RESILIENT POWER

Evolution of a New Clean Energy Strategy to Meet Severe Weather Threats

September 2014

CleanEnergyGroup
Innovation in Finance, Technology & Policy

Abstract

This introductory paper is the first in a series of reports and white papers Clean Energy Group (CEG) will publish in the next two years on the issue of Resilient Power. Resilient Power is the ability of a community to provide clean, reliable energy in the face of power outages, an increasingly regular event due to severe weather. New resilient power technologies can provide electricity during outages, and also at other times so communities benefit fully from clean reliable energy.

Clean Energy Group's Resilient Power Project is designed to help states and municipalities with program and policy information, analysis, finance tools, technical assistance, and best practices to speed the deployment of clean, resilient power systems in their communities. An important focus of the project is to help vulnerable and low-income communities deal with power outages due to severe weather events, as they have suffered disproportionately in damaging storms like Super Storm Sandy and Hurricane Katrina. Installing clean energy technologies such as solar and storage in multi-family housing, assisted living centers, fire stations, and schools that serve as shelters can protect people from harm, reduce pollution, and create community-driven decision making. This paper describes the fifteen-year effort of CEG to make resilient power a major part of disaster planning and energy policy, work that is now showing results in new state and local programs to fund resilient power across the country. But much more needs to be done.

Acknowledgements

This paper is a product of Clean Energy Group and part of a series of reports issued through the Resilient Power Project, a joint project of Clean Energy Group and Meridian Institute. This project works to expand the use of clean, distributed generation for critical facilities to avoid power outages; to build more community-based clean power systems; and to reduce the adverse energy-related impacts on poor and other vulnerable populations from severe weather events. This project has been generously funded by The JPB Foundation, The Kresge Foundation, and The Surdna Foundation. The views and opinions expressed in this report are solely those of the authors.

Introduction

Since 1998, Clean Energy Group (CEG), a national non-profit organization, has worked to expand markets for clean energy technologies, including solar, land-based wind, offshore wind, fuel cells, energy storage, and biomass. In 2002, CEG created and now manages a sister organization, Clean Energy States Alliance (CESA), another nonprofit organization that helps state and municipal clean energy funds to work together to deploy tens of thousands of clean energy projects around the country.

As part of our work, Clean Energy Group has advocated for the use of advanced clean energy technologies in critical public and private facilities that need reliable power during power outages. Instead of depending on dirty and unreliable diesel generations, CEG has advocated for the use of clean, community-driven distributed energy sources like solar PV with battery storage to provide energy security and back-up power in the event of power emergencies.

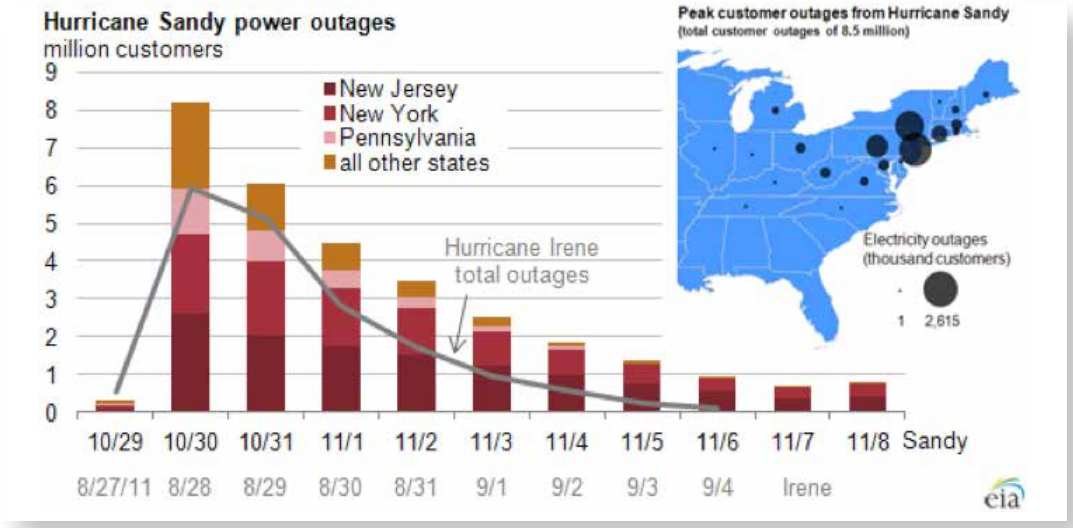
In 2013, with support from major foundations, CEG launched a new national project—The Resilient Power Project—to advance the deployment of resilient power technologies in states and local communities. The project will help communities to better prepare for, and more quickly recover from, damages caused by power outages during destructive weather events, with installations of cleaner distributed energy sources.

CEG will work to help communities install such systems in critical facilities such as police and fire stations, schools that serve as community shelters, multi-family housing, food banks, wastewater treatment facilities, and other locations that need power to keep communities safe when the grid goes down. The project is especially interested in ensuring that these new protective power technologies are deployed in low-income communities, which are particularly vulnerable to grid outages, and which are often overlooked when new, innovative technologies are adopted.

Resilient power, sometimes called "energy assurance," expresses a simple concept: it is the ability to provide needed power, independent of the grid. Because our electric grids are vulnerable to storms and other disasters, the ability to generate electricity to power critical facilities and infrastructure should the grid go down is paramount in emergency planning.

The Resilient Power Project will provide technical assistance on the technology options and on financing solutions that can make resilient power installations more affordable. It will not have the capacity to actually finance projects, but it will work with developers, state and local officials, and finance entities to help provide the best information about the financing options for clean-energy, resilient power projects.

Credit: Robert Hennelly. Used with permission.



Source: EIA, November 12, 2012. http://www.eia.gov/todayinenergy/detail.cfm?id=8730

The vulnerability of centralized electric service to disruption is not a new problem, although it has become more urgent due to the increasing frequency and severity of storms. Hurricane Sandy alone knocked out power to over 8 million utility customers across the Mid-Atlantic states and New England in 2012.

And the vulnerability of communities from power outages, especially low-income and vulnerable populations, has been well documented. According to a recent report, *One Storm Shy of Despair*, by the Center for American Progress, during Superstorm Sandy, 375,000 New Yorkers—including 45,000 public housing residents—lived in the mandatory evacuation zone area hit hard by the storm, yet only 6,800 made their way to emergency shelters.

Many of these low-income, elderly and disabled residents were stranded in their buildings, without heat, power, backup generators, emergency systems, or working elevators. Many had no other affordable place to stay, and no means of leaving their neighborhoods because multiple flights of stairs and mass transit was no longer operating.

