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EQUITABLE RESILIENCE

Opportunities to Advance Solar Paired with Battery Storage in Historically Marginalized Communities

Clean Energy Group

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ABOUT THIS REPORT

This report was produced as part of the Equitable Solar Communities of Practice program through the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO). Clean Energy Group managed the Resilience, Storage, and Grid Benefits Community of Practice, which aimed to research, evaluate, and identify opportunities to scale the meaningful benefits of solar paired with battery storage in historically marginalized communities. The report is designed to 1) educate a broad audience on the benefits of solar paired with battery storage, 2) identify barriers to deploying solar paired with battery storage in historically marginalized communities, 3) amplify early-adopters and innovative programs that support battery storage access across the nation, and 4) recommend best practices for programs and policies to adopt in advancing equitable access to solar and battery storage technologies.

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Executive Summary

The number of solar and battery storage installations nationwide is increasing rapidly each year. Yet, these technologies remain largely inaccessible to historically marginalized communities, including low-income communities, communities of color, and environmental justice communities. As power outages continue to increase in occurrence and severity—due primarily to more extreme weather events and the failure of outdated, polluting, fossil-fueled energy infrastructure—the economic, reliability, and resilience benefits of battery storage will become more important than ever.

Supportive battery storage programs and practices exist, but they are limited geographically and often lack public awareness. The significant, sustained, and equitable advancement of battery storage can only be achieved if utilities, industry leaders, and state and federal agencies encourage widespread adoption of the programs and policies necessary to overcome the obstacles to solar and battery storage adoption in historically marginalized communities.

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This report overviews the results of the Resilience, Storage and Grid Benefits Equitable Solar Communities of Practice, an initiative of the U.S. Department of Energy (DOE) Solar Energy Technologies Office. The report is designed to 1) educate a broad audience on the benefits of solar paired with battery storage, 2) identify barriers to equitable access of solar and battery storage, and 3) amplify best practices and innovative programs that improve battery storage access across the nation. The report concludes with program and policy recommendations that support the equitable advancement of solar and battery storage technologies.

Recommendations to Advance Solar and Battery Storage in Historically Marginalized Communities

Prioritize equity measures in performance metrics
Ensuring equitable deployment of renewable energy resources requires that equity-based goals are built into program performance metrics. For example, performance metrics related to capacity targets, which are based on the energy capacity deployment goal for a specific energy technology, should include an equity provision that mandates one-third of total capacity be reserved for residential properties and community-serving institutions located in historically marginalized communities.

Provide comprehensive grant support to projects located in and serving historically marginalized communities
Grant support for local capacity building, early-stage technical assistance, and project implementation are necessary to support community-led project development and market expansion in historically marginalized communities.

Support equitable finance solutions
Communities that have suffered years of disinvestment and industry neglect require competitive, accessible, and non-exploitive finance solutions to build a sustained market for solar and battery storage technologies.

Encourage incentives that recognize a comprehensive value of resilience
Incentives are necessary to recognize the multiple value streams of solar paired with battery storage—including economic, health, and broader grid reliability benefits.

Address permitting and interconnection barriers for systems that include storage
States and utilities should standardize and streamline permitting and interconnection processes for residential and commercial community-serving facilities that are working to build local energy resilience by installing a solar and battery storage system.

Part 1
Introduction

Historically marginalized communities disproportionately bear the brunt of the consequences of a society built on fossil fuel-powered energy infrastructure. Decades of environmental injustices—built upon structural racism and the intentional perpetuation of socioeconomic disadvantages—have resulted in chronic health conditions, economic disparities, and long-standing grid vulnerability issues in these communities. This has caused inequitable outcomes for low-income communities and communities of color, including higher energy burdens,[1] increased rates of asthma (four times the national average),[2] and a greater likelihood of living near polluting energy infrastructure, such as coal and oil-fired power plants.[3]

Clean, renewable, and reliable energy resources can mitigate the harmful effects of polluting fossil-fuel infrastructure and improve the outcomes of and recovery from power outages.

The energy landscape as it exists today is proving insufficient to withstand the impacts of increased energy demand combined with more frequent and severe weather events.[4] Over the last two decades, 80 percent of all major power outages in the United States were attributed to severe weather events.[5] Residents in wildfire-prone states must also be prepared for public safety power shutoffs, utility-led rolling power outages conducted to avoid utility-owned energy infrastructure from sparking a wildfire.[6] The duration and impact of power outages are not equal among communities; on average, power outages in lower-income communities last longer than those in higher-wealth communities.[7]

Clean, renewable, and reliable energy resources can mitigate the harmful effects of polluting fossil-fuel infrastructure and improve the outcomes of and recovery from power outages. Resilient power technology is readily available. Solar photovoltaic (PV) installations paired with battery storage have reached historic levels in the United States, with battery storage alone achieving a 100 percent increase from 2022 to 2023 and an additional 45 percent increase anticipated by the end of 2024.[8] Commercial and residential systems have become more accessible, thanks in large part to increased awareness, competitive pricing, and the availability of more economic incentives. Despite this growth, there remain significant barriers to solar and battery storage access in historically marginalized communities.

The impacts of environmental injustice are compounding. The solutions, therefore require a multilayered approach. Initiatives meant to build energy resilience should not only provide reliable backup power, but must also positively contribute to economic stability, public health, and grid reliability in the communities that they are meant to serve.

Part 2
Key Terms and Concepts

The following key terms and concepts related to energy resilience have, for the most part, consensus across a variety of resources and stakeholders. While there is a vast list of terms related to energy resilience and battery storage, those identified below are foundational and most relevant to this report. Key terms are bolded for clarity.

Prior to overviewing key terms and definitions, it's important to note that, in most cases, the resources most readily available (published, republished, and available through traditional research outlets) are those developed by stakeholders with the greatest access to resources, financial and otherwise (such as for-profit companies, government agencies, and academic institutions). While this fact does not negate the accuracy of the following definitions, it does highlight that battery storage and related topics, even those as basic as key terms, are driven not by community consensus or community input, but rather by stakeholders with the most decision-making power and resources.

Energy Resilience

Energy resilience, as defined by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, is the "ability of the grid, buildings, and communities to withstand and rapidly recover from power outages and continue operating with electricity, heating, cooling, ventilation, and other energy-dependent services."[9] Energy resilience can be achieved through a **microgrid**, which consists of interconnected distributed energy resources powering a group of specific critical loads (the electrical equipment and devices selected to maintain backup power to in the event of a grid outage).[10, 11] A microgrid can disconnect, or "island" from, and operate separately from the grid to provide electricity through a power outage.

It is important to note that these definitions do not specify a type of technology; a facility's energy resilience can be improved by installing a system consisting of any type of backup power technology (including diesel or natural gas generators). Energy resilience achieved through non-polluting technologies will rely primarily on renewable energy. When this report references energy resilience or microgrids, it is referring to renewable energy technologies, specifically solar PV paired with battery storage.[12]

Battery Storage

Battery storage is a rechargeable battery that stores energy from other sources, such as solar arrays or the electric grid, to be discharged and used at a later time. A **behind-the-meter microgrid** consisting of solar paired with battery storage can power residences and facilities in the event of an outage and, in some cases, generate revenue for the

system owner by providing grid services during regular grid operations, all without releasing hazardous emissions.[13] **Grid services** are activities that grid operators perform to maintain reliability, which depends on system-wide balancing of energy supply and demand and managing electricity transmission and distribution systems.[14] Common grid services provided through battery storage include demand response and energy arbitrage.[15, 16]

Community-Centered Energy Resilience

Community-led solar and battery storage development that prioritizes energy justice is a unique project development process. To provide a more comprehensive definition related to these types of projects and the associated processes, this report presents **community-centered energy resilience** as a project implementation model in which communities lead the development of and directly benefit from an energy resilience project in their community.

This report utilizes the National Collaborating Centre for Determinants of Health's definition of **historically marginalized community:** a community that has experienced discrimination and exclusion (social, political, and economic) because of unequal power relationships across economic, political, social, and cultural dimensions.[17]

Community-centered energy resilience encompasses project development among single family residences, affordable housing developments, and community-serving facilities, all of which are essential to advancing energy justice in historically marginalized communities.

Community-centered energy resilience projects:

- Are led by a local institution or community-based organization (or coalition of both) that has significant ties to and history with the community in which it is located.
- Include significant involvement from the leadership and/or membership of the facility installing the system, as well as the community at large.
- Pursue solar and battery storage development at what this report defines as a **community-serving facility**—a local institution that provides services to the surrounding community during regular grid operations and, if able, would continue to provide resources to the community in the event of an outage. Whereas some state and federal energy resilience programs dictate that only certain types of facilities such as food pantries and fire stations are eligible, a community-serving facility is intentionally broad in its definition.[18] Community-serving facilities are not defined by the type of facility, but rather the community's designation of their services as essential. Facility types can include, but are not limited to, institutions of faith, first responders, affordable housing developments, and community centers.

A shared definition of community-centered energy resilience project development—and how it differs from other types of solar and battery storage project development, for instance,

utility-owned and municipal-led—is not widely adopted. There are, however, similar concepts and case studies, including California Alliance for Community Energy's community-driven energy resilience model and 350.org's community-centered renewable energy project structure (see box on Community-led Clean Energy for additional information about each program).

Community-led Clean Energy Models

The community-driven energy resilience model was developed by the California Alliance for Community Energy (CACE) as an alternative to utility-owned and/or operated centralized, fossil-fuel dependent, energy infrastructure resources, like gas power plants, that were deemed unreliable, unsafe, and hazardous to the environment and public health.[19] CACE defined community-driven energy resilience as the ability to advance renewable energy microgrids and the policies and practices necessary to ensuring impacted communities are the core decision makers in developing projects.

Similarly, the climate advocacy organization 350.org defines a community-centered renewable energy project as one that "deliberately and meaningfully involves communities, either by local people owning the means for generating the energy or by them benefiting directly from its production. . . . Community-centered projects encompass community-owned and community-led initiatives, both of which are desirable."[20]

All three models (community-centered energy resilience, community-driven energy resilience, and community-centered renewable energy projects) advocate for community leadership in project development and direct community benefits. Where they differ is in scope: the California Alliance for Community Energy model includes goals related to program and policy advancement, and the 350.org model outlines opportunities for community-led and community-owned renewable energy resources more broadly. The community-centered energy resilience model defined in this report is a community-led, project development structure for building energy resilience through solar PV paired with battery storage at an individual community-serving facility. To read a brief case study about a project developed with community-centered energy resilience principles, see Case Study: Developing a Community-Centered Energy Resilience Project (p. 12).

CASE STUDY

Developing a Community-Centered Energy Resilience Project

United Parents Against Lead (UPAL), a Virginia-based environmental justice nonprofit, purchased a former United Service Organization (USO) center to be remodeled and developed into a resilience hub and workforce development training center in Petersburg, VA, a historically Black neighborhood. UPAL installed a 33-kilowatt rooftop solar array paired with a 60-kilowatt-hour battery storage system, which can supply 100 percent of the hub's electrical needs. In a crisis, the resilience hub's battery can power the entire building for several hours or support critical loads for up to three days.

The resilience hub, which serves a neighborhood that experiences frequent flooding, does not only operate during times of crisis. The hub hosts trainings in lead abatement and mold remediation, classes in safe driving and Basic First Aid, and includes a full-service restaurant. "We are here every day, so people know where to go when something happens," says Queen Shabazz, the Director of UPAL.

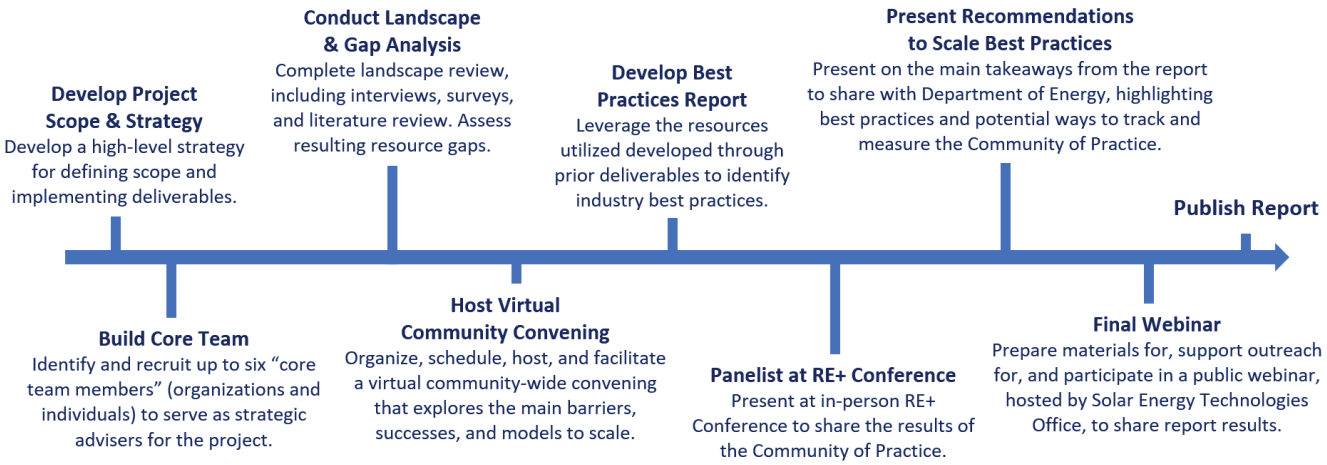
Community Resiliency Hub in Petersburg, VA. Photo: Queen Shabazz, UPAL.

