Photo: Sesame Solar

MOBILE RENEWABLE POWER NANOGRIDS

The Climate Resilience Solution for Essential Services in an Extreme Weather Future

A REAL ENERGY WRITERS WHITE PAPER

SESAME SOLAR
TURNKEY NANOGRIDS. SOLUTIONS INSIDE™

Executive Summary

Climate change-driven extreme weather events are forecasted to increase in frequency and severity across the globe. In the U.S., increased rainfall and flooding in the Northeast has already occurred this spring. The damage done by droughts, fires, hurricanes, tornadoes and extreme storms this year — which stranded many residents without power and essential services for days — is expected to equal or exceed 2021's $145 billion total.

Fortunately, sustainable technology innovations from mobile solar photovoltaics (PV) to hydrogen fuel cells are emerging to meet the moment. The demand from emergency response services to military and government preparedness divisions for rapidly deployable and easy-to-use renewable power generation requires that these innovations meet multiuse case scenarios for extreme weather and emergency response. Essential services after a weather disaster include the need for off-grid power when the grid is unavailable to charge devices and medical equipment, as well as access to communications, clean water, and medical and emergency assistance. Emergency responders don't have the time or personnel to learn new technologies during extreme weather events. They need mobile, turnkey solutions that can be set up in minutes to get power and services when and where needed.

Off-grid power solutions also need to be reliable and sustainably powered so they help communities adapt to climate changes that are inevitable and mitigate those that aren't.

Today, mobile, turnkey nanogrids can be pre-engineered with the renewable energy resources and solutions inside to provide climate change resilience for core essential services and emergency response scenarios. A nanogrid is a group of distributed energy resources (DERs) integrated and managed by a smart control system, which balances energy supply and demand for a small use case.

In this White Paper

Sesame Solar explores the use cases for renewably powered nanogrids in the face of a growing climate threat:

- Learn about several essential service and emergency response scenarios mobile nanogrids can serve.
- Discover the DERs that can combine to create a closed-loop nanogrid that delivers clean, reliable power 24/7.
- Understand the many benefits these systems deliver for customers.
- Read about cases in which mobile nanogrids have already served emergency responders and essential services in the wake of natural disasters.

Introduction

Extreme weather, driven by climate change, has caused a fivefold increase in natural disasters over the past 50 years, according to the U.N. Office for Disaster Risk and World Meteorological Organization. And it's only going to get worse.

In its *Climate Change 2022* report, the U.N. Intergovernmental Panel on Climate Change said the world faces "unavoidable multiple climate hazards over the next two decades" with increased poverty, hunger, death and damage to infrastructure and communities in the offing. The U.S. Department of Defense has identified climate change and extreme weather events as a national security risk.

Climate-driven hazards include worsening weather that will create more frequent wildfires, hurricanes, drought, severe storms and extreme heat. Those are conditions known to knock out power when communities need it most to respond, rebuild and save lives. Texas, unfortunately, stands as a prime case in point. Climate researchers predict extreme weather during future winters and from summer heat, drought and hurricanes remains a threat in the state, where new laws have improved generators' weatherization but do not protect the natural gas supply. "Overlooking other options may allow the climate crisis to keep messing with Texas," according to a Utility Dive report.

Neither mitigation nor adaptation alone are enough. Society needs emissions-free, off-grid, backup power solutions to adapt to and mitigate climate change.

Hospital workers need backup power to maintain or increase care at their facilities when the grid goes down. Health care professionals need energy to deliver mobile clinical care in communities devastated by a natural disaster.

Federal, state and local emergency responders need sustainable, reliable power that can last for days, weeks or months as they work to provide medical and emergency assistance, clean water, shelter, hot showers, communication and other basic necessities in the wake of a catastrophe.

Telecommunications and broadband providers, now a backbone of modern society, need solutions to meet mandates that their services be protected by backup power.