The traditional solution to deal with outages has been facility-based backup power in the form of diesel generators. But these are designed to run only during emergencies, and are therefore prone to fail when called upon. Furthermore, once on-site fuel supplies are exhausted, diesel generators are dependent on fuel deliveries that may not be possible during a disaster. And, because they sit idle most of the time, they represent sunk costs without associated value streams.

Clean Energy Group believes a better solution can be found in distributed generation systems, such as solar PV, combined with battery storage, as well as other systems like combined heat-and-power (CHP) systems and fuel cells. Such systems can provide on-going benefits such as energy cost savings and lower emissions, as well as provide emergency power to support local critical loads when the grid goes down.

These clean energy technologies can be scaled down to fit a single facility, or scaled up in a microgrid configuration to support a campus or larger distribution area. They can even create value streams when used to provide ancillary grid services, such as frequency regulation.

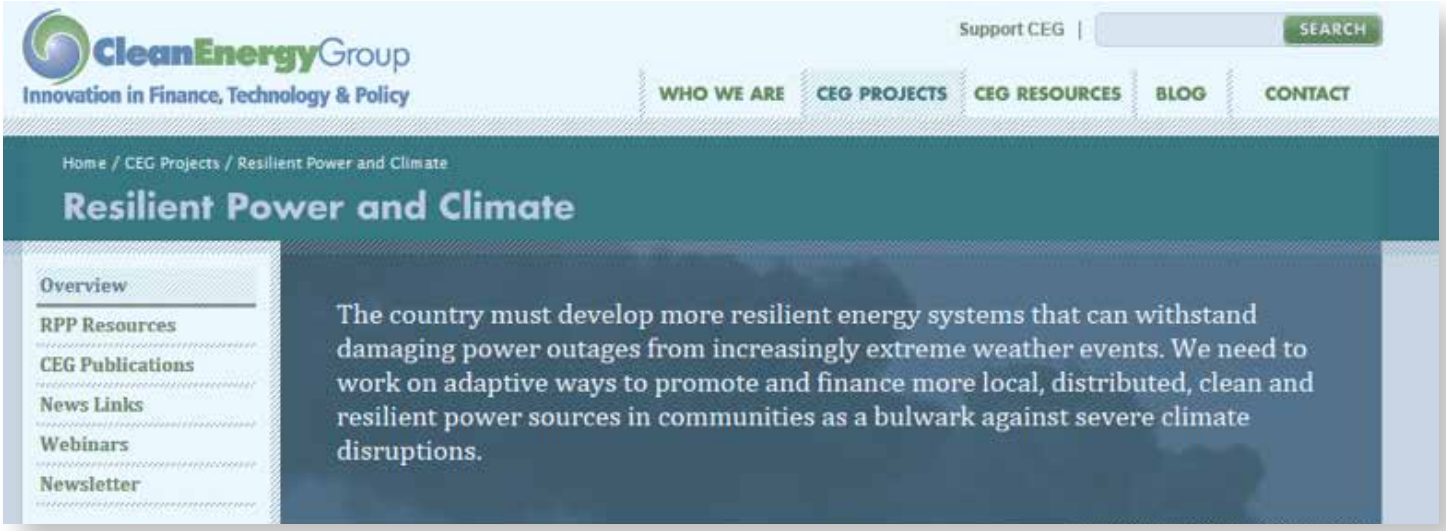
These technologies are available now, however, challenges to their widespread deployment remain, including high first-costs, uncertain value streams, regulatory gaps, and legal hurdles. These challenges are being addressed by declining installed costs, increased adoption of third-party leasing, innovative financing models, emerging markets, and new state policy initiatives. Furthermore, recent experiences with natural disasters such as Superstorm Sandy have provided an unprecedented impetus to make real changes to the status quo.

Clean Energy Group has embarked on a two-year project to accelerate the adoption of new resilient power solutions in states and communities. It will produce a series of reports, analyses, webinars, and information-sharing platforms to inform and educate state and municipal agencies about the need for resilient power planning, the technologies available to include in those plans, and the financing tools that are available to support the deployment of resilient power systems.

This paper, the first in a series of reports and white papers to follow in the next two years, provides an overview of the resilient power work CEG has pioneered over the years, a summary of the current work of the Resilient Power Project, and some examples of how these new technologies are being advanced by public programs. Other reports and case studies are in progress, including a white paper on Resilient Power Finance Options, and a Resilient Power Handbook.

More detailed information, including policy briefs, case studies, white papers, webinars and other materials, along with a link to sign up for the project's e-Distribution List, are available from Clean Energy Group on our Resilient Power Project website: www.resilient-power.org.

RESILIENT POWER
A Project of Clean Energy Group



Learn more about the Resilient Power Project at www.resilient-power.org

Why We Need Resilient Power

Losing power is always an inconvenience, but in many cases it can be life-threatening. Hospitals, nursing homes, 911 call centers, emergency shelters, and other critical facilities need reliable, resilient electrical power to deliver their emergency services to the community when the surrounding power grid is down. Elderly and disabled citizens rely on electrically powered technologies in their homes, as power is needed for pumping water, running elevators, refrigeration for medicines, heating and cooling systems, and respirators. As our reliance on electricity has grown over the last century, so too must its reliability and resilience.

Clean, distributed energy technologies such as solar and high-efficiency technologies such as combined heat and power (CHP) and fuel cells, offer many advantages, including reduced pollution, decreased reliance on fossil fuels, and economic development. But with the addition of new technologies, such as energy storage and microgrids, resilient power systems can provide another major benefit: they can help keep the power on when the electric grid fails.

Traditionally, critical facilities such as hospitals have used diesel-fueled backup generators, but these have several downsides. Diesel backup generators too often fail, as has been seen in several recent widescale outages. By some estimates, more than 60% of the region's diesel backup generators failed during Hurricane Sandy, leading to loss of life, hospital evacuations, and billions in damages.

Besides being polluting, diesel-powered generators require fuel deliveries that are not always possible during natural disasters, and they are often not properly maintained, which contributes to their high rate of failure. Furthermore, diesel generators represent sunk costs for equipment that sits idle 99% of the time.

By contrast, technologies such as solar power combined with energy storage and islanding technology can provide daily benefits to the host facility, including cost savings, and can be disconnected from the grid to continue supplying reliable, safe electricity to a facility when the grid goes down.

Credit: Dave Itzkoff, via Twitter.

