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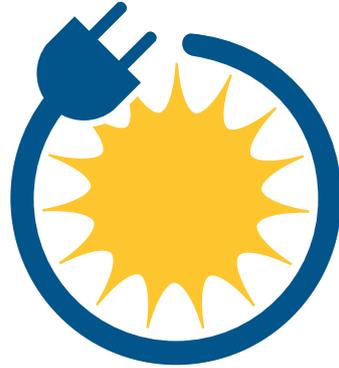
# RESILIENT SOLAR

Powering and Empowering  
Communities



Stories of communities  
building resilience with solar  
and energy storage.





# RESILIENT SOLAR

Powering and Empowering Communities



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# ABOUT THIS DOCUMENT

Communities across the U.S. are exploring how resilient solar can help strengthen community resilience, advance renewable energy goals, and best serve vulnerable neighborhoods during disasters.

The Institute for Sustainable Communities (ISC) is at the frontlines of this work. We helped each of the communities showcased in this report advance their projects, face obstacles, develop innovative strategies, and create models for others to adopt and adapt. While these projects are not fully implemented, we hold them up as promising examples of how resilient solar can power—and empower—communities.

This publication showcases efforts in four U.S. cities—New York, Baltimore, Duluth, and San Francisco. With strong leadership provided by community-based organizations, universities, and municipalities, these collaborative resilient solar projects are demonstrating the power to profoundly improve the health, safety, and well-being of communities, particularly those that are historically underserved and often most vulnerable to disaster. This report tells the stories of trailblazing resilient solar projects and connects readers to tools, resources, and lessons learned that they can put to use in their own communities.

The path to advancing resilient solar is different in each of our showcased cities—while some are working to move from one or more projects to a larger strategy, others are working on a citywide strategy and then scaling down to identify particular projects. These varied approaches reflect the unique needs and priorities of each community. Consistently across all projects, we observed that successful approaches were adaptable, created strong partnerships and opportunities for engagement, learned from those with experience, and considered the ongoing operation and maintenance of the resilient solar projects.



## DEFINITION OF RESILIENT SOLAR

For the purposes of this report, *resilient solar* is defined as the combination of solar power generation and energy storage. Unlike a traditional solar array, which cannot operate during outages, a resilient solar system is designed to provide power to critical community facilities such as shelters, medical facilities, and public safety buildings when the electrical grid is down.

# INTRODUCTION



Cities are increasingly focused on the need to strengthen their resilience. Faced with unprecedented natural disasters, economic uncertainty, social unrest, and other risks, communities are working to identify the actions they can take to strengthen their social, economic, and environmental footing. **As communities grapple with these challenges, innovative and cross-cutting solutions are emerging. We believe resilient solar is one of these solutions.**

The Institute for Sustainable Communities (ISC) ([www.iscvt.org](http://www.iscvt.org)) works at the nexus of clean energy and community resilience through two different programs. For the past three years, ISC has served as the national coordinator for the U.S. Department of Energy's Solar Market Pathways Program (SMP) ([solarmarketpathways.org](http://solarmarketpathways.org)). Through this initiative, ISC has been working to expand solar markets by supporting 14 solar projects across the nation. This has led to work on



cutting-edge solar deployment strategies with cities such as New York City; Duluth, Minnesota; and San Francisco—all featured in this publication. ISC’s Partnership for Resilient Communities ([bit.ly/isc-prc](http://bit.ly/isc-prc)), which began in 2016, supports community-based organizations working to deliver lasting, transformative, equity-driven solutions to address energy and water issues. Through this partnership, ISC has been working closely with Living Classrooms Foundation of Baltimore on their effort to incorporate resilient solar at community centers in some of Baltimore’s most underserved neighborhoods.

Solar power is advancing faster than ever—technologies are improving and prices have fallen significantly. There are now 1.5 million solar projects across the United States, producing more than 47 GW of energy. In 2016, solar represented 39% of all new electric generating capacity, topping all other energy sources for the first time ever. Over the last five years, the price of solar has dropped by 55% across the country.<sup>1</sup> While not as dramatic, the price of energy storage has also rapidly declined and the types, sizes, and efficiencies of batteries are increasing to provide consumers with more choices to suit their project needs. These advances are making resilient solar a viable option for communities that want to ensure they have reliable, clean power ready to meet the needs of their residents.

Too often, however, there is profound divide between those who have access to clean energy or power during emergencies, and those who do not. ISC is committed to closing that divide. Grid failures and natural disasters often hit low-income communities the hardest and can reveal long-standing systemic injustices (e.g. lack of infrastructure investment in specific neighborhoods). ISC supports the deployment of community-based energy sources to ensure the clean energy movement, and its potential for economic and environmental resilience, is beneficial to all.