As seen in California—where public safety power shutoffs resulting in power outages that impact communities for hours or even days have become an increasingly common phenomenon because of the risk of wildfires—it doesn't even take an extreme weather event to knock out power. Merely the heightened risk of a natural disaster is enough. Extreme weather in the form of high temperatures also creates high electricity demand that leads to grid brownouts and blackouts.

New Technology Arriving Just in Time

Just as climate change is increasing the need for off-grid power solutions, sustainable technology innovations are rising to meet the moment.

Distributed energy resources powered by renewable energy are opening doors to solutions that create more energy resilience in the face of climate change. Examples include:

- Solar PV.
- Microwind turbines.
- Hydrogen fuel cells.
- Electric battery storage systems.
- Next-gen diesel generators that run on biodiesel and other renewable fuels.

However, unlocking the potential of these technologies is not simple for the businesses, essential services and emergency responders who need them. The technologies need to be delivered to energy users as turnkey solutions that provide reliable, sustainable off-grid power. They need to be mobile, rapidly deployable, easy to use and available at scale.

Solutions must be tailored to the particular customer and service that customer needs. A dairy farm in California that needs off-grid energy to ensure reliable refrigeration presents an entirely different scenario than medical workers setting up a mobile clinic after a disaster that knocks out grid power.

Defining the use case: Off-grid solutions for essential services and emergency response

Everyone can benefit from reliable off-grid power — businesses, factories, farms, homes, municipalities and public-safety operations alike. That said, society relies on certain essential services to function, making those services a priority to keep online at all times, even in the wake of the most severe natural disasters. Core services that require total energy reliability and climate change resilience include:

- **Critical community services**
  Communities can't afford to have hospitals, water delivery and emergency response call centers go offline. While a hospital needs a significant amount of power — requiring a large, dedicated backup power system to remain fully operational when the grid is out — a critical level of service can be provided through simpler, less costly off-grid systems operating at a smaller scale.
- **Medical response**
  Whether it's a natural or human-caused disaster, medical response doesn't always happen in brick-and-mortar care facilities. Whether medical responders need to set up a mobile clinic to temporarily serve a remote community or the National Guard needs to establish a medical response operation, off-grid power at the nanogrid scale can be the answer.
- **Clean water**
  Access to clean water can be disrupted for any number of reasons, whether the local water delivery infrastructure is new, old or nonexistent. A nanogrid can power water purification and deliver clean water.
- **Communications**
  The cell towers and communications infrastructure that create a nearly seamless network of phone and wireless service around the United States require 24/7 electricity to remain operational. Everyone from governments to businesses to private citizens depend on this network for their most important work, meaning a dynamic strategy is needed to keep the network at least partially online in any scenario. Nanogrids can keep critical communications online as emergency power at the site of infrastructure or by powering mobile Wi-Fi stations if infrastructure does go down.
- **Emergency response**
  Emergency response situations require off-grid power for all of the use cases mentioned above because all of them are part of an effective response to deliver the aid and essential services citizens need in dire circumstances. Mobile nanogrid solutions can ensure all of these essential services remain operational in any emergency response scenario.

Photo: Namit Jhanwar

Sesame Solar H2 Nanogrid

A Renewable, Mobile Nanogrid Solution

Sesame Solar designs and manufactures mobile, turnkey nanogrids pre-engineered with the renewable energy resources and solutions inside to provide climate change resilience for essential services and emergency response scenarios.

In a Sesame Solar mobile nanogrid solution, the retractable solar array provides the energy to charge the battery storage system and to produce green hydrogen via electrolyzers. The green hydrogen is then stored at low pressure (less than 300 psi) in onboard solid-state hydrogen tanks, which can be easily and safely transported. Small wind turbines can also be added. Combining complementary forms of renewable energy generation and storage results in a mobile nanogrid with a closed loop of carbon-free, reliable energy and offers days and weeks of energy autonomy—only sunshine and water are required.