Electricity is the life-blood of communities. Without it, nothing works—not only lights but also heating and cooling, refrigeration, transportation, communications, and fueling. Tragically, during disasters, even critical services such as medical, police and fire, and disaster shelters cannot function properly without electricity.

Storms, floods, and other natural disasters have become both more frequent and more damaging. Our ability to deal with these challenges depends on our capacity to adapt to our changing environment and prepare for these events. The technology needed to make electric power more resilient in the face of extreme weather events is available now—our challenge is to adapt and to adopt clean, resilient power quickly.

THE NEW YORK TIMES **OP-ED** TUESDAY, JULY 13, 1999

The Lesson Hidden In the Blackout

By Lewis Milford

MONTPELIER, Vt.

Cancer and AIDS researchers at Columbia University are trying to figure out what crucial material they may have lost when some of their backup generators didn't work during last week's power blackout.

This sad state of affairs should prompt the rest of us to confront a simple truth: our 19th-century electricity system is not suited for 21st-century needs. If we are to prevent similar critical failures in the future, we must look now for smarter energy solutions.

Some companies already have a head start. The First National Bank of Omaha has stopped using electricity from the grid — the interconnected system from which almost everyone gets electricity — as its primary power source. It is now producing its own energy and is using the grid only as a backup. First National, the largest privately held bank in the country, runs the seventh-largest credit card processing operation. The bank needs to be able to crunch large amounts of data 24 hours a day, seven days a week.

That's why the bank has purchased its own system of four fuel cells, which, like batteries, create energy through a chemical process instead of by burning fossil fuels. They are so clean that they are exempt from most air pollution rules.

The bankers aren't doing this because they are environmental activists. The

and public health.

These problems will only get worse. The growing number of desktop computers and data centers running the Internet will increase the demand for high-quality power sources. As a result, computer-grade energy may soon add up to nearly 10 percent of demand for electricity, a figure that will only increase with greater Internet activity.

Most companies spend billions on back-up power systems, batteries or diesel generators to keep their computers running smoothly. These systems are necessary because the regular power system can be quite unreliable. But such stopgap measures can't supply the guaranteed power that computers or other sensitive electric loads need. The New York power blackout proved that. Columbia University's emergency backup generators weren't adequate.

First National Bank of Omaha isn't the only company that should turn to fuel-cell technology. Airports, post offices, telecommunications businesses, computer chip manufacturers — virtually any company or critical city service that needs reliable electric service could benefit from using fuel cells.

Just last week, before the Columbia lab shutdown, Harvard Medical

Time to replace our outdated power supply.

Security Managers Institute NEWS

Proposal for a New Federal and State Partnership

Clean Energy Group's Work on Resilient Power

"Our 19th-century electricity system is not suited for 21st-century needs. If we are to prevent critical failures in the future, we must look now for smarter energy solutions."

Lewis Milford, *Clean Energy Group President*, 1999

Clean Energy Group has advocated for clean and resilient energy technologies to address power outages from severe weather events, since its founding more than 15 years ago. The following is a brief timeline of key events and Clean Energy Group's efforts for resilient power.

1999

In 1999, major blackouts in Manhattan led to the loss of years of work on cancer and AIDS research projects when the diesel-powered backup generators at Columbia University failed and the refrigeration units in the labs were left without power.

At that time, Clean Energy Group had just started working on a project with medical schools in Boston, New York, and Pittsburgh to explore the use of fuel cells to power critical facilities in the health care industry. Major private financial operation centers were beginning to install fuel cell technology as their preferred backup power system, and the potential for fuel cells to power public facilities that needed reliable electric service became obvious.

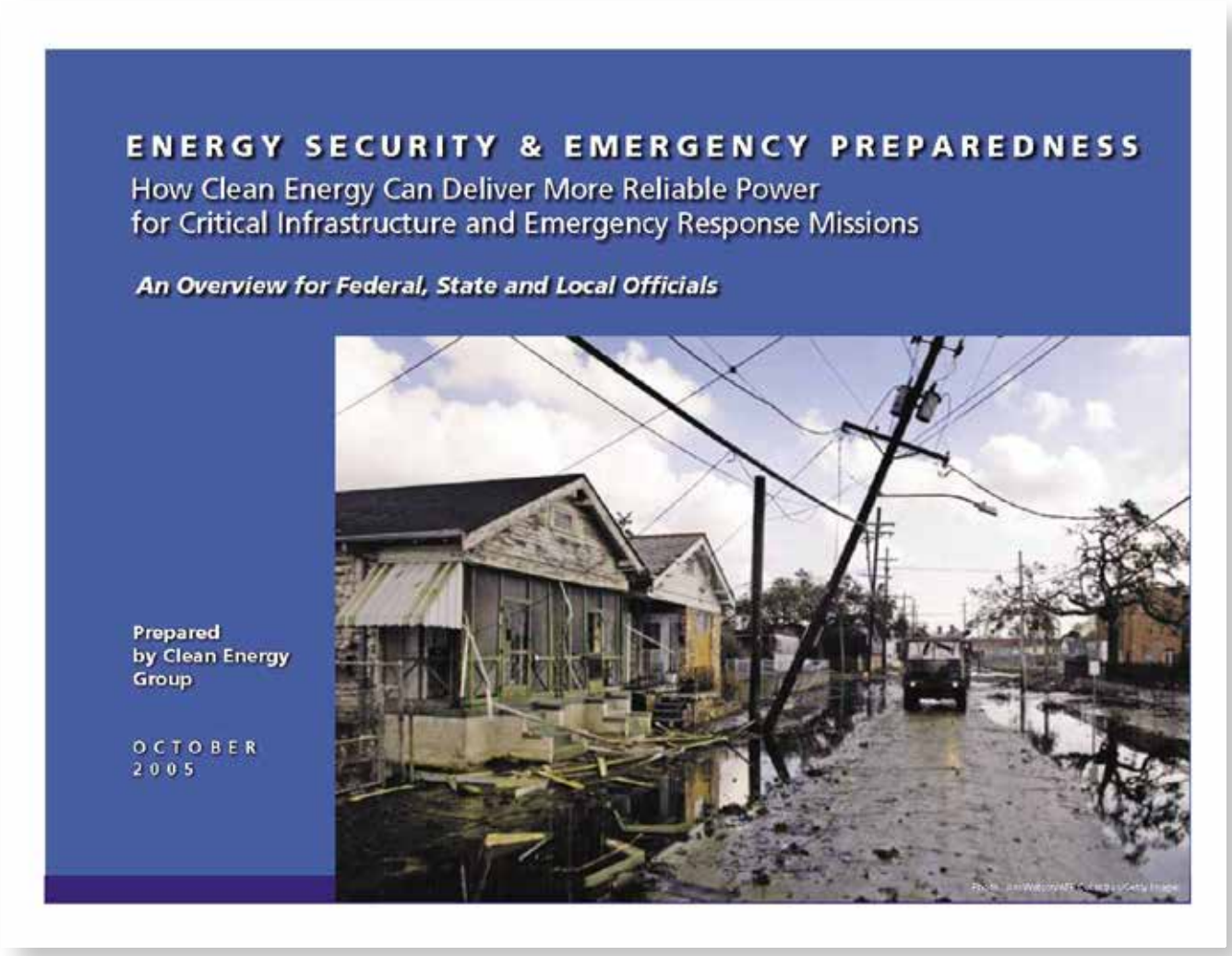
"We need to broaden the use of fuel cells in every industry that needs computer-grade power," wrote Clean Energy Group President, Lewis Milford, in a *New York Times* oped following the 1999 blackouts. "What's the price of losing a cure for cancer because an outmoded diesel generator failed to work?"