*Students and solar instructors tour the rooftop solar panels at the National Renewable Energy Lab in Golden, Colorado.*

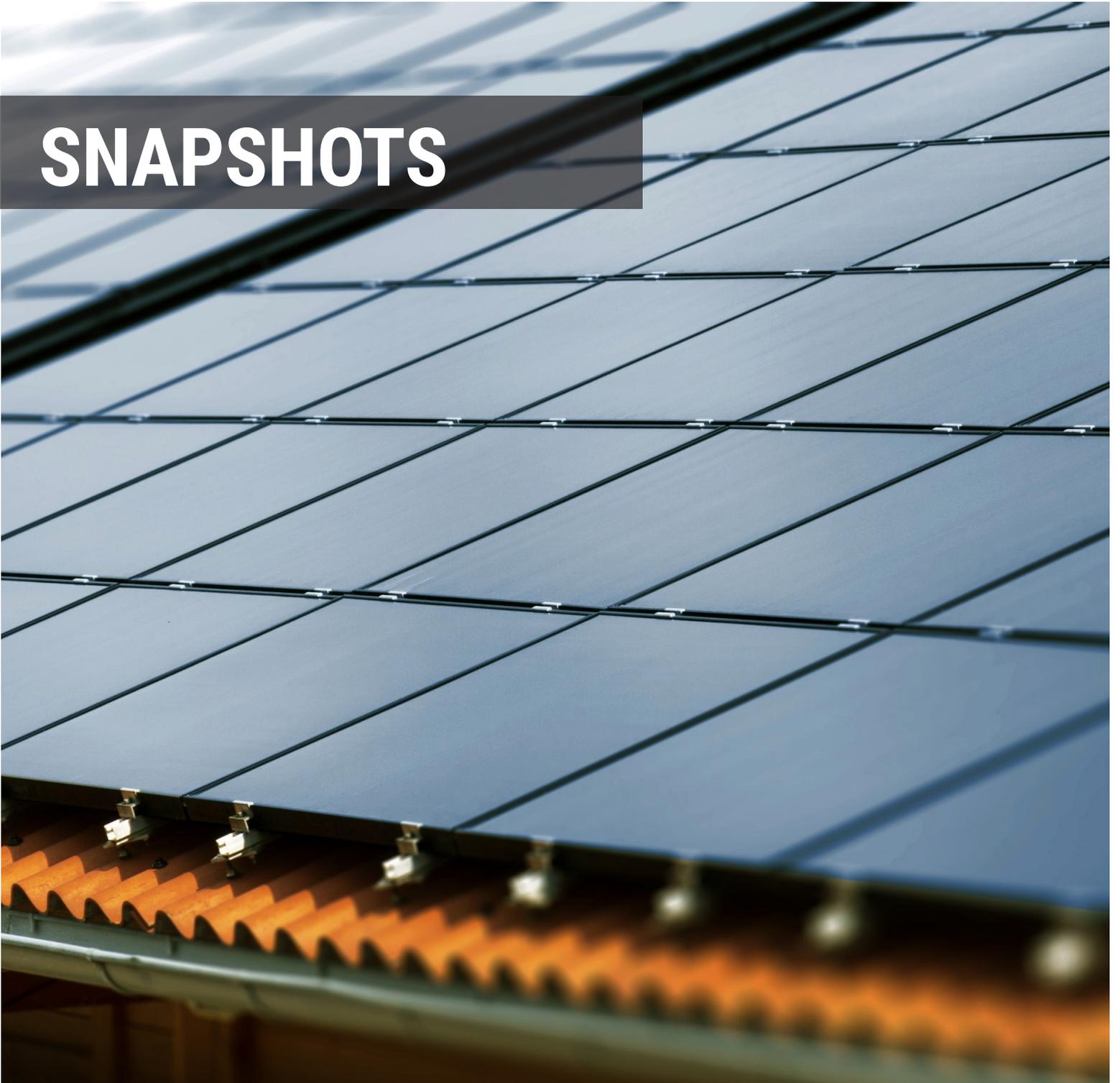
<sup>1</sup> <https://www.seia.org/solar-industry-data>

The projects highlighted in this report, though not fully implemented, are promising examples of the power and value of resilient solar. This report is intended to furnish real-world models that will inform and inspire many more projects rooted in a commitment to providing power to our most vulnerable populations.