Part 3
Methodology

This report is the culmination of a nine-month process through the Department of Energy Solar Energy Technologies Office's Equitable Solar Communities of Practice program. Each Community of Practice worked to identify resource gaps, support the development and dissemination of best practices and resources, and identify and propose new resources, tools, and technical assistance offerings needed to scale equitable solar. To learn more about the background of this effort, see Appendix A (p. 56).

An overview of activities and deliverables completed by Clean Energy Group for the Resilience, Storage, and Grid Benefits Equitable Community of Practice (Resilience Community of Practice) is outlined in Figure 1 below. To learn more about the methodology of this report, including research and analysis components, details regarding the organizations involved in this project, and outreach for the project's community convening, see Appendix B (p. 58).

FIGURE 1
Communities of Practice Timeline



The outlined activities and deliverables were conducted over a nine-month project period.
Source: Clean Energy Group

Project Scope and Strategy

There are multiple pathways to evaluating the potential benefits and opportunities to scale solar and battery storage for resilience. Clean Energy Group defined the scope of the Resilience Community of Practice to behind-the-meter solar paired with battery storage systems installed in residential properties and community-serving facilities that are located in and serve historically marginalized communities. Narrowing the scope allowed Clean Energy Group to focus research and provide more practical and specific best practices and recommendations.

Residential properties were defined as single-family homes and multifamily affordable housing properties. Community-serving facilities were defined as local institutions that provide essential services to the surrounding community, including health clinics, institutions of faith, and first responders. Key terms, including battery storage, community-serving institution, and behind-the-meter, are defined in the Key Terms and Concepts section of this report (p. 9).

CORE TEAM

Clean Energy Group and the U.S. Department of Energy assembled a Core Team in support of the Resilience Community of Practice. Led by Clean Energy Group, the Team consisted of six mission-aligned organizations that met monthly to discuss specific topics, which informed the research conducted.

Members of the Core Team for the Resilience Community of Practice consisted of the following organizations:

Smart Electric Power Alliance

The **Smart Electric Power Alliance (SEPA)** is a nonprofit organization that envisions a carbon-free energy system that is safe, affordable, reliable, resilient and equitable. SEPA's mission is to accelerate the electric power industry's transformation to a modern energy future through education, research, standards, and collaboration.[21] SEPA represented a utility perspective on advancing energy resilience initiatives.

MASSACHUSETTS CLEAN ENERGY CENTER®

The **Massachusetts Clean Energy Center (MassCEC)** is a quasi-public state clean energy economic development agency dedicated to accelerating the growth of the clean energy sector across the Commonwealth to spur job creation, delivering statewide environmental benefits and securing long-term economic growth for the people of Massachusetts.[22] MassCEC provided their experience as a state agency that funds climate innovation and accelerates the state's clean energy economy.

NORTHWEST ARCTIC BOROUGH

As a Home Rule regional government, the **Northwest Arctic Borough (NAB)** provides essential programs and services to improve the quality of life for all residents. The NAB is the second largest borough in Alaska, comprising approximately 36,000 square miles.[23] NAB shared their significant experience developing grid-edge and off-grid energy systems in rural and remote areas, including indigenous communities.

TOGETHER LOUISIANA

T BR WEST SIDE SPONSORING COMMITTEE CENLA INTER FAITH NORTH LA INTERFAITH DELTA INTER FAITH T NO

Together Louisiana is a statewide network of more than 250 religious congregations and civic organizations across Louisiana. Together Louisiana's mission is to give faith and community-based organizations an opportunity to develop the leadership capacity of their members and affect change on a larger scale than they could alone.[24] Together Louisiana provided insight informed by their experience leading the Community Lighthouse initiative in Louisiana.

Appalachian Voices

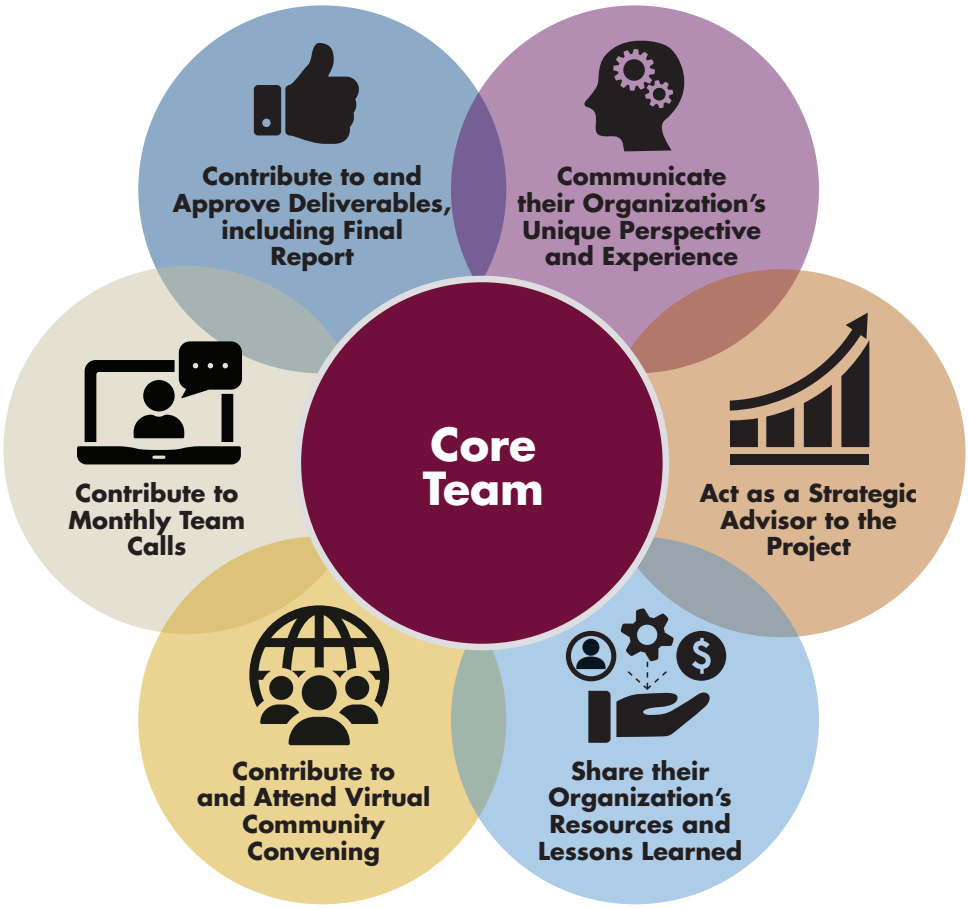
Appalachian Voices brings people together to protect the land, air, and water of Central and Southern Appalachia and advance a just transition to a generative and equitable clean energy economy.[25] Appalachian Voices provided insight into the experience of low-income, rural municipalities in developing clean energy projects.

REVISION ENERGY

ReVision Energy is a mission-driven, employee-owned solar company operating in Northern New England. Revision is a certified B Corp, with a commitment to Justice and Equity.[26] ReVision Energy represented a solar and battery storage installer perspective serving rural, suburban, and urban communities.

In addition to monthly meetings, members contributed approximately 15 hours of staff time over the nine-month timeline. Interviews were held with each Core Team member, each of whom is an expert representing a unique perspective on opportunities for battery storage advancement and program implementation. The Core Team also contributed to the final report through a review and feedback process. Core team recipients received stipends to compensate them for their time. Figure 2 details the contributions of the Core Team to this project.

FIGURE 2
The Activities of the Core Team



The figure details the Core Team's roles and responsibilities of the Resilience Community of Practice. Source: Clean Energy Group

Part 4
The Value of Resilience

Behind-the-meter battery storage provides a multitude of economic, health, and grid reliability benefits. These benefits are especially valuable for community-serving facilities and households located in historically marginalized communities, where residents must contend with disproportionate and adverse health, economic, and reliability consequences resulting from a grid dependent on centralized, fossil-fueled energy infrastructure.

A comprehensive definition of the **value of resilience** adheres to energy justice principles, in which energy is generated through clean and reliable technologies, affordability is guaranteed, and the benefits of energy systems are equitably distributed. Energy resilience projects that adhere to these principles should ensure that historically marginalized communities lead in the development and ownership of clean energy resources.

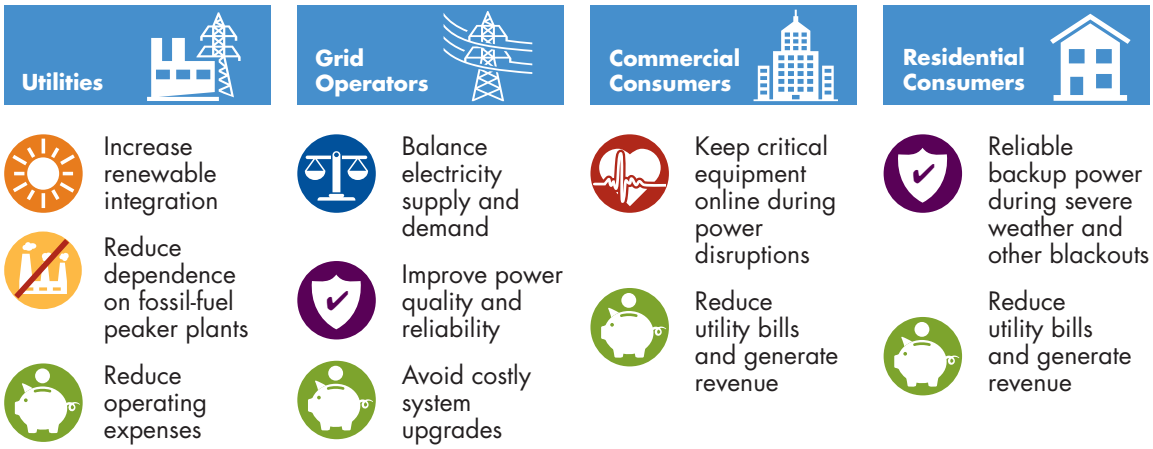
According to the American Public Health Assocation, **energy justice** is a guiding principle that "all people should have a reliable, safe and affordable source of energy; protection from a disproportionate share of costs or negative impacts or externalities associated with building, operating, and maintaining electric power generation, transmission and distribution systems; and equitable distribution of and access to benefits from such systems. A global energy system that 1) fairly disseminates the costs and benefits of energy services and 2) contributes to more representative and impartial energy decision-making."[27]

> *Energy justice is a guiding principle that "all people should have a reliable, safe and affordable source of energy; protection from a disproportionate share of costs or negative impacts or externalities associated with building, operating, and maintaining electric power generation, transmission and distribution systems; and equitable distribution of and access to benefits from such systems."*

This report focuses on three primary values of resilience: **economic stability** through reduced energy burdens, improved **public health** through reliable backup power resources and reduced reliance on fossil-fuel powered energy infrastructure, and enhanced **grid reliability** through grid services (see Figure 3, p. 18). While additional considerations

are also discussed, this report focuses on these three primary benefits as essential to valuing the benefit of battery storage projects serving historically marginalized communities, as determined through research and interviews.