2003

After the Northeast Blackout in 2003 and after the September 11th attacks, the national conversation about energy security became defense oriented.

"If the US is to meet the challenge posed by the vulnerability of our energy systems, a new appeal to energy security is needed," stated a 2003 Clean Energy Group report entitled *Distributed Power Generation for Homeland Security*: "Fuel cells and PV are potential aids in seeking security, but other useful technologies include micro-turbines, diesels, and UPS systems… Such technologies would address two related issues: energy independence and increased security."

However, despite the growing understanding about the links between national security and grid stability, emergency management practices in the US continued to focus on post-disaster planning and mass evacuation, not prevention. Resilient power was not widely seen as an important national strategy.



Download the report at http://www.cleanegroup.org/assets/Uploads/CEGCleanEnergySecurityOct05.pdf

2005

In 2005, Hurricanes Rita and Katrina caused massive devastation across the US, and a lack of reliable backup power led to the breakdown of emergency response systems. The result was a public safety crisis with tragic human consequences in New Orleans, especially at the major public hospital that lost power due to flooded diesel generators.

Again, Clean Energy Group called for resilient power solutions: "As Congress and the states take up energy issues in the aftermath of the massive power failures following Hurricanes Katrina and Rita, they should consider one crucial option for energy security—call for the installation of new, more reliable forms of on-site electricity generation at mission critical, public safety facilities." Clean Energy Group's 2005 report, *Clean Energy Security and Emergency Preparedness*, described the ways in which resilient power could have, and in some cases did, mitigate the consequences of the power outages after the storms, and outlined steps towards building better disaster preparedness with resilient power technology.

"While the upfront costs of on-site clean energy systems are higher than most diesel generators, the human and economic costs of depending solely on conventional systems for public safety are now painfully unacceptable. In the future, we cannot afford to rely on the same old energy systems that failed us when we needed them the most."

Once again, major storms had demonstrated the fragility of our power grids. Once again, diesel backup generators had failed when we most needed them. Once again, our communities had paid the price. And once again, this hard-won lesson was soon forgotten.

2012

This cycle of forgetfulness was finally broken with the landfall and devastating consequences of Hurricane Sandy in 2012. After Sandy, many started to realize that we were seeing a "new normal" for severe weather events. The effects of Hurricane Sandy on the East Coast were tragic, all the more so because power outages could have been mitigated.

There was one positive consequence of Hurricane Sandy in the area of energy security. For the first time, the conversation about resilient power did not die down after the storm passed. The public was angry; utilities, hit hard by the storm and struggling to restore power to their service areas, acknowledged that the electric grid was not built to withstand extreme weather events. Sandy was connected in the public dialogue with climate change and its associated risks to cause increasingly severe weather patterns—people began to talk about being better prepared for future storms.

Superstorm Sandy spurred a regional conversation about resilient power, and served as a catalyst for resilient power investment. What's more, the aftermath of Sandy actually drew responses from policy makers and industry towards resilient power solutions. For the first time, state and national policymakers acknowledged a "new normal" that included frequent severe weather events, and began to seriously address the need for resilient power, distributed generation, energy storage and grid modernization.

November 16, 2012 | by Lewis Milford, CEG

Sandy's Power Outages: We Can, And Should, Do Better

Category: Clean Energy Innovation, Resilient Power and Climate 0 Comments

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I'm looking in disbelief at images of Sandy's destruction in New York and New Jersey. I grew up near the Jersey Shore. so this is personal. It's bad up there: lines for rationed gasoline, homes and businesses destroyed. and millions of people still without electricity.

Read the full blog post at
http://www.cleanegroup.org/blog/sandy-s-power-outages-we-can-and-should-do-better

2013

A number of the Northeastern states began working with Clean Energy Group and its sister organization, the Clean Energy States Alliance (CESA), to discuss the need to set up and implement new resilient power programs.

Following Hurricane Sandy, CEG started a dialogue with several New England states that were interested in policy and financing solutions to address their resilient power needs. With seed funding from foundations, Clean Energy Group began the early stages of the Resilient Power Project, initially serving the six Northeastern states of New Jersey, New York, Connecticut, Rhode Island, Massachusetts, and Maryland, and also two West Coast states (California and Oregon).

The goal was to help these states to identify the opportunities and financial tools that could be used to develop clean, resilient power technologies. These states formed a working group to advance resilient power markets, financing and policy options. And the Resilient Power Project was launched.

The Resilient Power Project provides a platform for information sharing, coordination of multi-state efforts to find funding, and technology assistance for resilient power solutions.

2014

The project's goals expanded this year to assist states beyond the Northeast and to work with select municipalities. We also began an aggressive effort to bring the benefits of resilient power to low-income households and communities. With more information about clean energy and resilient power technologies, along with the finance tools to deploy them, communities across the country will have the knowledge to better prepare for extreme weather events and power outages when they occur, and be better positioned to power their way to recovery if disaster strikes.

Our ongoing work through the Resilient Power Project includes hosting information-sharing meetings between participating states, producing reports, white papers, and webinars on resilient power topics of interest, producing the bi-monthly Resilient Power Project Newsletter, and leveraging the resources of our existing project networks, including CESA's Energy Storage Technology Advancement Partnership, and our Clean Energy + Bond Finance Initiative.