*Solar installations in Tempe, Arizona demonstrate the potential for large institutions to integrate solar in creative ways. Photo credit: Institute for Sustainable Communities*

# SNAPSHOTS



# NEW YORK, NEW YORK

Creating a Citywide Storage Target and Pathway



Photo credit: Sustainable CUNY

Superstorm Sandy was one of the most powerful storms to ever hit the eastern U.S. The 2012 storm delivered winds of 80 mph and a 14-foot storm surge that flooded more than 90,000 buildings and parts of the subway system, leaving neighborhoods isolated and more than two million people without power.<sup>2</sup>

Following the storm, Sustainable CUNY, the sustainability office at the City University of New York (CUNY), found that 672 solar arrays in New York City (NYC) had weathered the storm but were not configured to provide power during the ensuing multi-day power outage—the panels represented about 6500 kWh that could have powered critical loads across the five boroughs. Some of CUNY's facilities—which served as emergency shelters for 2,700 of the city's 9,000 evacuees—faced fuel shortages that affected vehicles, backup generators, and buildings.

The City of New York had previously identified solar as a key strategy to attaining its climate action goals. However, the experience of Sandy pushed Sustainable CUNY and other community leaders to think about the potential for solar energy to not only be a source of clean power but also a source of back-up power during grid outages. In 2016, as a result of this project, the City of New York adopted the first citywide energy storage goal in the U.S., 100 MWh installed by 2020 (currently the city has approximately 6 MWh installed). Using resilient solar, the city aims to maximize the value of the solar energy installations and build its resilience to future disruptions, learning important lessons from the experience of Superstorm Sandy.

**By convening stakeholders through the Smart DG Hub, creating tools and resources to support resilient solar projects, and developing a citywide resilient solar strategy, CUNY is helping NYC meet its ambitious storage goal.**

<sup>2</sup> [www.nyc.gov/html/sirr/downloads/pdf/final\\_report/Ch\\_1\\_SandyImpacts\\_FINAL\\_singles.pdf](http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch_1_SandyImpacts_FINAL_singles.pdf)



### PROJECT LEAD: CITY UNIVERSITY OF NEW YORK

The City University of New York (CUNY) is the country's largest urban university. Sustainable CUNY is the office that manages the university's sustainability initiatives, as well as many citywide initiatives. For more than a decade, Sustainable CUNY has led the NYC Solar Partnership and worked with stakeholders to successfully grow solar in NYC from less than 1 MW in 2006 to 29 MW today, with an additional 3 MW in the pipeline. Since 2013, Sustainable CUNY has led the effort to accelerate the use of resilient solar in New York City and New York State, through its Smart Distributed Generation (DG) Hub, funded through the U.S. Department of Energy's Solar Market Pathways Program.



### LEARN MORE

To learn more about the Smart DG Hub, the NY Solar Map and the NY Storage Roadmap, visit: [www.nysolarmap.com/solarplusstorage](http://www.nysolarmap.com/solarplusstorage)



Photo credit: Sustainable CUNY

## HOW THEY ARE DOING IT

In January 2013, CUNY convened a meeting of stakeholders. With Superstorm Sandy fresh in their minds, the participants agreed on the need for a collaborative effort to advance the vision of a more resilient energy system—a system that used smart technology and clean, distributed sources of energy rather than large, centralized power plants, which are vulnerable to disruption. Accelerating the use of resilient solar was considered a key strategy of this vision.

The Smart DG Hub was organized into four stakeholder working groups, each addressing a key challenge to accelerating this vision: policy, finance, hardware, and software. They focused on creating tools and resources responding to needs identified by the working group participants and stakeholders beginning with a series of fact sheets to answer key questions about the hardware, software, and finance options. CUNY also invested to modify the NY Solar Map ([nysolarmap.com](http://nysolarmap.com))—an existing tool that allows users to see the solar potential of their building—to display the locations of resilient solar projects. The mapping tool includes a Critical Facility Solar + Evaluator ([bit.ly/solarplusevaluator](http://bit.ly/solarplusevaluator)) that displays critical facilities in NYC, such as fire stations, police stations, and evacuation centers, where installing resilient solar would be beneficial. Soon, the map will include a resilience calculator for users to explore the resilient solar potential of their property.

In 2017, the Smart DG Hub released the New York City Resilient Solar Roadmap ([bit.ly/roadmapnyc](http://bit.ly/roadmapnyc)), the first citywide strategy for deploying resilient solar in the country. The roadmap identifies the barriers to resilient solar, such as energy storage permitting, and sets out strategies to overcome them. An online roadmap tracker allows CUNY to track progress against each goal.

