across the entire system. When a home is disconnected from the grid, it loses access to the electricity that powers light, appliances, electric heating/cooling systems, and electronics, unless electricity can be generated through other means (e.g., solar panels, batteries or a household generator).

Post-disaster recovery is challenging for any electric power system, but that challenge is magnified if the existing infrastructure is not in peak condition.

A community can prepare its power system before a disaster by:

- Evaluating the system’s vulnerabilities — Are the generation units, substations and structures that house them well maintained? Has proper vegetation management been conducted for the transmission and distribution system?
- Evaluating what is needed to bring a system back online after it goes down — Are there enough skilled workers and fuel supplies (e.g., diesel or propane) for generators?

IMPACTS ON AGING AND POORLY MAINTAINED SYSTEMS

Years of improper maintenance and poor vegetation management around electric infrastructure created a perfect environment for Hurricanes Irma and Maria to wreak havoc on power grids. In rural areas of Puerto Rico and the U.S. Virgin Islands, power outages lasted from 4 months to a year. The conditions in these island communities illustrate the need for technical overhauls and design solutions. Equally important are policies to ensure that investments in electric power infrastructure are sustainable. The latest and greatest technological solution may not be the best, given the operational limitations of these smaller, more antiquated systems that are not immediately equipped to handle the addition of new generation and control technologies.

Photo: Power engineers working on high voltage power distribution station

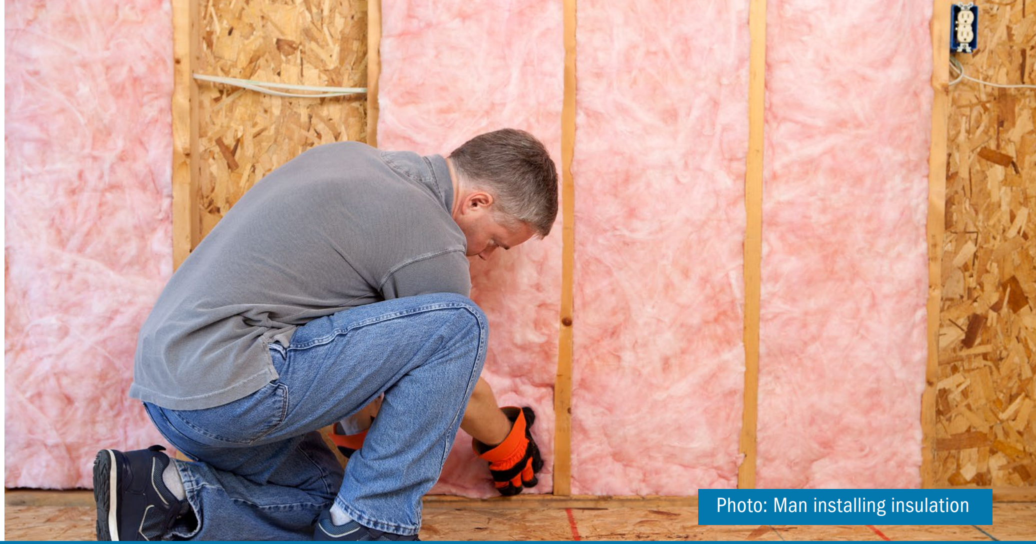

Photo: Man installing insulation

MAKING ELECTRIC POWER SYSTEMS MORE RESILIENT

Community officials can work with electric power professionals to bolster the resilience of their local electric power sector and infrastructure before, during and after a disaster. They should start by asking questions such as:

- Is tthe electric power system mapped—from production, to transmission, to the "last mile"—and do we understand the weaknesses and bottlenecks?
- How do hazards such as hurricanes, earthquakes or wildfires affect electricity production and transmission systems differently?
- How can we harden and support our electric power systems by redundancy and, also, overhaul and transition them to include more renewable, distributed systems?
- What can we do to mitigate the effects of greenhouse gas emissions caused by producing electricity from traditional sources such as fossil fuels?
- Was power lost in the aftermath of a disaster? What component(s) of the system failed? What component(s) of the grid functioned through the disaster?

Preparedness and mitigation measures for electric power systems have different roles in making your community safer. Preparedness (such as having backup generators) increases your community's capacity to respond to, and recover from, disasters more quickly. Mitigation is a more permanent solution to reduce disaster risk in the long run. Using disaster-resilient techniques to build or retrofit critical electric power infrastructure can mitigate risk. Examples include elevating substations above flood levels to improve a power system's performance during floods and upgrading powerlines from wood poles to concrete, steel or composite poles to improve their performance during high winds. Investing in distributed (decentralized) generation and microgrids can also help mitigate the risk to an electric power system.

In addition to evaluating how hazards affect electric power production and transmission, emergency managers and local officials should include mitigation actions for electric power systems in the hazard mitigation plan. Electric power professionals recommend three central mitigation strategies for electric power systems:

1. Increase efficiency by reducing the energy load per building: use energy-saving techniques, like upgrading insulation, reducing electricity loads from lighting and appliances, or revising building design guidelines to reflect local climatic conditions.
2. Bury electric distribution lines to improve system reliability during bad weather or consider investing in concrete, steel or composite poles that can better withstand sustained hurricane-force winds.
3. Develop distributed energy systems by investing in solutions like microgrids, which can be integrated into the traditional grid.

Communities should only consider investing further in backup systems, like generators, after addressing issues with efficiency and load distribution.

RESILIENT AND JUST ENERGY SYSTEMS

Safeguarding the reliability of energy infrastructure includes examining how the system could support environmental justice. Think about which residents in your community are most vulnerable to respiratory issues from living near power plants that burn fossil fuels. Consider those with unreliable power supplies and inadequate heating/cooling. If you are upgrading your energy infrastructure to be more resilient to disasters, can it also be designed to protect your at-risk residents?