To help support the efforts of cities and states with technical assistance, we have engaged engineers from the national laboratories, and we are also working to establish a resilient power technical assistance fund, supported by foundations and dedicated to providing technical assistance/consultant help to municipalities develop resilient power projects, especially those that would benefit low-income or vulnerable populations.

Credit: Maria Blais Costello

Todd Olinsky-Paul, CEG Project Director and Director of Clean Energy States Alliance's Energy Storage Technology Advancement Partnership project, at the August 2014 press event for Green Mountain Power's Stafford Hill PV and Energy Storage Project, with Green Mountain Power CEO Mary Powell, Vermont Governor Peter Shumlin, and US DOE's Energy Storage Manager Dr. Imre Gyuk. See http://www.cleanegroup.org/blog/solar-energy-storage-resilient-power-in-vermont.

How Cities Can Use Solar Energy to Become More Power Resilient

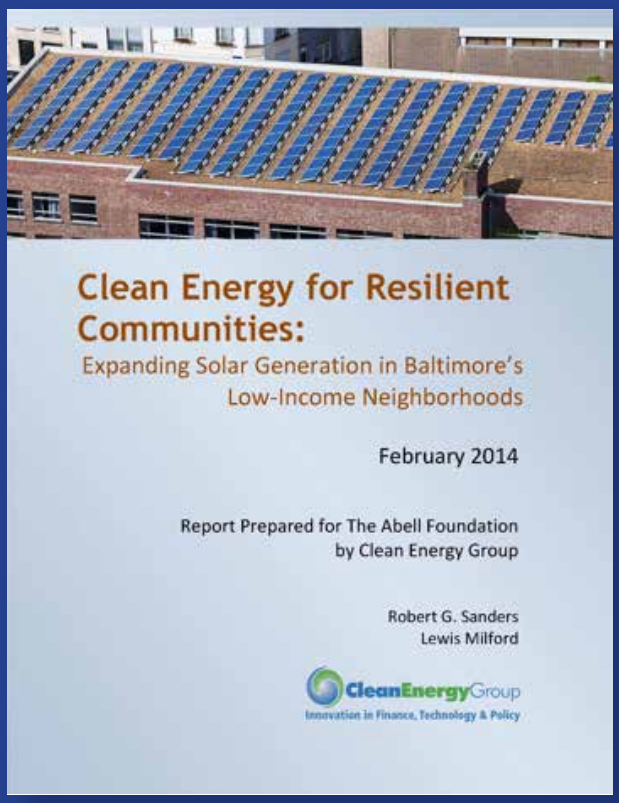
In a blueprint for how a city could become more "power resilient," Clean Energy Group produced a report in February 2014, *Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods*. The report shows how the city of Baltimore and other communities could use clean energy to create a more reliable electric system that protects vulnerable citizens during power blackouts. The report was written by CEG for The Abell Foundation, a leading private foundation in Baltimore. It is a first-of-its-kind, city-specific analysis of what a community can do to use solar and energy storage technologies to protect the low-income community from power outages.

The damage and suffering caused by powerful storms are always compounded by poverty. Low-income areas have more difficulty responding and recovering from the destruction caused by extreme weather events and related power outages. They often lack the income, savings, access to communication channels and information, and insurance to recover from the adverse impacts of extreme weather events.

Some of the report's recommendations for opening clean energy opportunities to low-income communities, and protecting vulnerable populations by securing critical power loads include the following:

- Critical facilities identified in Baltimore's Disaster Preparedness and Planning Project (DP3) report should be evaluated for their suitability for resilient solar power with battery storage.
- The city of Baltimore and its development finance agencies should utilize existing bond financing and credit enhancement mechanisms to develop solar with storage on public buildings and nonprofit-owned facilities.
- Third-party ownership—financed with power purchase agreements (PPAs) or lease-financed—should be considered for solar PV on public schools, libraries, police/fire stations, and other public buildings.
- The city and the state should explore their legal obligations to provide greater power resiliency to ensure that the elderly and the disabled are able to access emergency services during severe weather events. This is based on a recent federal court ruling holding the city of New York liable for violations of the Americans with Disabilities Act by not providing reliable electricity during Superstorm Sandy, resulting in the disabled not being able to equally access disaster relief.

The full report can be downloaded at www.cleanegroup.org/assets/Uploads/2014-Files/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.



The Resilient Power Project's Current Efforts

The projects and programs supported by Clean Energy Group's Resilient Power Project include the following:

- New Jersey's Energy Resiliency Bank (see sidebar)
- Maryland's resiliency through microgrids task force
- New York's microgrids initiative
- Connecticut's microgrid grant and loan pilot program for critical infrastructure resiliency
- Vermont's resilient power solar + energy storage project (see sidebar)
- Massachusetts' resilient power and microgrids solicitation
- New Mexico's energy storage task force
- Oregon's Energy Storage solicitation
- Alaska's energy storage projects
- California's energy storage mandate

Significant new investments in resilient power have been made by a core group of Northeastern states, including:

- Connecticut's $45 million, 3-year microgrids program
- Massachusetts' $40 million, 1-year resilient power program
- New York's $40 million microgrids program
- New Jersey's $10 million, 4-year resilient power program
- New Jersey's proposed $210 million energy resilience bank
- New York's and Massachusetts' grid modernization initiatives
- Utility initiatives, such as ConEd's $66 million CHP program

Several states have also investigated using federal disaster relief funds through C-PACE, municipal bonds, and other innovative financing methods to support resilient power deployment. CESA has also led an effort to find ways to leverage new and emerging markets for energy storage. With our assistance, four states were awarded an NREL technical assistance grant to address this issue. Taken together with additional utility resilient power programs, these initiatives represent more than $200 million in new investments in resilient power in the Northeast.

With more information about clean energy and resilient power technologies, along with the finance tools to deploy them, communities across the country will have the knowledge to better prepare for extreme weather events and power outages when they occur, and be better positioned to power their way to recovery if disaster strikes.

To learn more about the current activities of the Resilient Power Project and to sign up for our e-Distribution list to receive the Resilient Power Newsletter, and to be notified of upcoming webinars, reports, news and information on resilient power, go to www.resilient-power.org.

New Jersey Creates the First Energy Resilience Bank to Support Resilient Power Projects

In July of 2014, New Jersey created the nation's first Energy Resilience Bank (ERB). The ERB is an important step to create new public financing to support local, distrib-uted resilient power projects that can provide continuous power before, during, and after severe weather events like Hurricane Sandy.