FIGURE 3
The Value of Battery Storage

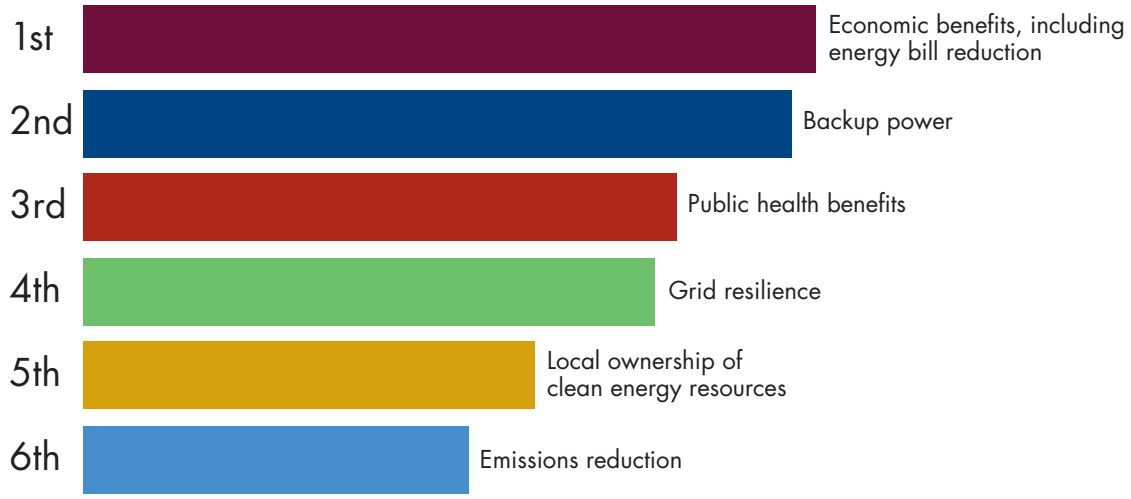


This depicts the benefits of battery storage, including the three prioritized in this report: economic stability through reduced energy burdens, improved public health through reliable backup power resources and reduced reliance on fossil-fuel powered energy infrastructure, and enhanced grid reliability through grid services.
Source: Clean Energy Group

Community feedback obtained through this project supported the three primary values of resilience reviewed in this report: economic stability, public health, and grid reliability (see Figure 4, p. 19).[28] Clean Energy Group organized and hosted a virtual Community Convening in August 2024 to share key findings, to date, resulting from the Resilience, Storage, and Grid Benefits Community of Practice and solicit feedback from attendees. It is important to note that community convening input was limited by the number of attendees and the organizations represented.

Of the meeting attendees, approximately 40 percent represented national laboratories and government agencies (local, state, federal, and Tribal) and 30 percent represented nonprofit organizations (including academic institutions).[29] Of the 131 attendees, approximately one-third to one-half (depending on the question) participated in the question and answer portion of the webinar. To learn more about the convening, see Appendix B (p. 58).

FIGURE 4
Community Convening Results on Values of Resilience



This depicts results from participant input during the Resilience Community of Practice Community Convening held in August 2024 to the question: What are the most important "values of resilience" when considering how a solar paired with battery storage project will benefit a community?
Source: Clean Energy Group/Mentimeter

In addition to overviewing the economic, health, and grid reliability benefits of battery storage, this section concludes with an overview of existing battery storage program metrics and the values of resilience each metric prioritizes in measuring a program's success.

Economic Stability

The economic impact of utility costs on a household can be measured as the percentage of gross household income spent on energy costs annually, also referred to as a household's energy burden.[30] The larger the percentage of income spent on energy costs, the higher the energy burden. Historically marginalized communities experience higher energy burdens than predominantly white, higher-income communities.[31]

On average, low-income households face an energy burden three times higher than other households.[32] Many low-income households live in energy poverty, which is defined as spending more than 6 percent of household income on energy expenditures.[33] Households in communities of color experience energy poverty at a rate 60 percent greater than those in white communities.[34] Rural households spend over 30 percent more on utility costs than the national average.[35]

These same populations are forced to deal with the negative economic impacts, among other harmful consequences, of fossil-fuel infrastructure being sited in or near their community. Real estate values fluctuate depending on proximity to energy infrastructure. For example, proximity to power lines can result in properties selling for more than 44 percent less than equivalent lots that aren't located next to them.[36]

Similarly, there is a direct correlation between grid reliability, power outages, and ratepayer utility costs. Developing and building centralized energy infrastructure, like peaker power plants, to improve grid resilience during times of peak energy demand or outages is time-intensive and costly. Fossil-fueled peaker power plants, for instance, are rarely utilized and sit unused except for brief periods of high electricity demand.[37] Furthermore, during times of high demand, utilities typically purchase power from wholesale markets, which can cost hundreds of thousands of dollars (or more) to supplement energy for even just one hour. Ratepayers incur these charges as utility rate increases, which exacerbates energy burdens.

There is a direct correlation between grid reliability, power outages, and ratepayer utility costs.

Investments in distributed energy resources, such as solar and batteries, can be utilized to build virtual power plants, which are aggregated networks of behind-the-meter resources that can be deployed to supply the grid with energy during times of high demand and energy services throughout the year. Virtual power plants can reduce or entirely replace the need for new centralized, utility-scale energy infrastructure by helping to balance electrical load fluctuations and reduce the stress on transmission and distribution systems.[38] One study found that the cost of supporting grid reliability through a virtual power plant can be up to 60 percent less expensive than alternative utility-scale options.[39]

Battery storage paired with solar can reduce energy burdens by:

- Offsetting utility costs by maximizing the value solar net metering credits and increasing solar self-consumption.[40]
- Generating revenue through participation in grid services programs.
- Reducing ratepayer costs as a less expensive alternative to investing in new or maintaining existing centralized, fossil-fuel energy infrastructure.

Health Outcomes

For medically vulnerable individuals, even a short-term power outage can be life threatening.[41] Over 3 million people in the United States rely on in-home, electricity-dependent, medical equipment such as oxygen concentrators.[42] The public health implications of increased reliance on electricity for medical support are profound. In the three months following Hurricane Maria in 2017, health care complications, including outage-related issues like medical device failure, accounted for almost one-third of the estimated 4,645 deaths reported.[43]

Potentially millions more Americans rely on refrigeration to store temperature-regulated medications. Common medications, including certain types of insulin, can become ineffective and unsafe to use if exposed to temperature fluctuations.[44] Extreme heat can also exacerbate physical and mental health conditions, with one study finding that people with schizophrenia were three times more likely to die due to extreme heat exposure than other conditions like asthma and diabetes.[45, 46]

Despite these health risks from power outages, most households and community-serving facilities do not have a backup power system. Federal backup power requirements only exist for hospitals and certain care facilities (e.g., nursing homes).[47] Similarly, Medicare and Medicaid programs typically do not provide funding for residential backup power generators.[48]

Despite these health risks from power outages, most households and community-serving facilities do not have a backup power system. Federal backup power requirements only exist for hospitals and certain care facilities.

Without access to local sources of backup power, medically vulnerable residents are forced to either wait out a power outage, which could result in the need for emergency and/or ambulatory support, or travel to a hospital that has power, which may be dangerous or not possible during severe weather and other widespread crises that limit transportation options and availability. Hospitals, which are often already experiencing capacity issues related to providing services in an emergency event, must also support medically vulnerable individuals who may only require a plug to charge their medical equipment. Beth Israel Medical Center in New York, the only hospital in lower Manhattan open during and following Hurricane Sandy in 2012, saw an increase in emergency department visits among all ages due to power outage related device failure.[49]

Those with access to backup power typically have a diesel generator, which can be deadly when improperly operated. After a 2013 power outage in the state of Connecticut, 133 carbon monoxide poisonings were reported, with the majority due to improper generator operation.[50] Furthermore, operating, maintaining, and refueling diesel generators can be physically laborious, which can be difficult for individuals with access and functional needs.

Finally, historically marginalized communities suffer multigenerational health impacts from fossil-fuel energy infrastructure emitting hazardous pollutants in their community over decades. Fossil fuel combustion has been linked to asthma, respiratory infections, cancers, and heart disease, to name a few.[51] Communities of color, especially Black communities, are most likely to live in close proximity to a fossil-fuel power plant.[52] In Pennsylvania, for instance, Black households, regardless of income, are two times more likely to live near a power plant than lower-income white households.[53]

Battery storage paired with solar can support public health by:

- Improving health outcomes in the event of a power outage by providing clean, reliable backup power to heating and cooling systems, refrigerators, and outlets to power electricity-dependent medical devices.
- Providing an automatic backup power solution that does not require refueling, ensuring backup power access is not subject to risks of fuel availability and that medically vulnerable or reduced-mobility households are not required to navigate diesel generator maintenance and refueling requirements.

- Reducing the burden on critical health systems, such as hospitals, during an emergency event, by providing in-home or locally available backup power resources to medical vulnerable populations.
- Offering emissions-free backup power, eliminating health concerns of carbon monoxide poisoning associated with the improper operation of diesel generators.
- Reducing reliance on polluting, fossil-fuel-dependent, energy infrastructure that negatively impacts community health, such as oil and gas peaker power plants.

Grid Reliability

Not all households have the opportunity or the resources to install solar and battery storage. This is especially true of low-income homeowners, whose homes are more likely to have structural issues impeding solar and battery storage development, such as older roofs and/or outdated electrical wiring.[54] Low-income households are also more likely to rent, which can make the installation of battery storage systems difficult due to conflicting landlord priorities.[55] In light of these obstacles, it is important that distributed energy solutions improve resiliency for all ratepayers, not just those who can benefit from having the solar and battery systems installed at their own home or facility.

The current United States electric grid is largely centralized, relying primarily on large-scale energy resources. The result is a grid that is vulnerable to widespread power outages when utility-scale energy infrastructure fails. Extreme heat and cold, especially, results in a significant energy strain on the grid as households utilize their heating and cooling for longer periods at peak times. When large-scale generation resources fail or cannot keep up with this high demand, rolling backouts and brownouts result.

The vulnerabilities of a fossil-fuel powered centralized grid were especially evident during the Texas cold spell of 2021. Unprecedented freezing temperatures resulted in the failure of centralized natural gas and coal firing power plants. Texas households had to contend without heat in frigid temperatures for days before the power system was able to recover.[56] Although Texas has significant front-of-the-meter wind resources, there are few programs supporting the development of behind-the-meter, distributed energy resources or grid services. The result is an energy grid almost completely reliant on utility-scale, centralized energy infrastructure.

Battery storage paired with solar can support grid reliability by:

- Providing demand response services to reduce brownouts and blackouts resulting from periods of high electricity demand, in which the grid is overburdened with energy demands and either fails or is shutdown to avoid further complications.
- Reducing ratepayer costs as a less expensive alternative to investing in new, or maintaining existing, centralized, fossil-fuel-reliant energy infrastructure.

Part 5
Measuring Success through Program Performance Metrics

This section provides an overview of the most common performance metrics utilized by developers, states, utilities, and government agencies in evaluating the success of a battery storage project, program, or policy. Metrics are organized into three categories: **carve-outs and capacity targets**, **monetizable metrics**, and **harder-to-monetize metrics**. Each metric provides an example of an existing program that utilizes this performance metric in measuring a program's success.

A **performance metric** measures the effectiveness of a program or policy. A performance metric should be measurable, have a clear definition, and be able to measure and track a programs progress. If equity measures are not incorporated into performance metrics, a program will be limited in its scope and, ultimately, benefits.[57]

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Carve-outs and Capacity Targets

A **carve-out** allocates a minimum percentage or resource deployment goal, within a larger program, to serve a targeted population. By using geographic or social eligibility requirements to incentivize project development in specific communities, carve-outs are meant to spur market development in areas that the market has thus far underserved. For example, the first community solar enabling legislation in the country, the Colorado Community Solar Gardens Act, initially required that low-income households represented at least 5 percent of all community solar subscribers for each project.[58]

A **capacity target** is a capacity deployment goal for a specific energy source or technology. Similar to a carve-out, a capacity target spurs market development by prioritizing the installation of a specific energy technology. The Connecticut Energy Storage Solutions incentive program has a capacity target goal of deploying 580 megawatts of behind-the-meter energy storage systems throughout the state, including residential, commercial, and industrial projects.[59]

Monetizable Metrics

Monetizable metrics focus on program success as measured by economic benefits. Goals typically relate to a dollar amount or percentage of energy cost savings (either for one or all rate-payers), including utility bill savings and revenue generation through grid services.

UTILITY BILL SAVINGS

Programs that prioritize utility bill savings measure success through a guaranteed cost reduction in customer electric bill expenses due to the increased utilization of renewable energy resources for their power consumption (either on-site or through a shared model).[60] For solar, these bill savings are typically achieved by either charging a lower rate for electricity generated by a third-party-owned solar system or by applying bill credits for solar generation to offset the cost of utility-supplied electricity, such as through community solar.

There are no significant examples of established incentive programs that guarantee savings associated with behind-the-meter battery storage.

To date, guaranteed savings models have primarily been geared to energy efficiency and solar programs. The Connecticut Residential Renewable Energy Solutions Program, for instance, requires that participating multifamily affordable housing providers share at least 20 percent of the total financial benefit of a solar installation with the tenants of the property. The savings are included on tenant utility bills. For master-metered buildings, which include utility costs in monthly rent charges, property owners can allocate an equivalent dollar amount to tenant-benefiting programs.[61] This financial benefit sharing does not extend to Connecticut's battery storage programs. Even if a property is participating in both the Residential Renewable Energy Solutions Program and the Energy Storage Solutions Program, a battery storage incentive program that provides upfront incentives and grid services performance payments, they are only required to share the savings associated with solar, not battery storage.