ALTERNATIVE ELECTRIC POWER SYSTEMS

Experts predict that extreme weather will continue to jeopardize electric power systems. The need to transition to renewable power sources (including solar, wind, hydro, biofuels and others) is immediate, and strategies to facilitate that transition should be expedited, especially in island communities. Rather than repairing a grid that does not provide sustainable or reliable power, communities should evaluate and shift to new solutions. For example, the U.S. Virgin Islands has a goal to reduce fossil fuel consumption by 60% by 2030, to reduce its dependence on expensive imported fuels. Similarly, New York City has a goal to create 70% of its power using renewable sources by 2030, and 100% by 2050.

The path to using renewables is not straightforward, but resources are available to help communities weigh their options. Without an overarching national policy for renewables, many states have policies that regulate renewables and offer funding for interested communities. The cost of renewables has lowered significantly in recent years and is additionally supported by federal tax credits and similar programs in numerous states.

Solar

Solar technology has evolved considerably in recent years and is much more accessible. Many communities recognize that it is less expensive to generate their own electricity via solar power than to buy from a major supplier. They see solar technology as a hedge against traditional electricity inflation. Solar power helps mitigate the impact of future hazards; it provides redundancy in case of disasters if it has battery backup, and it reduces the emissions from the electric power sector that contribute to the impacts of climate change. Roof- or ground-mounted solar systems can be installed in a storm-resistant manner. Floating solar arrays are an emerging option that can be placed in areas that do not require transmission to get energy where it is needed. Using solar power in emergency situations, however, is still not as competitive as fossil fuel-based tools, like diesel generators, because of economic and structural limitations.

DID YOU KNOW?

Hydroelectric power is a significant source of renewable energy in the U.S. It comes from water flowing from a higher elevation to a lower elevation that is used to turn turbines and generators that produce electricity. Hydroelectric powerplants are located on rivers, streams, and canals and use dams to store water to be released as needed to generate power. Through its National Dam Safety Program, FEMA offers grants to rehabilitate dams, including those that support hydroelectric facilities.

Photo: Solar farm panels

Renewable energy infrastructure is also at risk. Ground-mounted photovoltaic (PV) solar panel systems in Puerto Rico and the U.S. Virgin Islands were damaged during hurricanes Irma and Maria in 2017. This damage added demand to the already delicate grid and negatively affected the restoration time and price of the power supply. It also highlighted the need for proper design and installation to withstand high-power storms. To keep this from reoccurring, FEMA's Mitigation Assessment Team recommended mitigation and preparedness best practices to protect the ground-mounted, grid-connected PV solar facilities.

Microgrids

In addition to renewables, microgrids can help communities build resilient electric power systems. In times of crisis, like storms or power outages, a microgrid can isolate itself from the main grid and operate independently, using local energy generation. A microgrid can be powered by distributed generators, batteries and/or renewable resources, like solar panels. Depending on how it is fueled and how its requirements are managed, a microgrid could run indefinitely.

Microgrids can also cut costs or connect a local resource that is too small or unreliable for traditional grid use. A microgrid allows communities to be more energy independent and, in some cases, more environmentally sustainable. When developing a microgrid project for New Orleans after Hurricane Katrina, the U.S. Department of Energy considered the following questions:

- According to community partners, what characteristics of extreme events would result in the worst consequence to the community? How is that consequence measured?
- In these events, how does the grid perform? What other infrastructure services will be affected by a loss of power? What is the consequence of these service outages?
- What grid modernization technology options will minimize this consequence and best improve community resilience? How would these options be designed to work within the current grid?
- What scale and cost of grid improvements are needed to improve community resilience? How would resilience metrics be best defined and used for future community planning and adaption to future resilience challenges and needs?

ELECTRIC POWER REPRESENTATIVES

Which organizations should you invite to engage in the planning process? The answer will vary based on the community, but consider organizations like these:

- Regional energy companies.
- Water and power authorities.
- Renewable energy experts.
- Academic institutions.
- Energy nonprofits.
- Local electricians.
- Local community groups.
- U.S. Department of Energy.
- Federal Energy Regulatory Commission.

> Through its Energy Transitions Initiative, the U.S. Department of Energy offers technical assistance to support microgrid planning and design. This includes identifying assets, the duration of an outage for which the microgrid would need to run, and how to build the microgrid to operate as part of the grid under steady-state operations.

RESOURCES

Guides to Expanding Mitigation
https://www.fema.gov/mitigation-risk-reduction
Link to all available Guides to Expanding Mitigation.

FEMA Hazard Mitigation Planning
https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning
Review standards and guidance for the planning process.

Database of State Incentives for Renewables & Efficiency
https://www.dsireusa.org/
Learn about incentives and policies that support renewable energy and energy efficiency in your state.

U.S. Department of Energy State and Local Solution Center
https://www.energy.gov/eere/slsc/state-and-local-solution-center
Access resources to enable strategic investments in energy efficiency and renewable energy technologies.

Keep Safe: A Guide for Resilient Housing Design in Island Communities
https://keepsafeguide.enterprisecommunity.org/en/energy-generation-backup
Explore strategies for residential energy generation and backup.

National Dam Safety Program
https://www.fema.gov/emergency-managers/risk-management/dam-safety
Access resources to promote and maintain effective dam safety programs.

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ENGAGE WITH US

Are you a state, local, tribal or territorial official interested in making the connection between electric power and hazard mitigation? Are you an electric power professional interested in connecting with local officials to reduce risk from hazards? Please contact us at FEMA-ExpandingMitigation@fema.dhs.gov.