This innovative approach would be financed through use of $200 million of New Jersey's second Community Development Block Grant-Disaster Recovery (CDBG-DR) allocation. The New Jersey Board of Public Utilities (NJBPU) approved a sub-recipient agreement with the New Jersey Economic Development Authority (EDA) to work jointly in the establishment and operation of the ERB. According to the Governor Christie's announcement, "the ERB will support the development of distributed energy resources at critical facilities throughout the state …to minimize the potential for future major power outages and increase energy resiliency."

The ERB will make direct loans and grants, but can also provide credit enhancement for bond issuances and other private financing participations. Although the initial priority is clean water and wastewater treatment facilities, other critical facilities could also be funded, including hospitals, emergency response facilities, municipal town centers, correctional facilities, transportation and transit, public housing and regional high schools that can be used as shelters in case of emergency.

With this effort, New Jersey has created what could become a national model to finance resilient power projects to deal with severe weather events. This is especially important as severe weather creates havoc in the power sector, where power outages harm businesses, threated lives and disrupt vulnerable groups from recovering. After Superstorm Sandy, more than 8 million people were without power, causing hundreds of millions of dollars of damage, disrupting lives for the elderly, the poor and the disabled.

For more information, see the press release and the state's Sandy action plan amendment linked in the CEG Blog Post from July 30, 2014 at www.cleanegroup.org.

July 30, 2014 | by Lewis Milford, CEC President

New Jersey Creates Nation's First Energy Resilience Bank

Category: Clean Energy Finance , Clean Energy States Alliance, Resilient Power and Climate 0 Comments

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New Jersey recently created the first-in-the-nation "Energy Resilience Bank (ERB)." Designed to address a repeat of the devastating impacts of SuperStorm Sandy, when over 8 million people lost electric power in the region, the ERB will provide $200 million for municipalities to finance clean resilient power solutions. This will include "projects that would ensure a highly reliable power supply to critical public facilities such as water and wastewater treatment plants, hospitals, shelters, emergency response centers and transit networks in the event the larger electrical grid fails."

Source: http://www.cleanegroup.org/blog/new-jersey-creates-nation-s-first-energy-resilience-bank/

GMP Energy Storage Project Stafford Hills, Rutland, VT

Green Mountain Power, Vermont Public Service Department, Clean Energy States Alliance, and the US Department of Energy participated in the groundbreaking ceremony in August 2014 for new solar + storage microgrid project in Rutland, Vermont. The Stafford Hills project is being developed and funded by Green Mountain Power, in collaboration with Dynapower, GroSolar and Solar Grid Storage. The project's energy storage component is co-funded by a unique federal-state-NGO partnership involving the state of Vermont, the US Department of Energy, Office of Electricity, and the Energy Storage Technology Advancement Partnership (ESTAP), a project managed by Clean Energy States Alliance and Sandia National Laboratories. This project is unique in several ways:

- It is one of the first exclusively solar-powered microgrids in the US, and the first to provide full back-up power to an emergency shelter on the distribution network;
- It is the first solar+storage microgrid to be developed on a landfill site, contributing to brownfield redevelopment efforts in Rutland, VT;
- It incorporates 7,722 solar panels, capable of generating 2.5 MW of electricity, helping GMP to reach its goal of making Rutland, VT the Solar Capital of New England, and helping Vermont to reach its renewable energy goals;
- It incorporates 4 MW of battery storage, both lithium ion and lead acid, to integrate the solar generation into the local grid, and to provide resilient power in case of a grid outage;
- It will provide resilient power to a Rutland school that serves as a public emergency shelter (additional critical facilities may be similarly supported by this microgrid in the future);
- It will provide clean, distributed generation and resilient power to an economically challenged, urban community that is targeted for revitalization, and that suffers frequent power outages due to storms;

This project puts Vermont in the forefront of the new movement toward microgrids, energy storage, and grid modernization. Solar + storage and microgrid technologies are poised to revolutionize the electric grid, bringing clean, resilient, locally-generated power to communities all over the world. These systems strengthen grids and can keep critical facilities, such as emergency shelters, firehouses and fueling stations, operating when the grid goes down. With this project, Vermont takes a giant step toward addressing its resilient power needs, as well as meeting Vermont's clean energy and emissions reduction goals.

Learn more at http://www.greenmountainpower.com/innovative/solar_capital/stafford-hill-solar-farm/.

Source: Green Mountain Power

Finance Tools for Resilient Power

As more communities begin to make resiliency plans for the impacts of climate change and for emergency planning, having access to reliable power will be critical to implement those plans in a crisis. Though many community leaders would like to prepare for power outages using clean energy technologies, many municipal officials may not be aware that they have a suite of financing options and models from which to choose when considering how to support the deployment of resilient power technologies at public critical facilities.

Financial support for resilient power can take many forms, ranging from third-party ownership with power purchase authority (PPA) financing to a variety of bond financing tools. Other financing mechanisms include credit enhancement structures using system benefit charges (SBCs) for bonds and other private finance, New Market Tax Credits (NMTCs), and new public/private financing structures that allocate risk and reward among parties based on long-term project performance (West Coast Infrastructure Exchange).

Resilient power projects can also be financed with commercial/municipal PACE bonds that are repaid through secured annual property assessments, or by means of municipal improvement districts or casino impact grants, or through utility owned and ratepayer-supported models. These financing options are discussed below and are covered in more detail in an forthcoming report on Resilient Power Finance.

Options for Resilient Power Financing include:

1. *Third-party ownership with PPA financing*
2. *General obligation bonds for resilient power on critical public facilities*
3. *Morris Model (private developer/public bond/public facilities)*
4. *West Coast Infrastructure Exchange model*
5. *501(c)(3) bonds (nonprofit-owned hospitals, schools and other facilities)*
6. *Housing bonds (low income/elderly)*
7. *School construction bonds*
8. *Public benefit funds (also called system benefit charges)*
9. *New Market Tax Credits*
10. *Commercial/municipal PACE bonds*
11. *Municipal improvement districts*
12. *Casino local impact grants/licensing requirements*
13. *Utility owned and financed microgrids with resilient power*

State and federal grants and loans may also be available to help support resilient power system deployment. Furthermore, due in large part to recent FERC orders, new markets have opened for energy storage operators to access value streams by selling ancillary services, demand response, regulation services, and other energy services that batteries are adept at producing. New third-party battery companies are beginning to take advantage of the revenue streams made possible by these FERC orders. These companies provide a battery and inverter at no up-front cost, co-located with a solar PV or other distributed generation system. They stack value streams to earn money by selling grid services and reducing local energy costs.