There are no significant examples of established incentive programs that guarantee savings associated with behind-the-meter battery storage. However, SMUD's Energy StorageShares program in Sacramento, CA is a unique example of a front-of-meter application of battery storage that guarantees savings to the customer (in this case, commercial businesses). SMUD's StorageShares programs community-storage model is especially innovative: the customer makes an up-front payment to subscribe to a shared battery storage project in exchange for a monthly credit on their utility bill for 10 years. Like community solar, the battery storage system is off-site and therefore provides only economic benefits to the participating customer. The credit the customer receives is equivalent to what the business would have saved in demand charges had they installed battery storage at their own facility. SMUD utilizes the initial customer investment combined with their own capital to deploy battery storage projects that provide targeted grid benefits. In doing so, SMUD improves reliability for all customers and avoids costly infrastructure upgrades.[62]

GRID SERVICES

Grid services programs engage customers with behind-the-meter battery storage to improve grid efficiency and reliability. The performance metrics utilized for these programs will therefore take into consideration reliability metrics when creating a program goal. Reliability metrics are rooted in annual index calculations utilized by electric utilities, which consist of the following:[63]

- System Average Interruption Duration Index (SAIDI) is the total minutes of interruption the average customer experiences.
- System Average Interruption Frequency Index (SAIFI) is the average number of times a customer experiences an outage.
- Customer Average Interruption Duration Index (CAIDI) is the average outage duration that any given customer would experience. It can also be viewed as the average time required to restore services.

These indices are the driving calculations when determining a utility's system reliability. While these indices are important measurements of reliability, they are not all-inclusive. Averaging reliability over a broad region can devalue local disparities in reliability. A power outage is not recovered from equitably by all who are impacted, with wealthy communities often benefiting from quicker recovery times, whereas historically marginalized communities face longer power outages and therefore a longer road to recovery. One study found that for every decile drop in socioeconomic status, power outages lasted 6 percent longer.[64]

States can encourage utilities to improve system reliability by setting SAIDI and SAIFI improvement targets that could then be achieved through a combination of efforts, ideally, including grid services and virtual power plant programs. In order to incentivize participation in grid services programs, utilities and states will typically offer a pay-for-performance program, in which customers are paid to allow the utility to draw from their battery for grid services. This model allows for the utility to combat times of peak demand with local, dispatchable stored energy (virtual power plants are explored further in the Value of Resilience section of this report, p. 20).

Improving health outcomes in the event of a power outage can result in economic and societal benefits.

Connecticut's Energy Storage Solutions program is an example of a battery storage incentive and grid services program created to reduce peak demand and improve grid reliability. To learn more about Energy Storage Solutions, see the case study on the program on p. 47.

Harder-to-Monetize Metrics

Harder-to-monetize metrics have a social, environmental, or health benefit that is more challenging to calculate than a direct economic benefit. Harder-to-monetize metrics for behind-the-meter solar and battery storage projects include those related to improving health outcomes, building grid reliability, and/or reducing emissions.

HEALTH

Improving health outcomes in the event of a power outage can result in economic and societal benefits. Avoiding an emergency medical event can save thousands in health care costs. In the United States, the average emergency room visit costs an uninsured person, on average, $2,600.[65] Even with health insurance, the average cost still exceeds $400 for individuals.[66] For health care facilities, a power outage can cost upwards of $8,800 per minute in lost revenue or for costs associated with diverting resources to

ensure patient safety, such as transferring patients to other hospitals.[67] While these are real costs incurred to individuals and the health care industry, they are difficult to incorporate into individual project economics because potential avoided outage costs are challenging to anticipate and estimate.

Programs that measure success through health-related metrics are typically incentive programs for projects that have the potential to improve health outcomes in the event of an outage. California's Self-Generation Incentive Program incentivizes battery storage for public health by establishing different incentive tiers, with a base incentive and two equity incentives (equity and equity resilience). The equity incentive provides a higher incentive for disadvantaged and low-income communities. The equity resilience incentive covers almost 100 percent of project costs for electricity-dependent, medically vulnerable individuals located in high wildfire-prone areas of the state.[68]

GRID RESILIENCE

Vulnerable grid areas are regions of the electrical grid that are at a higher risk of experiencing power disruptions, outages, or other reliability issues. These areas often lack the infrastructure necessary to withstand natural disasters or are vulnerable to technical failures, which makes them more susceptible to blackouts or prolonged grid outages. Vulnerable grid areas are oftentimes more expensive to improve through grid hardening measures and repairs, for example, making improvements to long feeder lines serving rural and remote communities.[69]

Vulnerable grid areas are regions of the electrical grid that are at a higher risk of experiencing power disruptions, outages, or other reliability issues.

Through its Bring Your Own Device program, the Vermont utility Green Mountain Power will pay households an incentive of up to $950 per kilowatt to allow the utility to discharge the customer's home battery system for grid reliability services. Batteries in areas of the state where the grid is particularly vulnerable and in need of additional flexible battery storage capacity can receive an additional incentive of $100 per kilowatt of storage once enrolled in the program.

EMISSIONS

There are incentive and grid services programs that work to advance battery storage deployment as a tool to meet greenhouse gas emission reduction goals. Massachusetts was the first (and currently the only) state to adopt a Clean Peak Standard, requiring electric utilities to meet a certain percentage of annual peak electricity demand with clean peak resources. A clean peak resource is a "qualified energy storage system or a demand response resource that generates, dispatches or discharges electricity to the electric distribution system during seasonal peak periods, or alternatively, reduces load on said system."[70] Notably, renewable energy technologies are eligible and do not have to be paired with battery storage. The primary goal of the Clean Peak Standard is to contribute to the state's environmental protection goals concerning air emissions by replacing (or avoiding the development of) non-renewable generating resources during Seasonal

Peak Periods.[71] The Clean Peak Standard references reduced peak demand and improved grid reliability as added benefits of deploying clean peak resources, but these were not the main drivers for adopting the standard.

While the Clean Peak Standard has been in effect since 2020, there is no publicly available performance data as to the amount of storage deployed through the program or if/how the program has improved utility reliability. It's therefore difficult to judge the program's success.[72]

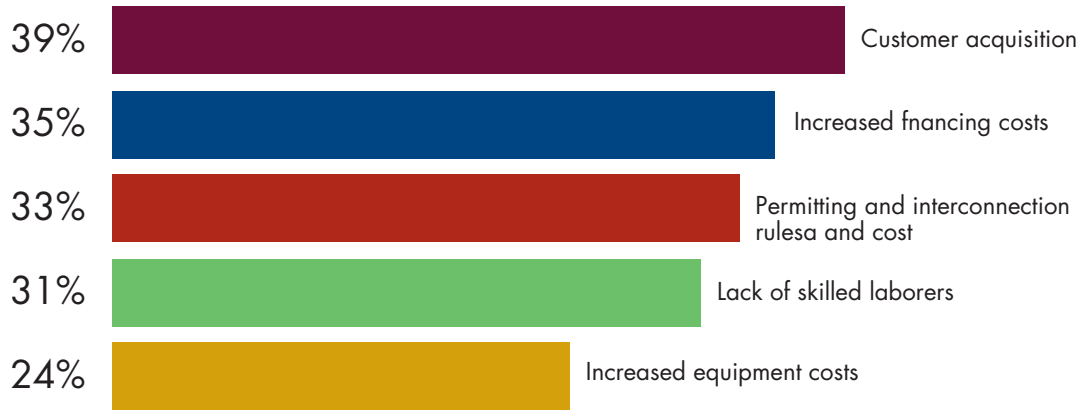
Part 6
Barriers to the Equitable Advancement of Battery Storage

While the battery storage industry has experienced a boom in the past decade, progress has not been equitable. Barriers related to pre-development support, economic feasibility, and permitting and interconnection are the most significant obstacles to the advancement of battery storage in historically underserved communities.

A 2024 Solar Industry Survey, led by SolarReviews, found that only 6 percent of solar and battery storage industry partners (56 percent of which were residential and small commercial solar installers) reported serving customers with an annual income of less than $50,000. This limited low-to-moderate income market penetration is not because of a lack of potential customers: low-to-moderate income households, including multifamily buildings, represent over 40 percent of residential rooftop potential.[73]

Rather, the primary concerns of solar and battery installers—customer acquisition, financing costs, and permitting and interconnection challenges—are compounded in historically marginalized communities (as detailed in Figure 5).

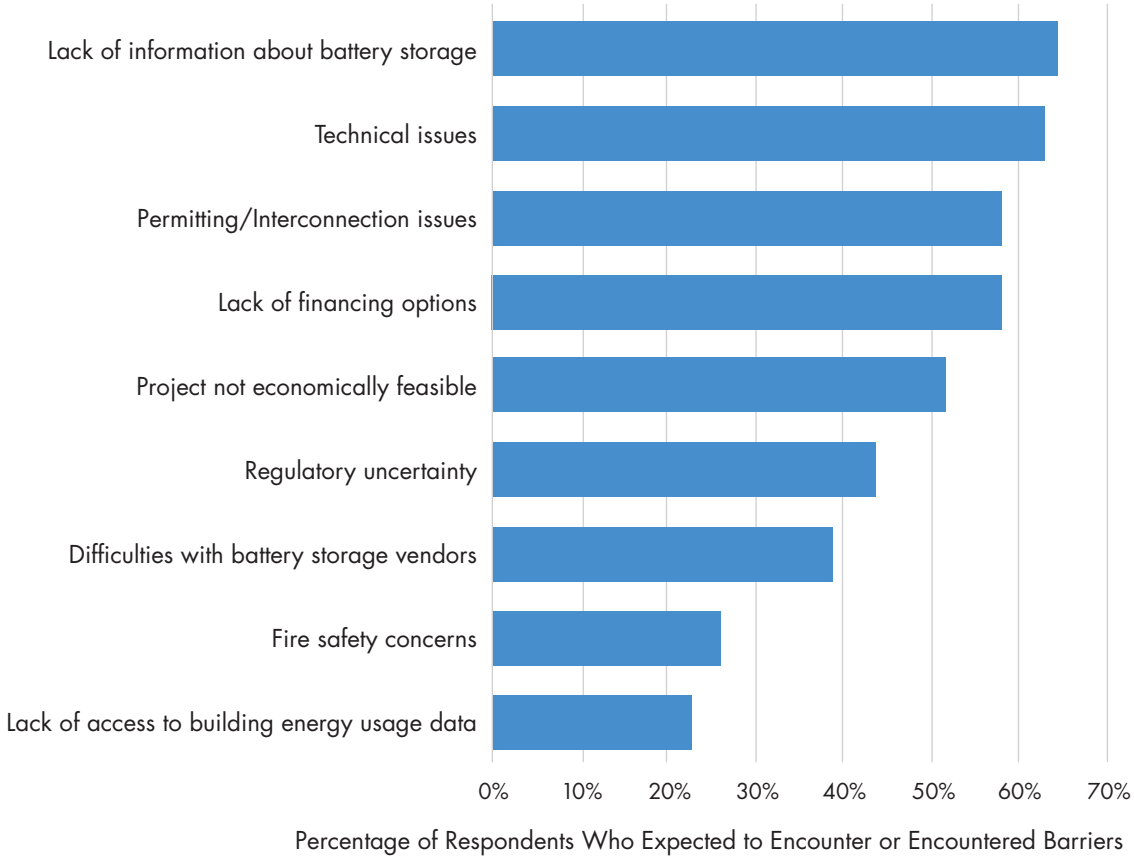
FIGURE 5
Barriers to Success for Solar and Battery Storage Installers



This shows the results from the SolarReviews Solar Industry Survey. Survey respondents, who were solar and/or battery storage installers or related partners (equipment manufacturer and electrician, for instance), ranked the top barriers to their business's success.
Source: SolarReviews, see https://frontend-cdn.solarreviews.com/2024-solarreviews-solar-industry-survey-report.pdf.

Households and community-serving institutions in historically marginalized communities report similar obstacles to battery storage development. In a 2021 Clean Energy Group survey of 60 community-service providers, respondents ranked early-stage and pre-development support (technical assistance and technology awareness), economic feasibility (including financing), and permitting and interconnection as top barriers to deploying solar paired with battery storage at their facilities (Figure 6). Overcoming the issues hindering the equitable advancement of battery storage will benefit not only the households and communities that are currently unserved, but also the installers hesitant to extend their market territory due to the elevated risk associated with project development in low-to-moderate income communities.

FIGURE 6
Barriers to Deploying Solar Paired with Battery Storage Technologies at Community-Serving Facilities



This represents the responses of 60 community-service partners when asked to identify the top barriers to successfully developing solar and battery storage at their facility.
Source: Clean Energy Group, see https://www.cleanegroup.org/publication/overcoming-barriers-to-solar-storage-in-critical-lmi-facilities.

The Resilience, Storage, and Grid Benefits Community of Practice process identified **lack of pre-development and capacity-building support**, **economic feasibility**, and **permitting and interconnection delays** as the most significant barriers in ensuring equitable access to solar paired with battery storage in single-family homes and community-serving facilities.