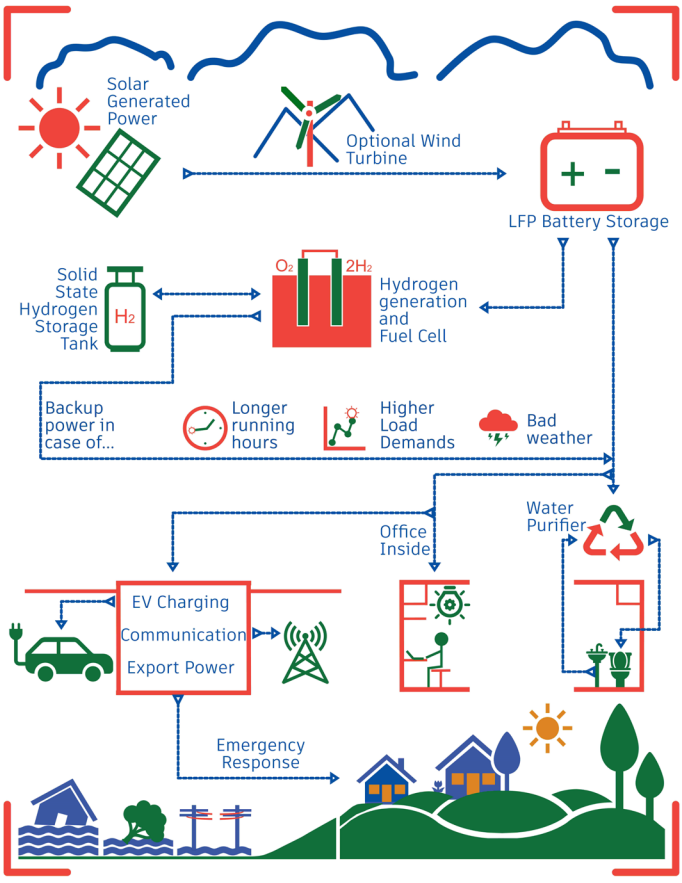
The nanogrid's integrated energy management system ensures the resources are working together to optimize available energy.
Off-grid alternating current power is available from multiple outlets inside and outside the nanogrid. The solar array charges the batteries, and power is managed by the inverter and electronics. When the batteries are at 35% capacity, the hydrogen fuel cell provides power to the inverter. Electrolysis, the process by which hydrogen gas is produced from splitting water molecules, is engaged at the same time the hydrogen fuel cell delivers electricity, so the solid-state hydrogen storage tanks are being refilled with hydrogen while hydrogen is being consumed by the fuel cell. When the batteries have been recharged by the solar array, the hydrogen fuel cell shuts down. Electrolysis continues until the solid-state hydrogen storage tanks are refilled, and then it shuts off as well. In wind favorable environments, a small wind turbine can be added to provide additional power to generate green hydrogen.

The renewable energy inputs and outputs are balanced so that customers experience a reliable supply of energy whether or not the sun is shining. Each nanogrid solution delivers **custom energy, custom design and solutions inside.** They are shipped ready to use to meet the specific needs of the use case.

Custom energy is defined as the sizing of the energy system, including solar array, batteries, inverters and electronics, and the green hydrogen system (water purification, water tanks, electrolysis, hydrogen purification, hydrogen storage tanks and hydrogen fuel cell), based on the energy needs of the service the nanogrid must support.

Custom design describes how the size and weight of the nanogrid is matched with the needs of the user. These systems meet people where they are via designs that range from trailers that can be hauled behind trucks to "boxed" versions ready to be moved by helicopters.

Solutions inside allow the nanogrids to double as facilities specifically designed, built and prepacked for multiuse case scenarios: A mobile clinic, an office, an emergency response center, a mobile retail pop-up or for remote military applications.



Understanding the benefits

What matters to energy users responsible for providing essential services is how these nanogrids make their services resilient in the face of climate change and extreme weather. Benefits include:

- Reliable energy: Off-grid power serves emergency response, essential services, first responders or military operations.
- Easy to use: Built out of tandem axle utility trailers or ISO containers, the nanogrids are preconfigured and shipped ready to use. They can be set up by one person in less than 15 minutes with minimal training. Augmented reality training and field support is embedded in the nanogrid and its energy components to enable nonexperts to rapidly access renewable power generation.
- Sustainable: These nanogrids use 100% renewable energy, providing reliable off-grid power without the use of fossil fuels.
- Easy to transport: Sesame Solar nanogrids can be moved by forklift, crane, truck, train, ship, cargo plane or helicopter for use anytime and anywhere.