Such new business models can make it much easier for customers to add storage to existing solar PV systems, or to build storage into new systems, through leasing or PPA arrangements, similar to the third-party models that have greatly expanded the deployment of PV systems.

New public resources combined with innovative financing models—as well as old finance tools used in new ways—are beginning to be applied to resilient power for critical facilities and infrastructure. In the coming years, we expect states and municipalities will begin to address barriers to resilient power deployment through additional funding programs. These programs will tackle technical, policy, financial and market barriers. Markets for resilient power will continue to develop, and resilient power will become an established and accepted part of any state or local public resiliency plan, with committed funding, technical support and program assistance.

For more information about financing, business models and markets, see Clean Energy Group's paper, *Financing Options for Clean Resilient Power*, will be available online at http://www.cleanegroup.org/ceg-resources/recent-ceg-reports/.

Resilient Power for Vulnerable Communities

A recent report from the Center for American Progress, *Heavy Weather: How Climate Destruction Harms Middle- and Lower-Income Americans,* finds that "on average, counties with middle-and lower-income households were harmed by many of the most expensive extreme weather events in 2011 and 2012." The report reinforced what we already knew: vulnerable communities, including the elderly, disabled and economically challenged, are more vulnerable than the general population to destructive storms and the power outages they create.

For the elderly and disabled, flooding, heat waves, ice and snow storms, and other natural disasters may present life-threatening challenges—and the lack of resilient power in retirement homes, assisted living facilities, and public shelters can exacerbate the problem. For example, if elevators are not running, these people may not be able to use the stairs to evacuate their homes or to access shelters. If shelters don't have resilient power to provide heat and air conditioning, refrigeration for medicines, and to recharge electronic medical and mobility devices, the elderly and disabled may not be able to shelter there.

By providing appropriately sized resilient power, vulnerable multi-family housing residents would be able to shelter in place during extended power outages, which would in turn reduce demands on overwhelmed first responder and emergency shelter services. Community-based, small resilient power installations would protect low income, elderly and disabled populations—the people who have the greatest difficulty responding and recovering from the destruction caused by extreme weather events and related power outages.

Financing resilient power may be more challenging in low-income neighborhoods, but the need is greater as well. Clean Energy Group is committed to helping municipalities find ways to deploy resilient power to serve vulnerable populations. Please see a paper Clean Energy Group prepared for the Abell Foundation, "Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods," at http://www.cesa.org/assets/2014-Files/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

Resilient Power and the Disabled

The importance of resilient power for vulnerable populations was underscored in November 2013, when a federal court ruled that New York City did not do enough to protect the disabled during Hurricane Sandy. While praising the city generally for its post-Sandy relief actions, the court found that the city violated the Americans with Disabilities Act by not providing resilient power to public shelters, thus failing to provide equal access for people with disabilities. This was the first such ruling in the country.

People with disabilities often depend on access to electricity for mobility and medical devices. For many, an emergency shelter is a safe spot for refuge only if the elevator is working in the buidling they need to leave or enter, if refrigeration is available for medicines, and if electricity can be provided for electronic medical devices and wheelchairs—meaning the shelter must have electric power even when the surrounding grid does not.

This ruling highlights the existing legal obligations of public agencies across the country. If upheld, it could have significant national implications for how cities plan to protect the disabled during disasters and, by extension, how they plan to protect the general population.

This is no small problem. According to the most recent census, almost 20% of the total U.S. population, 73 million people, are considered disabled. And among the elderly, the percentage of disabled rises to 30-40 percent.

Much has been written about how climate emergencies in the future will disproportionately harm these vulnerable populations. Now, for the first time, those warnings are backed by legal obligations that cities and states ignore at their peril.

Credit: Melpomene/Bigstock.com

A Brief Description of Resilient Power Technologies

Clean Energy Group is focused on advancing "appropriate technology solutions" for community-scale or building-scale resilient power projects, especially for those that would power critical facilities or emergency shelters. Below we will briefly describe four technologies—solar+storage, stationary fuel cells, microgrids, and CHP systems—that are being developed for those small-scale applications. Other technologies exist, but we will highlight these four in this short introduction.

Solar + Battery Storage

When Hurricane Sandy hit the Northeastern United States, many people who had invested in solar panels were surprised to find that their solar PV systems did not continue to generate electricity after the grid went down. For safety reasons, the vast majority of solar PV is configured to operate only when the grid is functioning.

Even if a solar PV system were configured to "island" in case of a grid outage, most do not include battery storage; and without it, the system will not provide needed power. Electricity generation from solar panels ramps up and down quickly depending on cloud cover, and this variable electricity output, if is not regulated (by inverter) or stored (by a battery), can damage electrical equipment, and cannot be relied upon to provide a steady supply of power.

In order for a PV system to be resilient, it needs energy storage. A battery can be used to regulate the output of electricity generated from solar PV systems, thus making it safe and dispatchable (ready and waiting if it is needed). With a solar+storage system, rather than powering local loads directly, the PV system now charges the battery, which is dispatched to meet the variable demand for the electricity by the home or facility.

The potential value streams for solar+energy storage system for critical facilities include the potential value-added to a community when the facility being served by the system provides power to essential services during a grid outage or natural disaster. This value-added can be immense, ranging from billions saved by businesses and research institutions, to lives saved by providing resilient power to emergency shelters, first responders, medical facilities and the like. In a world where extreme weather events are growing both more frequent and more severe, the value of these benefits continues to grow.

Clean Energy Group has written a blog on how solar storage systems work; see http://www.cleanegroup.org/blog/solar-storage-the-new-resilient-clean-energy-technology/. See also page 8 in the *Clean Energy for Resilient Communities* report at http://www.cleanegroup.org/assets/Uploads/2014-Files/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

Microgrids

A microgrid, also called a localized power grid, is an energy generation network that is connected to the main power grid but has the ability to generate and store energy independent of the main grid. In the event the main grid has a power outage, the microgrid will be able to disconnect from the main grid, "island" itself, and continue to provide power to its local network. The network of a microgrid might include a single building, a retail area, a hospital, or a neighborhood.

Energy generators within a microgrid can include fuel cells, solar power, wind power, and other small-scale renewable technologies. Microgrids embody the concept of "distributed generation," which means relying on multiple small and localized sources of energy production rather than one large centralized power source that must transmit energy long distances. Distributed generation is more energy efficient and encourages the development of alternative energy technologies.

Microgrids are typically equipped with "smart grid" technology, which tracks information about how energy is being used throughout the grid network. his technology allows the system to selectively disable power from some uses in order to prioritize critical power needs during a power outage.