Lack of Pre-Development and Capacity-Building Support

Lack of pre-development support is oftentimes the first hurdle organizations face when trying to deploy a solar and battery storage project. Before installation, communities need to understand the feasibility, potential barriers, benefits, and economics of their project, which requires significant pre-development work. Installing solar and battery storage requires navigating complex engineering, regulatory, incentive, and financing processes. Some communities, especially those in rural and remote areas, consist of municipalities with one or two employees working to implement a town-wide energy initiative. Many rural and small towns are not served by local battery storage engineers and/or installers.[74]

"The municipalities we support have such high energy burdens it prevents allocating funding to additional staff. Because there is no staff to support the clean energy initiatives, these municipalities can't pursue energy solutions."

—**Austin Counts**, SWVA Solar & Electrification Projects Manager at Appalachian Voices

Understanding and navigating solar and battery storage development processes require knowledge and trusted partnerships, both of which need significant investments of time and energy. Community service providers do not often have the staff capacity to pursue these projects or lack the information needed to evaluate the potential benefits of newer technologies such as battery storage. Furthermore, pre-development support, which provides an early-stage overview of system design, economics, and operations, can be costly, complicated, and/or have "strings attached," such as a requirement to engage a pre-development assistance provider or incur fees for the early-stage project development support.

Economic Feasibility

Battery storage policy, market, and regulatory barriers can all contribute to poor project economics, and a weak return on investment will negatively impact a proposed solar and storage system. In most states, the economics of battery storage is highly dependent on favorable solar economics, with the bill savings from solar energy typically more substantial than the economic benefits from storage. Improved solar economics can help to offset the cost of a system that is paired with battery storage. There are few states with battery storage incentives or grid services programs, and even fewer states that prioritize equity in their incentive and program structures. A lengthy system payback timeline can impact a solar and battery storage project's ability to secure financing.[75, 76]

Even if the project economics support further exploration of financing options, common third-party options, such as leases and Power Purchase Agreements, are complex concepts that either do not result in direct ownership or require lengthy repayment timelines until

ownership can be achieved.[77] Lack of pathways to ownership can be problematic for community-serving institutions that prioritize local ownership of clean energy resources as part of their value framework for resilience.

Low-interest loans, which are often necessary to finance projects in low-income communities, are not widely available or may have stringent requirements, such as high credit scores. Financial institutions serving multiple states must juggle different storage regulatory environments and incentive offerings depending on a project's location, further complicating project financing processes.

Permitting and Interconnection Delays

Finally, assuming pre-development and economic feasibility obstacles are overcome, solar and storage projects must still navigate complex and time-intensive permitting and interconnection processes.

Permitting is the processes in place to regulate project siting and construction, including compliance with relevant building, electrical, and fire safety codes.[78] **Interconnection** is the process of obtaining approval from the local utility and grid operator to interconnect energy resources to the local distribution grid or transmission system.[79]

A major obstacle to a project even making it to the permitting and interconnection queue is the issue of process inconsistencies nationwide. Permitting and interconnection processes can vary greatly depending on the state, municipality, and utility provider, which requires installers to potentially navigate an entirely new and complex process for each new project location.[80] One survey found that almost 50 percent of solar and battery storage installers (and related partners) indicated that permitting rules are too complicated. A quarter of respondents ranked permitting inconsistencies among jurisdictions as one of the largest project development issues.[81]

Interconnection process reforms have not kept in pace with renewable energy project development. In 2023, solar, wind, and battery storage represented 95 percent of the 2 terawatts of capacity pending in grid interconnection queues.[82] This backlog has resulted in delays of months, or longer, with batteries sitting unused for economic or resilience benefits.[83]

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Community-serving renewable energy projects awaiting interconnection may be required to pay for costly utility interconnection studies and necessary grid upgrades, impacting project timelines and adding to project costs, which can result in a project becoming economically unfeasible. Residential systems often benefit from a much less intensive and more standardized interconnection process, typically lasting no more than a couple of days.[84]

CASE STUDY

The Impact of Interconnection Delays on Community-Led Energy Resilience

The California Indian Museum & Cultural Center (CIMCC) is a vital hub for 24 Tribes and over 25,000 Native American people across Sonoma, Lake, and Mendocino Counties. To enhance energy independence and resilience for these communities, CIMCC installed a 76.5-kilowatt solar system and a 220-kilowatt-hour lithium-ion battery storage system that will support critical loads at the center for up to 72 hours during power outages. A major setback for the project has been significant interconnection delays for the battery storage system. Despite the system being physically installed in 2023, it remains inoperable as of November 2024, due to pending interconnection approvals. This delay has hindered CIMCC's ability to achieve its energy resilience goals, limiting the system's potential to provide critical backup power during power outages and extreme weather events. These delays underscore the challenges often faced in integrating renewable energy systems into the existing grid infrastructure, particularly for smaller-scale projects.

California Indian Museum and Cultural Center, Solar Array.
Photo: California Indian Museum and Cultural Center

Part 7
Existing Programs and Policies

This section overviews existing efforts as they relate to overcoming the three primary barriers identified: **pre-development support** (technical assistance and capacity building), **economic feasibility** (finance and incentives), and **permitting and interconnection**. The programs overviewed do not represent a comprehensive list of all available options for improving access to battery storage technologies, but rather programs that are either widely available and/or unique in their approach. This section also includes case studies highlighted for their success in optimizing the meaningful benefits of battery storage and minimizing the obstacles to equitable deployment, by presenting opportunities that encourage participation of households and community-serving facilities in historically marginalized communities.

While each initiative supports the equitable advancement of clean energy resources, the existing programs and relevant case studies highlighted may not directly incorporate equity or be specific to battery storage. This discrepancy is due to the fact that there are so few supportive battery storage programs in general, and even fewer that incorporate equity components. In these instances, obstacles to equity are overviewed.

Pre-Development Support

Technical support and capacity-building efforts are essential for nonprofits looking to develop solar paired with battery storage because they enhance the organization's efficiency, effectiveness, and sustainability. These efforts help increase organizational efficiency by strengthening their structural and internal processes, which can reduce overhead, enhance internal coordination, and enable staff to work more effectively towards their mission.

Many nonprofits and community-serving entities operate on limited budgets, with those budgets generally being allocated towards the primary mission of the organization. With funding specifically dedicated for solar and storage capacity building, these organizations are better situated to overcome their day-to-day operational challenges and expand their capacity to access funding and implement solar and storage projects.

Capacity-building funding opportunities allow organizations to dedicate staff and resources toward advancing clean energy projects. Technical assistance funding allows organizations to

With funding specifically dedicated for solar and storage capacity building, these organizations are better situated to overcome their day-to-day operational challenges and expand their capacity to access funding and implement solar and storage projects.

access support in assessing the feasibility of projects and connects them with renewable energy experts and resources that make project development a more manageable process.

The following section overviews various federal-, state-, and nonprofit-led technical assistance and capacity building grant programs. The programs highlighted represent some of the most widespread and accessible programs available as well as some innovative, locally based opportunities.

The following programs support community-serving organizations in building their internal capacity to advocate for and develop solar and battery storage projects in their community.

FEDERAL PROGRAMS

U.S. Department of Energy, Renewables Advancing Community Energy Resilience (RACER) Funding Program

The U.S. Department of Energy Solar Energy Technologies Office 2022 Renewables Advancing Community Energy Resilience (RACER) program enabled communities to implement solar and solar paired with battery storage to prevent disruptions in power caused by extreme weather and other events, and to rapidly restore electricity in the event of grid outages.[85]

Funding was available under three topic areas: 1) innovative community-based energy resilience planning, which supports projects that develop energy resilience planning frameworks at a community level through stakeholder participation and collaboration; 2) automation strategies for rapid energy restoration, which supports projects that enable rapid identification of available assets to re-energize power systems after extreme events and outages; and 3) innovative solutions to increase the resilience and hardening of solar power plants.

With funding for these topic areas, the RACER program aimed to increase the resilience of energy systems and community preparedness to withstand and recover rapidly from disasters.

With funding for these topic areas, the RACER program aimed to increase the resilience of energy systems and community preparedness to withstand and recover rapidly from disasters. The program offered $33 million for over 30 diverse communities across the nation, and includes partners from local and state governments, national labs, universities, and nonprofit organizations.

While this program was a one-time funding opportunity within a limited time frame, it serves as an example of a program that provided community-level support. RACER, or similar programs, could be reinstated provided that additional funding resources become available.

STATE PROGRAMS

Solar plus Storage for Resilient Communities Program (Washington)

The Washington State Department of Commerce's Solar plus Storage for Resilient Communities Program provides technical assistance to help position and prepare communities to apply for future grant funding opportunities. The program is included in a broader Washington Clean Energy Grant Programs offering, and it is available to public entities in the state such as local governments, public higher education institutions, K-12 public school districts, state agencies, tribal governments and their affiliates, and nonprofit organizations.[86] The program connects grant awardees with energy resilience specialists who provide site-specific feasibility studies at no cost.[87] Grants support installation as well as planning work for solar paired with battery storage at community buildings.[88]

The program's technical assistance grants for predevelopment support help reduce barriers surrounding technical knowledge and staff capacity to begin the development process for solar paired with battery storage projects.

Resilient Maryland

Resilient Maryland, a program administered by the Maryland Energy Administration, provides grant funding and technical expertise to help nonprofits and community-based organizations reduce their utility costs and reinvest those savings into their programming.[89] The grant program offsets the cost of planning, designing, and constructing microgrids, resilient facility power systems, and resilience hubs. The program's goals are to 1) help entities identify optimal microgrid and other distributed energy resource configurations, 2) enhance the resilience, sustainability, energy affordability, and efficiency of essential facilities and operations, and 3) safeguard communities from the harmful effects of prolonged power outages. Resilient Maryland provides predevelopment funding for feasibility analysis and other preconstruction activities.[90]

Resilient Maryland provides predevelopment funding for feasibility analysis and other pre-construction activities.

EmPower Massachusetts

MassCEC's EmPower program is an initiative aimed at the exploration, development, and implementation of innovative program models or projects that will provide access to the benefits of clean energy or reduce energy burden for previously underserved or vulnerable populations in the Commonwealth. The program has two tracks: an Innovation and Capacity Building track and an Implementation track. Both tracks provide funding to a variety of organizations and partnerships, including community-based organizations, tribes, municipalities, clean energy installers, and financial institutions.[91] Clean energy projects, including solar paired with battery storage, are eligible for these funds.

The Innovation and Capacity Building track provides capacity building or "seed funding" for applicants to explore innovative ideas for potential program models or projects and to build organizational capacity to support future clean energy program models or projects in underserved or vulnerable populations. Funding can be used for activities such as

staff or individual time devoted to program model or project concept development or refinement; costs associated with initial and/or ongoing community engagement, especially direct payment to participants; technical support needed to move program model or projects forward; and compensation for a grant writer, accountant, lawyer, or other professional services. For instance, building internal capacity and technical expertise on solar and battery storage technologies and project development models would be an eligible concept.[92]

The Implementation track provides funding for similar activities and supports the implementation phase of program models or projects aimed to increase clean energy access to underserved or vulnerable populations. Applicants can also use Implementation funding to support capital expenses towards clean energy installations such as solar PV projects or battery energy storage. Those capital expenses are capped at 25 percent of the requested grant budget. The program also facilitates peer learning and relationship-building among grantees.

NONPROFIT-LED PROGRAMS

Clean Energy Group Technical Assistance Fund (Nationwide)

Clean Energy Group (CEG) is a nonprofit organization operating on a nationwide scale, providing technical, economic and policy solutions to enable communities to participate equitably in the clean energy transition. CEG's Technical Assistance Fund (TAF) program has supported over 150 community service providers in developing local solar and battery storage projects through one-on-one tailored technical assistance. Since 2014, the TAF program has distributed $2 million in small grant awards. Grants support predevelopment feasibility assessments for solar and battery storage at community facilities.

CEG's TAF is an example of how grant funding for predevelopment analyses spurs larger and further investment in solar plus battery storage developments.

CEG's TAF is an example of how grant funding for predevelopment analyses spurs larger and further investment in solar plus battery storage developments. Every dollar invested in early-stage support through the TAF has activated, on average, $127 in external capital to install solar and battery storage.

Clean Energy Group also offers a capacity building program, the Resilient Power Leadership Initiative (RPLI), in which BIPOC-led, nonprofit organizations can receive $10,000 grants to support internal capacity building or a community education program specific to advancing resilient and renewable technologies. Although the RPLI and TAF are separate projects, some organizations have utilized both; typically, the RPLI first, to dedicate staff time to specific capacity building efforts related to energy resilience, followed by the TAF, where that newly developed knowledge can support the design and feasibility process related to solar and battery storage at a specific facility.[93]

Urban Sustainability Directors Network Resilience Hub Project (Nationwide)

The Urban Sustainability Directors Network (USDN) brings together local government sustainability practitioners to learn, collaborate, and accelerate the work of local sustainability. USDN's work currently serves over 100 million residents in over 280 participating communities and municipalities. This broad reach and diverse set of members creates a large network that can be drawn upon as a resource and for information sharing. USDN provides members with resources and connects them with their peers for information and knowledge sharing.