As part of the citywide strategy, CUNY partnered with the National Renewable Energy Lab (NREL), to evaluate and compare the costs and financial impacts of different resilient solar technologies and configurations at three critical facilities:<sup>3</sup>

- A school that serves as a shelter (Susan Wagner High School)
- A fire station (FDNY Engine Company 309)
- A cooling center (Brownsville Senior Center)



### TOOLS YOU CAN USE

The Smart DG Hub Fact Sheets provide clear and concise explanations on key questions related to resilient solar. While they are specific to NYC, they contain information applicable in other cities and could serve as templates for cities interested in making their own fact sheets. [bit.ly/nysolarfactsheet](http://bit.ly/nysolarfactsheet)

<sup>3</sup> [nysolarmap.com/media/1719/updated-dghub-economic-resiliency-impact-of-pvstorage-on-nyc-critical.pdf](http://nysolarmap.com/media/1719/updated-dghub-economic-resiliency-impact-of-pvstorage-on-nyc-critical.pdf)

CUNY and NREL took a unique approach to considering the economic benefits of these projects. By estimating the avoided cost of a power outage, they were able to attribute value to the resilience benefits provided by the system. Their analysis ([bit.ly/impact-of-storage](https://bit.ly/impact-of-storage)) found that resilient solar can be economically viable for NYC's critical infrastructure. This work revealed that the full range of resilient solar benefits is often not recognized by decision-makers, emphasizing the need to monetize the value of resilience more formally.

## NEXT STEPS

Through its roadmap, CUNY is helping to overcome this barrier by laying out several strategies to tackle permitting. A recent grant from the New York State Energy Research and Development Authority aimed at reducing the soft costs of energy storage will enable CUNY to expand its work to formalize the permitting process. They will focus primarily on lithium-ion batteries, and will also create a platform for approving other storage types. Ultimately the goal is to foster a more streamlined and transparent permitting process for resilient solar projects in NYC and to develop tools and guidelines that other municipalities can adopt. In addition, the DG Hub is continuing efforts to expand work on the value of resilience. Articulating the benefits in economic terms will help decision-makers as they assess the potential to use resilient solar.



*Installers assemble a rooftop solar array overlooking the Statue of Liberty in New York City.*

Photo credit: Sustainable CUNY



Photo credit: Sustainable CUNY

# BALTIMORE, MARYLAND

Building Resilient Community Centers and Empowering Residents



Photo credit: Institute for Sustainable Communities

*Living Classrooms Foundation, Power52 Foundation, and Institute for Sustainable Communities staff gather in Baltimore to kick-off the Partnership for Resilient Communities work on resilient solar.*

The Baltimore Target Investment Zone (TIZ) ([bit.ly/targetzone](http://bit.ly/targetzone)) is a 122-acre area in east Baltimore that struggles with high levels of poverty, crime, unemployment, low educational achievement, and chronic health issues. The neighborhood has struggled with power outages due to aging infrastructure and more intense storms. The low-income residents of the TIZ are particularly vulnerable to the impacts of these power outages. Fundamental needs like refrigerating insulin, powering oxygen tanks, or replenishing spoiled food can become insurmountable challenges.

In its 32-year history, area nonprofit Living Classrooms Foundation has continually expanded its portfolio of programs to benefit struggling Baltimore communities with an increasingly holistic array of services. **Driven by community need, Living Classrooms Foundation is installing resilient solar at its east Baltimore community centers and training local residents to become certified solar installers.**

## HOW THEY ARE DOING IT

To complete this project, Living Classrooms is working in close partnership with the Power52 Foundation ([www.power52.org](http://www.power52.org)), an organization that brings significant technical experience in solar



### PROJECT SNAPSHOT

The POWER House Community Center features a 50 kWh battery charged by a 10 kW solar array with an expected annual output of 1,362 kWh. When paired with a 15-25 kW generator, this system is able to support critical loads for three days, including emergency lighting, fire alarms, a small refrigerator, and localized heating and cooling systems. Living Classrooms has also partnered with the City of Baltimore's sustainability and emergency management offices to provide basic resources, such as water, during emergencies.



### PROJECT LEAD: LIVING CLASSROOMS FOUNDATION

Living Classrooms Foundation is a nonprofit community organization dedicated to providing experiential learning, workforce development, and other services to underserved youth and adults in the east Baltimore area—an area which struggles with high levels of poverty, crime, unemployment, and chronic diseases. Living Classrooms serves residents through many mechanisms. The most visible are community centers, which deliver education, training, and health services. In 2016, Living Classrooms joined ISC's Partnership for Resilient Communities and began work to implement resilient solar and solar workforce training.



### LEARN MORE

[www.livingclassrooms.org](http://www.livingclassrooms.org)

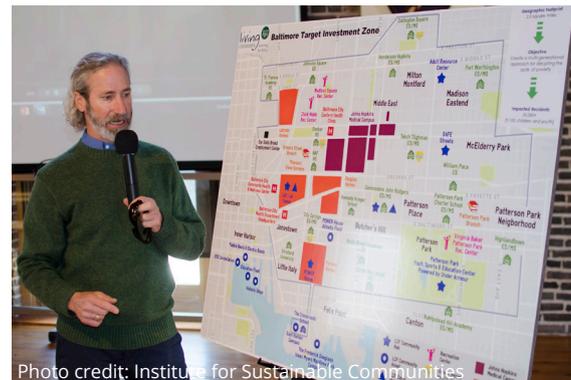


Photo credit: Institute for Sustainable Communities

*James Piper Bond, President and CEO at Living Classrooms Foundation, talks about the Baltimore Target Investment Zone.*

“It’s a real asset working with a large nonprofit like Living Classrooms who has strong community ties that were developed over years through their multi-layered programming. It’s a pleasure and an honor to partner closely with nonprofits on this important work.”