Simply “Open Sesame” by electronically unfolding the nanogrid’s retractable solar walls and the energy-independent solution inside is ready to use.

Cases in Point

The best way to understand how a solar nanogrid can meet the needs of essential services and emergency response is to learn about how they have already passed the test. Here, we present four cases of Sesame Solar nanogrid solutions in action.

Comcast’s crisis response offices

After Hurricane Ida, telecommunications company Comcast sought to quickly set up crisis response offices. The company deployed Sesame Solar mobile nanogrids in Houma and LaPlain, Louisiana, opening them in Home Depot parking lots to provide pop-up offices for cell phone purchases and emergency assistance, power to Comcast vans that provided Wi-Fi, and power to large trailers containing toilet and shower facilities.

With its mobile infrastructure in place, Comcast reported the crisis response offices were operational in minutes once the mobile nanogrids arrived, and they operated reliably for days while community disaster recovery continued.

Comcast Crisis Response Nanogrid

Cox Community Connector Nanogrid

Cox's community connectors

Cable television and internet provider Cox deploys Sesame Solar mobile communications nanogrids after extreme weather events, power outages or other emergencies to provide communications and mesh networks in parks, parking lots or schools to keep communities connected.

Grand Fond clinic's post-hurricane response

Hurricane Maria rocked the Caribbean island nation of Dominica in 2017, leading to power outages that lasted for months and impacted the island's roads, access to clean water and medical assistance. Sesame Solar worked with Direct Relief, the largest U.S. medical charity, to provide a mobile nanogrid to support a medical clinic in the remote community of Grand Fond. The mobile nanogrid was configured with a retractable solar array, battery storage and electronics, Wi-Fi communications, a rainwater water filtration system, a furnished workspace, storage and medical grade refrigeration. It has export power generation sufficient to power and charge a wide range of medical and communication devices. It was also filled with medical supplies and humanitarian aid from Direct Relief.

Direct Relief Grand Fond Medical Nanogrid

In a community that frequently stands in the path of major hurricanes, the Sesame Solar nanogrid medical hub is now available to serve as a backup power source for the clinic, a medical triage office, a meeting area for nurses and visiting physicians, and an emergency response command center. Medicines and vaccines can be safely stored when power is out in the clinic, and potable water is now readily available.

US Air Force's medical and security centers

Sesame Solar has an AFWERX SBIR Phase II contract with the U.S. Air Force to make mobile, solar plus green hydrogen-powered medical and security center nanogrids that can be rapidly deployed and easily operated, require minimal training and have sufficient energy autonomy to execute missions in remote areas for extended periods of time, without the need for fossil fuels.

Conclusion

Climate change-driven extreme weather means more power outages and disaster recovery scenarios are in the near future. The status quo of fossil-fueled backup generators and fossil fuel-powered emergency response units needs to change. Fossil fuel generators compound the environmental damage from extreme weather events, adding particulate emissions to air and water as well as contributing to noise pollution. They also add the complication of buying and transporting fossil fuels for the generator, which diverts time and energy better spent supporting the people in need.

Communities need solutions to ensure climate change resilience for emergency response efforts and essential services, especially when the grid is offline. Off-grid power solutions need to be reliable and sustainable so they help society adapt to climate changes that are inevitable and mitigate those that aren't.

Nanogrids that combine solar power with battery storage, hydrogen fuel cells and green hydrogen deliver 100% renewable power in a closed loop that ensures reliable off-grid power. They are quick and easy to set up by a single person, easy to use and shipped ready to meet the specific needs of emergency responders.

Contact Sesame Solar to learn how mobile solar + green hydrogen nanogrid solutions can serve your organization.

sales@sesame.solar
1.734.407.8844
www.sesame.solar

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