In one of the organization's focus areas, USDN works with municipalities to develop Resilience Hubs, which serve as centers of reliable backup power during a power outage and as important community pillars during every other day of the year.[94] Partnering primarily with local governments and municipalities, USDN provides coaching, capacity building funding, and technical support to develop Resilience Hubs, including advancing solar and storage solutions to generate clean energy and provide backup power in the event of an outage.[95, 96]

Economic Feasibility

Sustained development for solar paired with battery storage in historically marginalized communities requires some combination of upfront incentives and grant support, grid services revenue-generating opportunities, and competitive finance solutions. The grant opportunities, existing finance structures, and incentive programs identified in this report are tailored to meet the needs of and overcome the economic challenges faced when developing community-centered energy resilience projects in historically marginalized communities.

Sustained development for solar paired with battery storage in historically marginalized communities requires some combination of upfront incentives and grant support, grid services revenue-generating opportunities, and competitive finance solutions.

FINANCING MECHANISMS

On-bill Financing

On-bill financing enables utility customers to borrow money for energy improvements, including renewables such as solar and storage, and pay it back through a pay-what-you-save model on their utility bill, either directly to their utility or through a third-party lender.[97] On-bill financing allows customers to access renewable energy or energy efficiency upgrades without the burden of a significant upfront cost; it is currently available through at least 110 utilities in 33 states.[98] On-bill financing benefits from installer support as well, with installers appreciating the consistency of the program across different utilities and states.[99] On-bill programs are most commonly used to finance energy efficiency or solar.

Customer eligibility for on-bill programs is primarily determined through low-barrier and accessible finance qualification and terms. Some on-bill programs do not require a credit check, and instead use energy bill payment history for program eligibility. The on-bill obligation is tied to the utility meter, which can allow the monthly charge to transfer to

the next owner or renter in the event the customer relocates.[100] The most beneficial and successful on-bill programs include strong consumer protections, including guaranteed savings or, at minimum, are bill neutral.[101, 102] These protections would need to apply to an on-bill program designed for solar paired with battery storage.

There are many examples of on-bill financing programs for energy efficiency, including the Hawaii Green Energy Money $aver Program, the Washington Orcas Power and Light Cooperative Switch It Up! On-Bill Program, and Colorado's Fort Collins Utilities Epic Homes Program.[103,104,105]

Most on-bill programs do not include battery storage as an eligible technology. This could be because of economic concerns or due to limited understanding of the technologies and their benefits. Battery storage-only projects are not likely the best fit for on-bill programs as the economic benefits will likely not meet the minimum system payback requirements (such as guaranteed savings or a net neutral bill). However, solar paired with battery storage could be economically feasible, depending on the state and considering the robust federal tax incentives available today. This is especially true for commercial buildings—including community-serving facilities—that have time-of-use rates and/or can participate in grid services programs.

Where solar paired with battery storage is economically feasible, on-bill programs can be an effective, easily accessible, and non-exploitive solution to battery storage financing in low-to-moderate income communities.

For these reasons, few on-bill programs include solar and/or battery storage as eligible technologies. However, where solar paired with battery storage is economically feasible, on-bill programs can be an effective, easily accessible, and non-exploitive solution to battery storage financing in low-to-moderate income communities.

The following case study is highlighted as an example of a utility on-bill financing program that includes battery storage as an eligible technology.

CASE STUDY

On-Bill for Solar and Battery Storage— La Plata Electric Association On-Bill Financing

La Plata Electric Association (LPEA) is a member-owned, not-for-profit, electric distribution cooperative serving nearly 47,000 customers in five counties in southern Colorado[106] LPEA provides customers with on-bill financing to invest in green infrastructure and energy efficient improvements for their home or business. Loans are provided through the First Southwest Bank, which is the entity responsible for setting the interest rate.[107]

LPEA's program requires no upfront payments and provides low-cost, fixed interest rate loans that are repaid through payments built into the customer's monthly utility bill. Importantly, the program is designed to "pay as you save," not "what you save," meaning that participating customers could end up making loan payments that exceed a month's anticipated savings amount.

The on-bill financing program covers the cost of materials and labor for a wide variety of energy efficiency upgrades including solar and battery storage systems. Customers can apply for loans up to $35,000. LPEA also provides a list of qualified installers to make the process easier to navigate.

Third-Party Power Purchase Agreement or Lease

Power Purchase Agreements (PPAs) and leases typically provide a no upfront cost option to finance solar paired with battery storage, in which the project developer pays for the system. The main difference between a PPA and a solar lease is the payment structure. With a solar lease, the customer pays a fixed monthly fee for the use of the solar panels. With a PPA, the electricity consumed is usually at a lower rate than utility-supplied electricity, which results in savings. Operations and maintenance are also typically included in lease and PPA agreements, which is an added relief for customers less familiar with renewable energy technologies. In some cases, the customer may also economically benefit from time-of-use savings or lower utility demand charges through shifting the timing of their energy consumption to lower cost periods of the day.[108] However, PPA and lease options result in significantly less savings for the customer than if they owned the system outright, as much of the savings generated is returned to the developer as part of the monthly payment.

There are various nationwide lease and PPA programs that allow nonprofit and community-serving institutions to participate, although not every state allows for PPA's and/or lease options. In most cases, it is harder to incorporate storage into a PPA or lease due to the high cost and relatively low payback generated by battery storage savings, and in every case it's more complicated to include battery storage. For this reason, battery storage

PPAs are often bundled with solar to help improve project economics.[109] Oftentimes, PPA and lease agreements have contract terms spanning 10-25 years, which may deter customers who are wary of decades-long financing arrangements.

In addition to options available through solar developers and installers, there can be unique benefits to financing solutions established and administered by mission-aligned, nonprofit organizations.[110] These nonprofit-led programs usually focus eligibility on a specific facility type or project location, for example rural projects, and sometimes pair low-interest loans with grant opportunities and/or other types of support, such as technical assistance. The nonprofit CollectiveSun, for example, offers a loan product tailored to meet the needs of nonprofit community-serving facilities.[111]

The case study on RE-volv highlights an example of a nonprofit organization that provides tailored financing for nonprofits pursuing solar and batter storage projects at community-serving facilities.

In addition to options available through solar developers and installers, there can be unique benefits to financing solutions established and administered by mission-aligned, nonprofit organizations.

CASE STUDY

RE-volv

RE-volv is a climate justice nonprofit organization that helps nonprofits across the country to install solar and battery storage, while raising awareness about equitable climate solutions and training the next generation of clean energy leaders.[112] RE-volv offers affordable solar financing that aims to expand an organization's ability to reduce their energy costs, cut carbon emissions, and serve as a clean energy leader in their community.

RE-volv's largest program, the Solar Seed Fund, collects donations and secures grant funding that supports solar installations for community-based organizations.[113] Nonprofits can choose from one of two financing mechanisms through RE-volv: a lease or PPA, which is restricted to solar-only projects, or a loan, which provides financing for both solar and battery storage. As organizations reduce their energy and save money on their bills, monthly repayments are made to RE-volv. The payments are then funneled back into the Solar Seed Fund for the financing of additional projects, creating a sustainable cycle of clean energy investment. The Watts-Willowbrook Church of Christ in Compton, California, included battery storage in their project and financing package with RE-volv. Solar has been installed at the church and the battery storage installation is underway, which will make it the first house of worship to finance solar and battery storage through RE-volv's loan program.[114]

Community Development Financial Institution Green Loan

Community Development Financial Institutions (CDFIs) are lenders whose mission is to provide fair, responsible financing to rural, urban, Native, and other communities that do not always have access to traditional financing structures.[115] These organizations specialize in lending to under-resourced communities and aim to provide loans that increase economic potential and help build wealth, in historically marginalized communities.[116]

CDFIs are available broadly throughout the country, with over 1,400 certified nationwide.[117] The Capital Good Fund, for instance, recently launched a program in Pennsylvania that will lease solar and battery storage solutions to low-to-moderate income homeowners.[118] However, CDFIs are not evenly distributed, and some more rural or underserved areas may not have the same level of access to funding as others. Community-serving facilities may also still need to cover a portion of project costs if the loan does not meet the full out-of-pocket cost, which creates an additional financial burden for these facilities.

The case study on Kentucky Highland Investment Corporation highlights a program that addresses the need for comprehensive loans for solar and battery storage at multifamily housing, start-up companies, and small businesses.

CASE STUDY

Kentucky Highlands Investment Corporation CDFI

The Kentucky Highlands Investment Corporation (KHIC) is a Community Development Financial Institution dedicated to fostering economic development in Southeastern Kentucky through responsible investments, training, and management assistance. KHIC has invested over $350 million in more than 22 Kentucky counties.[119]

KHIC offers a Solar Energy Revolving Loan Fund, which is designed to finance new buildings or retrofit existing buildings with solar energy systems.[120] Through the Solar Loan Fund, KHIC works with HOMES, Inc., an affordable housing provider that has expertise in solar installation, as well as with additional Kentucky-based CDFIs that provide financing for small start-ups and expanding businesses in central Appalachia.[121]

KHIC's work has expanded to solar and storage financing for small businesses with a project on a medical office building in Monticello, Kentucky. The building was able to access financing through the CDFI's loan programs and installed 76 rooftop solar panels and two Tesla Powerwalls for energy storage, which are being used to provide essential power for the building's pharmacy and walk-in community medical clinic.[122]

Utility Lease Program

Utility-administered lease programs are run by an electric utility and allow customers to lease solar, battery storage, or solar paired with storage systems directly from the utility. These programs have the potential to make distributed energy resources more affordable and accessible by eliminating or reducing the upfront costs typically associated with installing these systems. Utility lease programs are often part of broader utility or state efforts to support grid resilience, reduce peak demand, and promote renewable energy. Utility management of a lease ensures consistent grid integration of the renewable systems and an easy payment method, similar to utility on-bill financing.

The following case study highlights an innovative program that enables customers to maintain power during outages and deliver benefits to the utility. Additional examples of utility-administered lease programs include Hawaiian Electric's Battery Bonus Program and the Salt River Project's Residential Distributed Energy Resource Program in Arizona.[123]

CASE STUDY

Green Mountain Power Battery Lease Program

Green Mountain Power (GMP), an investor-owned utility in Vermont, provides multiple pathways for customers to access battery energy storage. In addition to its "bring-your-own-device" program, in which customers can qualify for incentives and additional economics benefits by having their battery systems provide grid services, GMP offers a Tesla Powerwall program that provides customers with two Powerwall batteries. The cost to participating customers is either $55/month over a 10-year lease period or a one-time payment of $5,500. Notably, the lease program only provides resilience benefits for the customer. There is no economic advantage (through incentives or grid services) for the customer when participating in the lease program. Green Mountain Power owns the battery, although it is sited behind-the-meter in the customer's home.

Customers participating in either the bring-your-own-device or lease programs are enrolled in GMP's peak demand reduction program, where access to the battery is shared with GMP during peak energy times. Through reducing customer demand for grid electricity during times of peak systemwide demand, customers help reduce GMP's overall operating costs, as well as diminish the negative climate impacts of their energy usage. In 2018, GMP utilized 10 megawatts of distributed battery storage capacity to save ratepayers $900,000 after responding to a single hour of peak summer demand.[124]

While the model used by GMP's Tesla Powerwall program is innovative in its usage of distributed battery storage systems, opportunities for equitable expansion include expanding program eligibility to include community-serving facilities, incorporating lease options for solar, adding incentives for income eligible customers, and establishing tiered or no-cost lease options for low-income customers.

CONTINUED

CASE STUDY (CONTINUED)

According to Jared Leader, Senior Director of Resilience at SEPA, "Green Mountain Power's (GMP) Home Energy Storage Programs, including the pioneering 'Bring Your Own Device' and Powerwall initiatives, have set a new standard for how utilities, third-party solar+storage providers, and end-use customers can collaborate effectively. Recently recognized with SEPA's 2024 Resilience Power Player Award, GMP's innovative leadership in leveraging new tools and technologies has ensured both grid and customer resilience. These programs are a testament to GMP's commitment to creating common-sense, customer-friendly incentives that deliver system-wide savings through demand reduction and peak management while providing clean, reliable backup power during outages."

"The pioneering "Bring Your Own Device' and Powerwall initiatives have set a new standard for how utilities, third-party solar+storage providers, and end-use customers can collaborate effectively."

—**Jared Leader**,
Senior Director of Resilience, SEPA

Grants

Grant programs are beneficial for solar and storage project development because they reduce financial barriers, making these technologies more accessible to a broader range of people, including both residential customers and community-serving organizations. By covering part or all the costs of project development and/or implementation, grants encourage adoption without the burden of loan payments or upfront expenses. These programs can promote energy resilience, reduce dependency on fossil fuels, and contribute to climate goals by reducing the cost of clean energy. In communities prone to grid disruptions and outages, grants for energy storage can provide essential backup power, enhancing resilience and energy security.