*Anne Draddy, Sustainability Coordinator at  
Baltimore Office of Sustainability*



Photo credit: Institute for Sustainable Communities

project development and finance. In 2016, the two organizations began to plan for the installation of resilient solar at three of its community centers: the POWER House Community Center ([bit.ly/powerhousecenter](http://bit.ly/powerhousecenter)), the Under Armour (UA) House at Fayette ([bit.ly/ua-house](http://bit.ly/ua-house)), and the Patterson Park House ([bit.ly/patterson-house](http://bit.ly/patterson-house)). In addition to assessing project feasibility, they also conducted a survey of local residents to understand the kinds of services they needed from community centers during disasters.

As they were getting started, Living Classrooms learned of an effort being led by the City of Baltimore’s Office of Sustainability to create a network of resiliency hubs located in trusted community facilities to serve residents during emergencies. Living Classrooms partnered with the city to integrate their community centers into the resiliency hub network. The program provides a checklist for the kinds of supplies and services the hubs should have available, integrates the hubs into the city emergency operations, and offers training and support.

Living Classrooms recognized that resilient solar not only offers a way to power facilities, it is also a growing economic opportunity and a potential source of jobs for their community. Together, Living Classrooms and Power52 have developed a solar energy professional training course with a focus on solar panel installation for area residents facing barriers to employment. Course participants are receiving on-the-job training at installation sites including the Living Classrooms centers. These energy professional trainees, along with Living Classrooms staff, and other community residents, are also receiving Community Emergency Response Team ([bit.ly/comm-emer-team](http://bit.ly/comm-emer-team)) training provided by the city to help develop informed first responders. This workforce development program ensures that solar installed on the community centers is completed by, and for, the community it serves. It also fosters economic resilience by creating



#### TOOLS YOU CAN USE

Living Classrooms has developed a survey for residents to gauge their level of preparedness for emergencies and to help inform the design of resiliency hubs. [bit.ly/lcfsurvey](http://bit.ly/lcfsurvey)

employment opportunities in the rapidly growing field of solar energy and battery storage.

Living Classroom' strategic partnership with the City of Baltimore and the Power52 Foundation marshals the unique strengths of these three public and private entities. It enables Living Classrooms to use the emerging technology of resilient solar to address an acute resilience challenge in some of Baltimore's most vulnerable communities.

## NEXT STEPS

The resilient solar installation is expected to be complete at the POWER House in early 2018 and at the UA House later in the year. Living Classrooms hopes to execute a memorandum of understanding with the City of Baltimore to become official resiliency hubs soon after the solar installations are completed. The third class of solar installers began in February 2018.



A new class celebrates its graduation from Living Classroom Foundation and Power52's Resilient Jobs Training program.



“Relaunching the UnderArmour House at Fayette with the addition of workforce development caused us to think about our relationship with the community: how to be a better neighbor and a better partner, how to be more than just a presence.”

*John Huffington, Director of  
Workforce Development,  
Living Classrooms Foundation*

Photo credit: Institute for Sustainable Communities

# DULUTH, MINNESOTA

Connecting Solar Goals to Community Values and Disaster Preparedness



*Ecolibrium3 discusses ways to further integrate solar and battery storage into the Duluth community.*

In June of 2012, a 500-year rainfall event in Duluth damaged homes, businesses, roads, and municipal water systems—causing more than \$100 million in damages.<sup>4</sup> As the regional organization designated to lead post-disaster household rebuilding, Ecolibrium3 began exploring options for greater energy resilience in the area. In this process, Ecolibrium3 identified an opportunity to create a community resilience center at the Hartley Nature Center ([bit.ly/hartley-nature-center](http://bit.ly/hartley-nature-center)), a community institution on city-owned property, to demonstrate community energy independence and resilience.

**Using the Hartley Nature Center as a model, Ecolibrium3 is working to advance Duluth’s solar market toward its first megawatt of solar by connecting the concept of energy resilience with existing community goals of independence and preparedness.**

## HOW THEY ARE DOING IT

Ecolibrium3 is in the unique position to listen to and articulate its community’s needs. Through extensive community resilience design sessions, energy charrettes for expanding solar, day-to-day education and engagement with local residents, and partnerships with the university and city, the organization is able to understand and act on the needs and goals of the community. The Hartley Nature Center is considered a valuable community asset, and the opportunity to invest in the facility in a way that would build community resilience garnered broad community support.