Besides the benefit of resilient power, microgrids are also appreciated for the independence they provide from the grid and big utilities, as they can allow local users to have

more choices and control over their power sources. CEG and CESA have produced several informative webinars on microgrids, including:

- An Introduction to Fuel Cell Applications for Microgrids and Critical Facilities, see http://www.cesa.org/webinars/cesa-webinar-an-introduction-to-fuel-cell-applications-for-microgrids-and-critical-facilities
- Microgrid Technologies: A Guide to CHP, Energy Storage, PV and Fuel Cells, see http://www.cesa.org/assets/Uploads/ESTAP-Webinar-Slides-4.4.14.pdf
- Energy Storage Solutions for Microgrids, http://www.cesa.org/webinars/showevent/estap-webinar-energy-storage-solutions-for-microgrids?d=2012-11-07

Other resources on microgrids include:

- Resilient Power Case Study: CT DEEP Microgrid Project, see http://www.cleanegroup.org/assets/Uploads/2013-Files/Reports/CT-Microgrids-project-summary-Sept2013.pdf

Fuel Cells

Fuel cells are an ideal primary power source, providing both an extremely reliable and high-quality source of on-site power. This reliability makes them ideal for public safety facilities such as 911 dispatch centers, police and fire stations and hospitals. For private facilities such as computer server farms, data centers, and laboratories where even momentary losses of power or voltage changes can disrupt computers and sensitive equipment, fuel cells deliver the sustained power quality needed and can use the grid power acting as a backup. Even non-critical facilities such as office buildings, retail stores, and hotels can benefit from a grid-independent source of power that can also provide heat for heating, cooling and refrigeration.

Stationary fuel cells result in dramatically reduced on-site air pollution relative to backup diesel generators. They can also result in reduced emissions relative to grid power depending on the source of generation that is displaced. This is due the fact that fuel cells are driven by electrochemistry versus high-temperature combustion; if the fuel input is hydrogen, then only water vapor is generated in the exhaust. Because of the high electrical efficiency of fuel cells, the amount of CO_2 emitted per kWh of electricity generated is lower than from conventional fossil-fuel generation. Avoided emissions are further increased when the facility is configured to utilize the waste heat from the fuel cell.

Fuel cells can be deployed in any commercial, industrial, or institutional setting where a reliable source of base-load, on-site power is desired and, ideally, where waste heat generated by the system can be effectively utilized for process or space heating and cooling. They are also well-suited as alternatives to batteries or diesel generators for strictly back-up power applications, particularly in remote areas (such as cellular phone towers), and in urban areas with air quality issues and critical public safety facilities.

For more information about fuel cells, see a collection of briefing papers prepared by Clean Energy States Alliance at http://www.cesa.org/assets/2011-Files/Hydrogen-and-Fuel-Cells/CESA-Fuel-Cells-Brifing-Papers-for-State-Policymakers-Aug2.pdf.

Combined Heat and Power (CHP)

Combined Heat and Power, also known as cogeneration, is an integrated electricity and thermal energy system that generates electricity on-site and recovers waste heat for heating, cooling, or other applications. Many facilities with large electric and heat loads, such as hospitals and universities, employ CHP systems to generate a portion of their heat and electricity. With waste heat recovery, CHP can provide improved fuel efficiency and reduced emissions, improved power reliability, and energy cost savings. If designed to operate independent from the electric grid, CHP systems can provide uninterrupted heat and power to their host facility when the grid goes down. This was demonstrated during Superstorm Sandy power outages in New York City, when a number of large institutions in Manhattan that had invested in CHP systems were able to remain up and running, while the buildings connected only to the grid were left in the dark.

The U.S. Department of Energy (DOE), the U.S Department of Housing and Urban Development (HUD), and the U.S. Environmental Protection Agency (EPA) have produced a guide that provides useful information on CHP applications for resilient power. The guide is titled "Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings" and is available at http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_for_reliability_guidance.pdf.

Conclusion

With the Resilient Power Project, CEG will work to accelerate the adoption of clean energy technologies to meet severe weather threats. For too long, disasters have brought power outages and little was done to prepare better for the next one. This time, after countless hardships on so many communities from weather events like Superstorm Sandy, the public has demanded a new approach.

As in so many other areas, even with this new public demand, advocacy is needed to ensure vulnerable populations share in the benefits of new resilient energy technologies. That will be a key focus of our work. We need to work harder to make sure the poor, the elderly and the disabled—those most in need of protection—can get it when their world is put at greater stress from severe weather events.

If we are successful, in a few years, more resilient power projects will be installed in community shelters, food banks, affordable housing, assisted living and other places where vulnerable communities are protected.

They will be sheltered from the storm.

Credit: Geoff Stearns @ Flickr Creative Commons

Clean Energy Group - Resilient Power Project Staff

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President and Founder of Clean Energy Group

Lewis Milford is president and founder of Clean Energy Group (CEG) and founder of the Clean Energy States Alliance (CESA), two national nonprofit organizations that work with state, federal, and international organizations to promote clean energy technology, policy, finance, and innovation. For Clean Energy Group, Mr. Milford directs the Clean Energy Finance Project (www.cleanegroup.org/ceg-projects/clean-energy-finance/) and the Resilient Power Project (www.resilient-power.org) as well as other projects involving natural gas and renewable power. Mr. Milford is also a nonresident senior fellow at the Brookings Institution. He works with many public agencies and private investors in the United States and Europe that finance clean energy. Mr. Milford is frequently asked to appear as an expert panelist at energy conferences throughout the United States and Europe. His articles on clean energy have appeared in many publications including The New York Times, The Boston Globe, The National Journal, The Huffington Post, and Solar Today. He has a J.D. from Georgetown Law Center. LMilford@cleanegroup.org

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Clean Energy Group

Clean Energy Group (CEG) is a national, nonprofit organization that promotes effective clean energy policies, develops low-carbon technology innovation strategies, and works on new financial tools to advance clean energy markets. CEG works at the state, national, and international levels with stakeholders from government, the private sector, and nonprofit organizations. CEG promotes clean energy technologies in several different market segments, including resilient power, energy storage, solar, and offshore wind. Above all, CEG also works to create comprehensive policy and finance strategies to scale up clean energy technologies through smart market mechanisms, commercialization pathways, and financial engineering. CEG created and now manages a sister organization, the Clean Energy States Alliance, a national nonprofit coalition of public agencies and organizations working together to advance clean energy through public funding initiatives.

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Innovation in Finance, Technology & Policy

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