Solar has benefited from increased familiarity, but energy storage, being a more nascent technology with markets still developing, still poses a level of uncertainty, risk, and hesitation from more traditional financial institutions. Grant support for battery storage projects sited in historically marginalized communities can encourage more sustainable market development by supporting projects and demonstrating to finance institutions that battery storage can result in reliable financial returns, while also generating benefits for the community.

Some grant programs completely remove cost barriers by fully funding the development and implementation of clean energy projects. For instance, U.S. Department of Energy Office of Indian Energy Policy and Programs provides grant opportunities for Indian Tribes and Alaska Native Corporations, many of which cover the entire costs of the solar paired with battery storage.[125] Other grant programs provide complementary coverage through a cost-share requirement that requires the customer to find additional funding sources for their project. The following two case studies highlight programs that either fund large portions of project implementation or lower cost share requirements for projects serving historically marginalized communities.

Department of Energy – Office of Clean Energy Demonstrations' Energy Improvements in Rural or Remote Areas Program

With funding from the Bipartisan Infrastructure Law, the Energy Improvements in Rural or Remote Areas (ERA) program is designed to boost resilience, reliability, and affordability for energy systems in communities of 10,000 people or fewer. This program supports projects that bring new energy solutions, provide real benefits to residents, and build clean energy knowledge and infrastructure across rural America.[126]

The funding opportunity includes multiple topic areas including dual-use and co-located projects, smaller scale and community-centered projects, isolated micro-grids, and unelectrified buildings. For all but the dual-use and co-located projects, the applicant is required to provide a 5 percent cost share.[127] While this offering covers a majority of project costs, for some high-cost projects, the 5 percent cost share and administrative burden of managing a federal grant can still present significant barriers to participation by community-based organizations.

Grant opportunities providing 100 percent of the cost for project implementation allow funding barriers to be fully eliminated, increasing participation and reducing the requirement for community-serving organizations to seek out additional funding sources.

"Building renewable energy projects like solar PV and battery storage in rural communities hedges against fluctuating fuel prices and stabilize the cost of electricity produced, to ultimately make the communities more resilient against changes in the global energy market."

—**Ingemar Mathiasson**,
Energy Manager, Northwest Arctic Borough

California Energy Commission Electric Program Investment Charge Program

The California Energy Commission's (CEC) Electric Program Investment Charge (EPIC) Program invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals.[128] The EPIC program invests more than $130 million each year, funding research to expand the use of renewable energy, build a safe and resilient electricity system, advance electric technologies across sectors, enable a more decentralized grid, improve affordability, health, and comfort, and to support local economics and businesses.

CONTINUED

CASE STUDIES (CONTINUED)

The CEC encourages diverse applicants and requires that 25 percent of EPIC technology demonstration and deployment investments are sited in and benefit disadvantaged communities. An additional minimum 10 percent of investments are required to be located in and benefit low-income communities. These carve-outs ensure that low-income and underserved communities can access funding.

Incentives

Incentive programs for solar energy have been available in many US states, as well as offered at the federal level.[129] In recent years, more battery storage incentive programs are emerging—through utilities and state and federal agencies—as utilities, states, and federal government increasingly adopt energy storage targets, develop storage policy and regulation, and seek to drive energy storage deployment to achieve climate and social goals.[130] Programs vary greatly in design, but in general, aim to address the key barriers that prevent widespread adoption of these technologies. Without these incentives, battery storage can be very costly and inaccessible for those who would benefit the most. In some programs, solar incentives offer "adders" specifically for energy storage, which increases the incentive amount when storage is paired with solar installations.

Without these incentives, battery storage can be very costly and inaccessible for those who would benefit the most.

The following section overviews four types of incentives to support battery storage: grid services incentives, incentives for vulnerable grid areas, incentives for low-to-moderate income communities, and incentives for medically vulnerable customers.

Grid Services Incentives and Incentives for Vulnerable Grid Areas

Behind-the-meter battery storage can participate in grid services programs, in which utilities and grid operators work with customers or third-party energy providers to help manage and stabilize the electricity grid. These programs vary in their approaches and often involve coordinating the deployment of distributed energy resources (DERs), including battery storage and solar paired with battery storage systems, to provide benefits to the grid, such as balancing supply and demand, reducing peak demand, and improving reliability.[131] By reducing peak demand on a specific portion of the grid, behind-the-meter batteries can also be used to defer or avoid costly distribution system upgrades, as demonstrated by initiatives like Con Edison's Brooklyn Queens Demand Management program in New York City.[132, 133]

The following two case studies focus on programs that incentivize behind-the-meter battery storage as a grid resource during times of high electricity demand.

Massachusetts ConnectedSolutions

Massachusetts utility companies, such as National Grid and Eversource, provide opportunities for customers to enroll their home battery energy storage system in the state's ConnectedSolutions program.[134] Through enrollment in ConnectedSolutions, customers are paid for allowing the utility to use the energy stored in their home battery at times of high electricity demand. Incentives for home batteries are based on the average kilowatts discharged each time the utility calls the battery over a seasonal period. The utility company does not draw energy from customer batteries during forecasted extreme weather events, which provides customers with the added benefit of resilience in the event of a weather-related outage. Customers earn an average of $1,500 per year for enrolling qualified residential batteries in the program.[135] For those who don't have a battery storage system in their home yet, the state's zero-interest HEAT Loan program allows customers to access financing for battery installation equipment and labor.[136]

Opportunities for expanding and increasing equity incentives include incorporating higher incentive rates for income-eligible customers and added incentives for vulnerable households.

A recent review of the equity components of various Massachusetts battery storage programs by Clean Energy Group found that ConnectedSolutions lacks specific equity provisions and does not report on participation in the program.[137] Opportunities for expanding and increasing equity incentives include incorporating higher incentive rates for income-eligible customers and added incentives for vulnerable households.[138]

Green Mountain Power Resiliency Zones

In partnership with Vermont communities, Green Mountain Power's Resiliency Zones program aims to help communities keep access to power when severe weather hits. The utility has identified key target communities and is in the process of developing microgrids to support them. This model will be replicated in an estimated three additional communities every year. The communities are selected based on outage frequency data along with data from the CDC about community vulnerability.[139]

In addition to the Resilience Zones program, Green Mountain Power is undertaking a larger Zero Outages Initiative which commits the utility to a comprehensive, data-driven plan that bolsters resilience across its service territory.[140] The initiative will combine proactive undergrounding and storm-hardening of powerlines with deployment of distributed energy resources such as energy storage and microgrids. This initiative will prioritize the most vulnerable communities in rural central and southern parts of the state, which were impacted by a series of severe storms in recent years.

Incentives for Low-to-Moderate Communities

Incentives need to be tailored to support historically marginalized communities in overcoming the barriers and equity gaps related to renewable energy and storage access. Distributed solar, and to a lesser extent energy storage, have been widely deployed in recent years, but not all communities are able to access these technologies equally.[141] Low-to-moderate income communities experience obstacles in accessing and implementing renewable energy, including lack of access to funding and financing, renter verses homeowner status, unfamiliarity with renewable energy technologies and benefits, and lack of trust with developers.

Increasing access to renewable energy technologies through carve-outs or incentives for low-to-moderate income communities can provide benefits including a lower energy burden, improved resilience during grid outages, lessened harmful environmental impacts of climate change, and improved community health outcomes. Several states, including California, Colorado, Massachusetts, Minnesota, New York, and Oregon, continue to be leaders in policies to expand access to renewable technology in historically marginalized communities.[142]

The following case study highlights a program in the state of Connecticut that incentivizes low-to-moderate income enrollment by providing a significant increase in incentive rates.

CASE STUDY

Energy Storage Solutions

The Energy Storage Solutions program, overseen by the Connerticut Public Utilities Regulatory Authority (PURA), aims to make battery storage more accessible for low-to-moderate income households.[143] The program offers a combination of both upfront and performance-based incentives. Upfront incentives improve the economic feasibility of a project by reducing the initial cost. Performance payments, which are paid seasonally for 10 years, are generated by allowing the utility to deploy the battery during period of peak demand in the summer and winter.[144]

Qualifying low-income customers are eligible for $450/kWh upfront payments, and those residing in designated Underserved Communities qualify for $600/kWh, a higher rate than the standard $250/kWh upfront for non-qualified customers.[145] The $600/kWh incentive also applies per unit of affordable housing properties, making it one of the most economically beneficial battery storage incentives for multifamily affordable housing in the US. The low-income and underserved community rates are only accessible to affordable housing and residential customers, but this model could be replicated for community-serving facilities, community-based organizations, and nonprofits to further expand access.

Incentives for Medically Vulnerable Customers

Individuals who are dependent on in-home medical equipment are uniquely vulnerable in the event of outages. Those who depend on reliable electricity to power their medical devices face disporportionate health consequences in the event of an outage.[146] Even short-term outages can be potentially fatal and/or require emergency transportation to hospitals or other facilities for care.[147]

The following case study highlights a California program that incentivizes the ownership of energy storage for medically vulnerable customers and prioritizes access to communities who are at higher risk of wildfires.

CASE STUDY

California Self-Generation Incentive Program

The California Public Utilities Commission's Self-Generation Incentive Program (SGIP) offers rebates to install battery storage systems at both residential households and non-residential facilities. Additional funding was added to the program budget specifically to address the risk of prolonged outages due to increasingly common seasonal wildfires in California. This funding includes the prioritization of communities located in high wildfire-threat areas, communities that have experienced two or more utility public-safety power shutoffs, as well as low-income and medically vulnerable customers. The funds are also available for "critical facilities" that support community resilience in the event of shutoffs or wildfires.[148]

SGIP offers two categories of rebates: "Equity" and "Equity Resiliency." Equity rebates cover roughly 85 percent of the cost of an average energy storage system and are available for residential and non-residential customers. Non-residential customers must be either located in a disadvantaged community or in a census tract with a Median Household Income below 80 percent of Statewide Median Income. The Equity Resiliency rebates cover close to 100 percent of the total cost of an average energy storage system and require additional criteria to be met related to medical vulnerability and risk of utility shutoffs or wildfires.[149]

Permitting and Interconnection

For commercial projects, including small battery storage projects at community-serving facilities, the permitting and interconnection processes can be time intensive and require significant installer capacity to ensure a project achieves approval.

The following case study highlights an existing program that supports streamlined permitting processes, ensuring more projects are able to make it to the interconnection queue.

CASE STUDY

SolarAPP+

Solar Automated Permit Processing+ (SolarAPP+) is "a web-based platform that automates solar permitting for local governments and other jurisdictions."[150] Initially funded through the U.S. Department of Energy Solar Energy Technologies Office, SolarAPP+ standardizes and improves efficiency of the solar and battery storage permitting process.[151] For installers, an improved permitting process equates to reduced soft costs, improved installation times, and reduced project cancellations. Of the solar and storage installers that use SolarApp+, over 85 percent said it makes permitting significantly easier.[152]

SolarAPP+ is not available everywhere (although SolarApp+ is available at almost 200 jurisdictions) and not every installer is aware of the program.[153] Only 46 percent of respondents to a SolarReview survey of solar and battery storage industry partners said their jurisdiction participated in the SolarAPP+ program.[154] Others have expressed concerns about the user-friendliness of the software and how it incorporates into their current processes.

> *"It takes years for a program to be established knowledge in the solar+storage industry. There are compliances that have existed for years but the average installer, even those with capacity, is having difficulty navigating the complicated compliance structure of state and federal programs."*
>
> —**James Hasselbeck**, Chief Operating Officer and Employee-Owner, ReVision Energy

Part 8
Recommendations

The best practice recommendations of this report focus on overcoming obstacles related to deploying solar paired with battery storage in historically marginalized communities through programs that support a comprehensive value of resilience framework, including the economic, health, and grid reliability benefits of resilience. Recommendations related to the utilization of program performance metrics as a tool to ensure equitable access to battery storage technologies are also included.

Prioritize Equity Measures in Performance Metrics

1

Currently, the success of a clean energy initiative is most commonly measured through an economic-centered, performance-based metric. For example, a program may be deemed a success if it reaches a specified installed capacity goal. The battery storage programs that exist today measure success similarly, meeting a deployment or capacity threshold or reaching a peak demand reduction target. This report recognizes the importance of these metrics but recommends that economic benefits be just one component of how a program measures success.

Ensuring equitable deployment of renewable energy resources requires equity-based goals built into program performance metrics. This recommendation is less aimed at identifying a specific performance metric as "ideal" for measuring success and more focused on identifying opportunities for equity within each performance metric.