The Hartley Nature Center was constructed as a “net-zero building” and had been equipped with a 13 kW solar array, but the system had fallen into disrepair. The nature center partnered with Ecolibrium3 and the City of Duluth to retrofit the existing solar array and add a 6 kW battery backup system.

<sup>4</sup> <https://blogs.mprnews.org/updraft/2013/06/anatomy-of-a-mega-flood-duluth-flood-1-year-after/>



### PROJECT LEAD: ECOLIBRIUM3

Ecolibrium3, a nonprofit organization based in Duluth, seeks to inspire and lead change in the community toward an equitable and sustainable future through community work in energy, resilience, and revitalization. Since 2011, Ecolibrium3 has led nationally recognized community-scale weatherization and energy efficiency programs, built partnerships and enabled participation in the community to revitalize neighborhoods, and focused on renewable energy and sustainability as a means to improve the livelihoods of Duluthians. With funding from U.S. Department of Energy’s Solar Market Pathways Program, Ecolibrium3 is working to accelerate the development of Duluth’s solar market.



### LEARN MORE

[www.ecolibrium3.org](http://www.ecolibrium3.org)



*The Hartley Nature Center in Duluth, Minnesota now has solar+storage.*

The project's potential value was made clear just before installation, as a major rainstorm with hurricane-force winds ripped through the city, knocking down trees and power lines and taking out the center's power. The summer camps, which largely fund the center's programming, had to be cancelled and parents were forced to find alternative child care or take time off of work. The increased cost of battery backup became financially justifiable as an added-insurance element, even if it could carry the nature center and community through just one similar event.

Not only did the Hartley Nature Center project succeed in educating the community and demonstrating the value of resilient solar, it also built the organizational capacity of Ecolibrium3 and its partner, the University of Minnesota-Duluth (UMD), to support additional resilient solar projects.

The university, which provided technical assistance to the retrofit and helped bolster Ecolibrium3's understanding of storage, has continued to work on energy resilience. Since the battery system was installed, graduate and undergraduate students have been monitoring the storage system, optimizing the battery for the building's load for each season, and watching battery performance to reduce peak demand over the course of each month. UMD students also complete sustainability projects with the community each semester, with an increasing focus on energy resiliency.

Ecolibrium3 has continued to partner with UMD to elevate the Hartley project as a successful demonstration of resilient solar through professional educational engagements and community outreach. Ecolibrium3 incorporates energy resilience and storage into their programming and one-on-one engagements with community members, which has led to one of the first installations of a Tesla power wall by a private residence in the area.

The project's educational outreach ranges from explaining the basics of resilient solar to providing technical assistance on how a storage system could help residents and businesses island, or detach from the grid, during a disaster. It has gained the attention of energy stakeholders across the state, with University of Minnesota's Energy Transition Lab using the Hartley retrofit as an example for testimony to state public utilities commission, showing the potential for storage in the state.



#### PROJECT SNAPSHOT

The Hartley Nature Center hosts educational programs and camps for more than 10,000 school-aged children/year and serves more than 30,000 park visitors/year. Retrofitted to include energy storage in 2016, it can now be used as a community shelter and a base of operations for the city during emergencies. A detailed case study is available at [bit.ly/hartley-nature-center](https://bit.ly/hartley-nature-center)

## NEXT STEPS

Ecolibrium3's work to educate the community on storage and the project at Hartley Nature Center has helped city officials see the value and potential of resilient solar. The city is now pursuing resilient solar at each of their main parks and community centers and are working to identify funding to support their work. Duluth reached its goal of 1 MW solar electric generation by the end of 2017.

In addition, Ecolibrium3, the city, and UMD have identified water treatment and distribution as a high priority for resilient solar installation, as the city came close to not having enough backup power to pump water as a result of the 2016 windstorm. This work also prompted further resilience research from UMD students on hybrid generation and resilient solar for water treatment and distribution.



### TOOLS YOU CAN USE

#### Duluth Shines! Solar Resource Map

The Duluth Shines! online portal ([bit.ly/duluthshines](http://bit.ly/duluthshines)) allows residents of Duluth to explore the solar potential of a single property or an entire neighborhood, then estimate appropriate installation sizes and costs through a customizable calculator. The portal also connects residents to solar resources, including local PV installers, incentives, and financing options.



# SAN FRANCISCO, CALIFORNIA

Developing Planning Tools and a Collaborative Process



The City and County of San Francisco is acutely aware of the potential for disaster and the vulnerability of its residents due to the frequency and intensity of earthquakes in the region. Since 1979, the city has experienced four earthquakes with a magnitude of six or greater, and studies show that an even stronger earthquake is likely to occur within the next 30 years.<sup>5</sup> The city also anticipates an increasing risk of disaster due to the impacts of climate change, including sea level rise, flooding, forest fires, and extreme heat.

In response to these potential risks, the City and County of San Francisco has been developing strategies to better serve communities and ensure access to basic services during emergencies in each of the city's neighborhoods. **Using resilient solar, San Francisco is advancing both the city's energy and emergency preparedness goals and creating valuable tools and resources along the way.**

## HOW THEY ARE DOING IT

San Francisco has been working to create a model planning process to identify and plan for resilience centers throughout the city and serve as a template for other cities that want to implement resilient solar on community facilities.

As a first step toward identifying sites, San Francisco's Department of the Environment, Department of Emergency Management, and other agencies mapped buildings that are part of an existing disaster preparedness plan, those with critical power needs should a disaster strike, and opportunities for a cluster of buildings to be served via a microgrid. The resulting map featured hundreds of facilities, including shelters, fire stations,

<sup>5</sup> <http://www.earthquakesafety.com/earthquake-faults.html>



### PROJECT LEAD: CITY AND COUNTY OF SAN FRANCISCO

In San Francisco, the effort to use resilient solar to support neighborhood resilience centers has been led by the City and County of San Francisco Department of the Environment, in close collaboration with several other city departments, including Public Health, Emergency Management, and the Office of Resilience. With technical support from ARUP, a national engineering firm, as well as a grant from the U.S. Department of Energy's Solar Market Pathways Program, the City and County of San Francisco has worked since 2016 to create tools, resources, and a resilient solar roadmap to plan solar and storage projects that they hope will one day serve each of the city's 11 districts.



### LEARN MORE

[bit.ly/resilientsf](http://bit.ly/resilientsf)



### PROJECT SNAPSHOT

Thurgood Marshall High School also serves as an emergency shelter in the Bayview-Hunter Neighborhood ([bit.ly/bayview-hunter](http://bit.ly/bayview-hunter)). The school is equipped with an 87 kW solar array but currently has no source of back-up power. The [SolarResilient.org](http://SolarResilient.org) tool was used to determine that using a 63 kw/250 kWh lithium ion battery could satisfy the critical loads during a disaster. A detailed case study is included in the Solar+Storage Roadmap.

“Solar plus battery projects create a nice intersection between the city’s renewable energy goals and the city’s resilience goals.”

Jessie Denver, Energy Program Manager,  
City and County of San Francisco  
Department of the Environment



Photo credit: Institute for Sustainable Communities

health facilities, and schools. Some of the facilities mapped already had solar panels, but many lacked back-up power of any kind.

Using the map, the city, district supervisors, and neighborhood empowerment networks collaborated to determine which sites would best serve the most vulnerable populations as resilience centers. After selecting a dozen facilities to serve San Francisco’s 11 districts, the city has been working to create detailed plans for the first four representative resilience centers: a high school, marina, recreation center, and health center. At each location, they determined the feasibility of installing solar+storage and determined the critical power needs for each building. An important step in this process was thinking about how a building would operate in an emergency. Working closely with emergency management staff, the team considered how the building would function and how much energy would be needed to meet those functions in an emergency.



#### TOOLS YOU CAN USE

The best practices guide is a truncated version of the roadmap with lessons learned and strategies created specifically to help other municipalities learn more about resilient solar. San Francisco’s *Solar+Storage Roadmap* is available at [bit.ly/ssroadmap](https://bit.ly/ssroadmap). The *Best Practices Guide* is available at [bit.ly/solar-storage-guide](https://bit.ly/solar-storage-guide)

In November 2017, the city released its *Solar+Storage Roadmap*, which documents the entire project from stakeholder engagement to identifying project sites. They also published a best practices guide that shares lessons learned and strategies targeted specifically toward other municipalities exploring resilient solar. Both documents were heavily informed by the city’s experience planning its first four resilience centers.

One important outcome of this work has been the relationship that formed between those working on the city's clean energy programs and the emergency management department. Resilient solar is now a strategy being included in the city's emergency management plans.

Together, these departments are now working to raise capital for further project implementation by engaging their capital planning department, philanthropic donors, and exploring grant opportunities.



### TOOLS YOU CAN USE

[SolarResilient.org](https://solarresilient.org) is a free online calculator created to help size batteries to ensure a building has enough power to run critical loads during emergencies. The calculator allows building owners, energy professionals, and city departments across the country to develop preliminary solar+storage equipment sizing estimates on a portfolio of buildings so they can incorporate optimum scenarios into their energy resilience strategies.