Furthermore, in measuring the success of a project (or program or policy), multiple benefits of battery storage should be incorporated into a value of resilience framework. In doing so, project developers and community-centered energy resilience efforts would be supported to develop solar paired with battery storage projects that deliver multiple benefits to historically marginalized communities.

Ensuring equitable deployment of renewable energy resources requires equity-based goals built into program performance metrics. This recommendation is less aimed at identifying a specific performance metric as "ideal" for measuring success and more focused on identifying opportunities for equity within each performance metric.

The following tables display the type of performance metric, as well as an example of how equity can be incorporated into each metric.

TABLE 1
Carve-Outs and Capacity Targets

Resilience Program Metric	Metric Definition	Equity-Focused Metric Example
Carve-Out	Allocated percentage or minimum energy deployment goal, within a larger program, to serve a targeted population	At least one-third of total deployment should be allocated to projects in low-to-moderate income communities, communities of color, and energy communities.
Capacity Target	Energy capacity deployment goal for specific energy source/technology	At least one-third of total capacity deployment should be reserved for affordable housing and single-family households and community-serving facilities located in communities of color, low-income communities, and/or energy communities.

TABLE 2
Monetizable Metrics

Resilience Program Metric	Metric Definition	Equity-Focused Metric Example
Utility Bill Savings	Reduction in customer electric utility bill expenses.	Require mandated percentage of utility bill kilowatt-hour reduction through energy arbitrage and demand response for single family residential participants. Require mandated share of savings distributed to tenants for affordable housing participants. Affordable housing providers that receive the economic benefit of battery storage (through grid services, for instance) should be mandated to reinvest a percentage into community resources, such as energy efficiency improvements or community activities (similar to the Connecticut Residential Renewable Energy Solutions program for solar at master-metered buildings).
Grid Services	Utility use of behind-the-meter storage resources located in its territory to deliver valuable grid services, such as peak demand reduction	Participating battery storage located in areas of the grid that are especially vulnerable to power disruptions should be eligible for a higher tier of grid services payments.

TABLE 3
Harder-to-Monetize Metrics

Resilience Program Metric	Metric Definition	Equity-Focused Metric Example
Health	Incentives for projects that improve health outcomes in the event of an outage	Increased or separate incentive tracks are necessary for single-family households and affordable housing institutions with electricity-dependent residents as well as community-serving facilities that agree to provide specific services (such as outlets to charge equipment or refrigeration for medications) to medically vulnerable individuals during an outage. Similar to the Self-Generation Incentive Program in California, provide higher incentives for the medically vulnerable, electricity dependent individuals to improve health outcomes in the event of an outage.[155]
Grid Resilience	Incentives and grid services programs that incentivize battery storage deployment that supports broader grid resilience efforts	Additional incentives, per kilowatt-hour, for battery storage projects located in areas of grid that are highly vulnerable to power disruptions.[156] These incentives should be stackable with other available incentives, such as incentives for low-income customers.

Provide Comprehensive Grant Support to Projects Located in and Serving Historically Marginalized Communities

2

Battery storage advancement in historically marginalized communities requires market development. Grant support through **capacity building, technical assistance**, and **project implementation dollars** advances the development of demonstration projects in underserved communities. These grants create a foundation for further battery storage development by building local capacity, technology awareness, replicable case studies, and partnerships between communities and developers. The need for this type of funding is significant and requires coordination from state and federal agencies, as well as private foundations.

Capacity-building and technical assistance programs are most effective and accessible when the program has a low-barrier to entry, requires minimal reporting requirements, and marketing for the program includes outreach to key demographics (i.e., it isn't assumed that capacity strained, community-serving organizations will discover the program on their own). Organizations that lack capacity are less likely to apply for funding when applications are lengthy and complex. Nonprofit organizations that provide technical expertise to communities (see Clean Energy Group and USDN, for example, on pp. 36 and 37) are better positioned than federal and state agencies to administer flexible, nationwide programs with a lower barrier to entry for community-serving organizations because independent nonprofits are not typically required to implement the same level of complex processes and protocols as federal and state administered programs. Nonprofit organizations will require funding support from state and federal agencies, as well as private foundations, to administer these programs.

Technical assistance programs in particular are important for community-serving organizations looking to develop solar paired with battery storage projects, because direct technical assistance enables them to navigate the technical, financial, and regulatory challenges that are often beyond the organization's in-house expertise and capabilities. Grants for upfront technical assistance reduce barriers related to technical knowledge and staff capacity so that organizations have the resources and expertise to begin the predevelopment process for clean energy projects.

State-specific programs are beneficial in that they are tailored to serve the localized needs of their communities. In addition to providing more in-depth education for state-specific resources, state programs oftentimes include project implementation funding opportunities in addition to technical assistance and capacity building support (see Washington Department of Commerce example on p. 35). This could be because clean energy implementation directly supports state energy goals and/or because state energy agencies typically have access to more funding resources than independent nonprofits in developing a program.

Support Equitable Finance Solutions

Finance options for battery storage projects are a critical element of project development. Historically marginalized communities require access to competitive, accessible, and flexible finance solutions. A successful finance solution will be non-exploitative and beneficial to different socioeconomic demographics, while also supporting energy resilience and/or advancing broader grid resilience efforts through distributed energy technology adoption.

Utility-administered lease programs (see case study on Green Mountain Power's Battery Lease Program on p. 42) may be the most effective finance solution for a wide range of customers. Utility lease programs allow for 1) equitable eligibility requirements (all customers of the utility are eligible), 2) competitive terms, such as zero interest loans with no upfront costs and no credit check required, and 3) easy accessibility, as repayment is on the monthly utility bill. Utility lease programs should also serve both residential customers and community-serving facilities (that are likely on a commercial meter).

For utility lease programs that provide battery storage as a resilience benefit (and not a revenue generating benefit for the homeowner), there should be a sliding scale for payment, ensuring low-income homeowners can participate. Medically vulnerable customers should receive a second battery at no cost to ensure resilience is always available, even when the utility has deployed the battery for grid services. Lease payments from higher-income households and the revenue generated for the utility through peak demand savings (provided through the virtual power plant) can, and should, offset or eliminate the costs for low-to-moderate income and medically vulnerable customers.

Encourage Incentives that Value Resilience

4

Incentive programs address key economic barriers to the equitable advancement of battery storage. Without specific provisions and incentives for historically marginalized and medically vulnerable communities, solar and storage will remain inaccessible.

Incentive programs should encourage larger batteries that can provide resilience, rather than a smaller battery that provides more limited resilience (shorter duration and/or fewer critical loads). For multifamily affordable housing providers, the Connecticut Energy Storage Solutions program is a great example of an incentive that encourages a larger battery by making it more economic, allowing the provider to build systems that ensure more robust, longer-duration resilience benefits to tenants.

Incentives should be awarded upfront to the developer, in advance of construction and after interconnection approval, ensuring that vulnerable organizations and residences do not have to front any portion of the incentive and wait to be reimbursed.

When possible, incentive programs should build grid reliability and revenue generating opportunities through performance payments for the grid services provided by battery storage.

When possible, incentive programs should build grid reliability and revenue generating opportunities through performance payments for the grid services provided by battery storage. Performance payments should be higher for systems serving particularly vulnerable areas of the grid, or for communities located near demand response fossil-fuel powered infrastructure (such as peaker power plants), which would help to avoid the utility needing to activate these polluting energy infrastructure resources.[157]

Expedite Permitting and Interconnection for Systems that Include Storage

5

Community-serving facilities should have a similar path to solar and battery storage permitting and interconnection approval as residential projects, despite these facilities typically being considered commercial projects. Many community-serving projects are more similar to residential solar and battery storage system in size and scope than a typical, larger-scale commercial project.[157]

States and utilities should enact expedited interconnection processes for commercial, community-serving facilities that are working to install a solar and battery storage system that will provide resilience to a historically marginalized community in the event of an outage. Understanding there are more complications and considerations with larger solar and battery storage projects, utilities could responsibly support an accelerated interconnection process for community-serving facilities by setting a threshold by which a commercial project would be eligible for expedited review (such as projects sized at 100-kilowatts or less). Utilities should also provide publicly available distribution system maps that clearly identify portions of the grid that have available capacity for new solar

and storage interconnections and portions where capacity is constrained, which may require impact assessments prior to interconnection.

As to permitting, SolarAPP+ should be expanded to include commercial projects. SolarAPP+ is a proven tool for installers in navigating the permitting process. At present, it is only available for residential solar and battery storage projects. Enabling the software's application to serve commercial properties would improve the permitting process for community-serving facilities.

Utilities should also provide publicly available distribution system maps that clearly identify portions of the grid that have available capacity for new solar and storage interconnections and portions where capacity is constrained, which may require impact assessments prior to interconnection.

Deploying SolarAPP+ and streamlining the interconnection process for community-serving institutions would remove barriers to resilience development in historically marginalized communities and reduce the bottleneck of projects waiting for interconnection. Furthermore, by reducing development barriers, it would encourage more solar and storage installers to market their services to these institutions, which builds technology awareness in communities while also improving the bottom line for installers.

APPENDIX A

Background

In 2024, the Department of Energy Solar Energy Technologies Office launched the Equitable Solar Communities of Practice (Community of Practice) program with the purpose to support the expansion of the equitable benefits of solar and battery storage adoption. Five organizations were selected to lead one of five topics related to the equitable distribution of solar.[158] The list of lead organizations and their respective topic is illustrated in Figure 7.

FIGURE 7
Communities of Practice by Topic Area and Lead Organization

Source: U.S. Department of Energy (2024). Equitable Solar Communities of Practice, Lead Organization Kick-Off Meeting [PowerPoint slides].

The Community of Practice process was stakeholder-driven and collaborative, with each lead organization, in partnership with the Department of Energy, responsible for identifying six organizations to join the effort as part of a Core Team. Organizations recruited for the Core Team represented a wide variety of stakeholder perspectives, such as project developers, utilities, nonprofit organizations, community-based organizations, and municipalities.

Resilience, Storage, and Grid Benefits Equitable Solar Community of Practice

Clean Energy Group led the Resilience, Storage, and Grid Benefits Equitable Solar Community of Practice (Resilience Community of Practice), which was defined by Department of Energy as advancing the meaningful benefits of battery storage, such as household and community-level resilience, grid strengthening and grid-level resilience, and improved health outcomes through reduced or shortened power outages.[159]

Through this effort, Clean Energy Group worked to create a framework for project development that encouraged layering multiple benefits of battery storage. Achieving this required defining the value of resilience as it pertained to the unique public health, economic stability, and grid reliability priorities of historically marginalized communities, identifying barriers to battery storage adoption, and evaluating existing programs and practices working to overcome these barriers. This process resulted in an overview of best practices and recommendations aimed specifically at scaling the equitable advancement of battery storage technologies.

APPENDIX B

Methodology

An initial landscape analysis was undertaken, which included an in-depth literature review and corresponding gap analysis, which identified topics lacking research and resources as well as areas of uncertainty and debate among stakeholders, such as key term definitions. Clean Energy Group also conducted interviews and a survey of state agencies leading solar and battery storage program development efforts. The results of this research, in addition to a community convening, informed the recommendations outlined in this report.

Community input and feedback was an invaluable part of the Community of Practice model. Clean Energy Group organized and hosted a virtual community convening in August 2024, which was open to everyone and promoted by both Clean Energy Group and the U.S. Department of Energy. The community convening was intentionally interactive to solicit stakeholder input, with emphasis on participation from community-based and community-serving organizations including grassroots organizations, affordable housing providers, and healthcare providers.[160] The results on the community convening influenced the research conducted and recommendations resulting from this effort.

The convening utilized Mentimeter software to solicit feedback from participants regarding topics related to energy resilience, with a focus on defining key terms and identifying barriers to development. Registration totaled 289 registrants, with day-of participation reaching 131 attendees. The webinar was recorded and posted online, where it has received an additional 117 views. The audience consisted of approximately 40 percent national laboratories and government agencies (local, state, federal, and Tribal) and 30 percent nonprofit organizations (including academic institutions), with the remaining attendees representing engineering firms, consultants, utilities, and other stakeholders. The feedback and graphics generated from the convening are referenced in this report.

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About Clean Energy Group

Clean Energy Group (CEG) is a national nonprofit that works to accelerate an equitable and inclusive transition to a resilient, sustainable, clean energy future. CEG fills a critical resource gap by advancing new energy initiatives and serving as a trusted source of technical expertise and independent analysis in support of communities, nonprofit advocates, and government leaders working on the frontlines of climate change and the clean energy transition. CEG collaborates with partners across the private, public, and nonprofit sectors to accelerate the equitable deployment of clean energy technologies and the development of inclusive clean energy programs, policies, and finance tools. CEG created and manages the Resilient Power Project to accelerate access to the benefits solar PV and battery storage technologies in historically marginalized and underserved communities. Learn more at *www.cleanegroup.org and www.resilient-power.org*.

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