“It’s one thing to discuss theoretically and quite another to really work through what a project requires. While we haven’t secured funding for the solar+storage installations yet, we now have data about what is feasible and what is not, from the technical difficulties to the financing options for each site. And what were once disparate emergency management and renewable energy strategies from each department are now partnerships that meet different goals. Our citywide strategies have grown from the experiences we’ve had working through these projects.”

*Jessica Tse, Project Manager and Distributed Energy Resources Professional, City and County of San Francisco*



# LESSONS LEARNED



Photo credit: Institute for Sustainable Communities

Resilient solar is a tangible solution for communities seeking to prepare for future disasters, to ensure power for critical needs, to maximize clean energy production and, in some cases, to save money. A powerful aspect of resilient solar is the potential to support low-income communities that are often least prepared for disasters and frequently underserved by clean energy programs.

Like any new idea, the implementation of resilient solar is not without significant challenges. The stories throughout this publication are each considered groundbreaking in their community, yet they have all encountered delays, unexpected expenses, political challenges, and other roadblocks on their way to implementation.

The advice they offer to others looking to implement resilient solar includes:

## CREATE STRONG PARTNERSHIPS

The key to advancing resilient solar projects and strategies is in collaborating with the necessary partners. These projects inherently sit at the intersection of work in community development, social equity, emergency management, clean energy, and climate adaptation. As these stories demonstrate, these projects can be led by many different types of partners, from community organizations and city governments to universities and utilities. Beyond initial obstacles of commitment and property for deployment, the complexity of these projects requires a diverse set of skills rarely contained within a single organization, including planning, engineering, community engagement, communication, finance, and construction. Successful implementation requires strong partnerships that bring all of these skills to bear. Furthermore, creating projects that truly deliver all the potential benefits requires close collaboration with a diverse set of partners and providing everyone a seat at the table.



*Anthony Rose, Solar PV Master Trainer for the Power52 Foundation, talks about an energy professional training initiative for individuals facing barriers to employment.*

Photo credit: Institute for Sustainable Communities

## UNDERSTAND AND PRIORITIZE COMMUNITY NEEDS

Each of the highlighted projects has worked to engage the community, to understand the needs of residents, and to deploy resilient solar in ways that will build and support community resilience. Engagement processes are particularly critical when designing resilience centers intended to serve a community in disaster. Design sessions, community surveys, workshops, and other community engagement strategies are important steps in the process. Enabling community-based organizations who have longstanding connections to the communities they serve to play a leading role in these projects is among the most powerful way to not only build a solar project but to strengthen a community.



*Yusef Ali, a Board Member for Larimer Consensus Group, discusses opportunities for advancing community resilience at a Sustainable Communities Leadership Academy hosted by ISC.*



*Solar energy professional trainees install panels on Living Classroom Foundation's POWER House Community Center in Baltimore.*

## BE PREPARED TO ADAPT YOUR APPROACH

Designing and building any solar energy system for a nonresidential building can often come with complications. Implementing a resilient solar project or strategy starts with a strong work plan but rarely unfolds as intended. If you are pursuing one of the first projects in your community, you may encounter challenges, such as finding contractors that are familiar with both solar and storage, delays caused by permitting agencies or utilities, and difficulty selecting battery options with new products frequently hitting the market. Even if you are adding batteries to a building that already has solar, you may run into technical complications and other building upgrades may be required to meet current electrical codes or isolate the critical loads, or power needs.

## CONSIDER OPERATION AND MAINTENANCE

When planning a resilient solar installation on a building intended to function in disasters, it is important to understand the realities of how the system will be operated and maintained after installation. Engage with stakeholders to identify community needs and the critical loads required to meet those needs. Consider who will be responsible for maintaining the system so that it will be ready to perform when needed most. On community projects, ensuring community ownership is critical to long-term success.



Photo credit: Institute for Sustainable Communities

*City and County of San Francisco team members craft a strategy for maximizing the impact of their work to identify and plan for resilience centers throughout the city.*



Photo credit: Council of Independent Colleges in Virginia  
*A rooftop solar array at Eastern Mennonite University in Virginia provides education opportunities for students.*

## LEARN FROM THOSE WITH EXPERIENCE

The organizations featured in this publication are all mission-driven and committed to helping others learn from their experiences. ISC is committed to creating opportunities for peer learning and exchange as communities continue to advance their resilience efforts. As such, we have compiled resources developed by organizations working on resilient solar into a toolkit ([bit.ly/resilient-solar-toolkit](https://bit.ly/resilient-solar-toolkit)) to help those interested in solar+storage get started.



**READY TO START A PROJECT OF YOUR OWN?**

Check out our resilient solar toolkit [bit.ly/resilient-solar-toolkit](https://bit.ly/resilient-solar-toolkit)



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