Charleston

RESILIENT SOUTHEAST

Exploring Opportunities for Solar+Storage in Charleston, SC

CleanEnergyGroup
Innovation in Finance, Technology & Policy

ABOUT THIS REPORT

Resilient Southeast—Charleston is one in a series of reports that explores the obstacles and opportunities for solar PV and battery storage (solar+storage) to strengthen the resilience of communities throughout the Southeast. In this report, four types of facilities that could provide services during a disaster are evaluated for the potential economic opportunities resulting from the installations of solar alone or solar+storage systems. This report also presents potential near-term opportunities for policies and regulatory changes that could advance resilient solar+storage development in Charleston and concludes with a set of recommendations. Clean Energy Group partnered with Upstate Forever, Southern Environmental Law Center, and Southern Alliance for Clean Energy for this report. The economic analysis was performed by The Greenlink Group.

ABOUT THIS REPORT SERIES

Resilient Southeast is a collection of reports that evaluates the current policy landscape and economic potential for solar and battery storage to provide clean, reliable backup power to critical facilities in five cities: Atlanta, GA; Charleston, SC; Miami, FL; New Orleans, LA; and Wilmington, NC. These reports are produced under the Resilient Power Project (*www.resilient-power.org*), a joint project of Clean Energy Group and Meridian Institute. The Resilient Power Project works to provide clean energy technology solutions in affordable housing and critical community facilities, to address climate change and resiliency challenges in disadvantaged communities. The Resilient Power Project is supported by The JPB Foundation, Surdna Foundation, The Kresge Foundation, Nathan Cummings Foundation, The New York Community Trust, Barr Foundation, and The Robert Wood Johnson Foundation.

The full report series, including a *Series Overview* and a *Technical Appendix*, is available online at *www.cleanegroup.org/ceg-resources/resource/resilient-southeast*.

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COVER PHOTO:
Solar panels on the roof of the Beaufort Fire Station in Beaufort, SC.
Photo: Alder Energy Systems

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Executive Summary

In the event of an emergency, residents often turn to trusted local services, like emergency response centers, police, and fire stations, for support. Unfortunately, natural or man-made disasters and extreme weather can result in widespread power outages that leave critical community facilities in the dark. Without electricity, public service providers may be severely limited or completely unable to provide assistance to the communities they serve. Even facilities with diesel generators face issues due to equipment failure and limited fuel supplies. Resilient power systems that combine solar PV with battery storage (solar+storage) represent another option for reliable backup power to keep critical facilities up and running in cities like Charleston, ensuring that residents have access to critical services in the event of an emergency.

When savings from avoiding the loss of power are considered, solar paired with battery storage was found to make economic sense for all building types evaluated.

By exploring the opportunity for deployment of solar and battery storage systems for critical facilities in Charleston, this report aims to answer the question: does solar paired with battery storage make economic sense for strengthening the resilience of South Carolina communities? Based on the results of detailed economic analysis of critical building types in Charleston, the answer is yes, though some challenges and barriers still remain that must be addressed to allow these types of resilient power systems to be widely adopted. *Charleston ranked second for opportunities to deploy resilient solar and battery storage among the five Southeastern cities evaluated in this report series.*

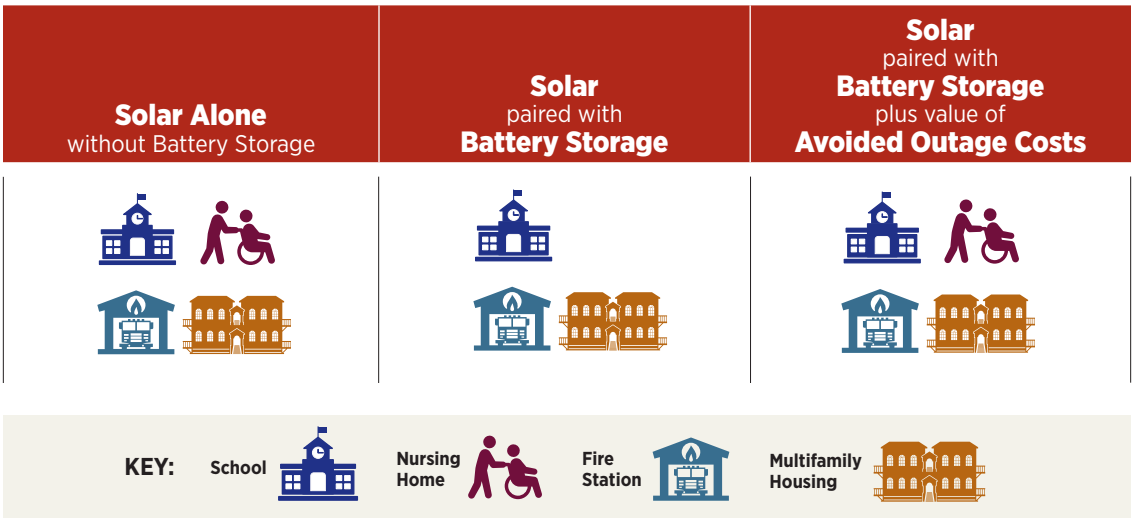
Figure 1 summarizes the findings of detailed economic evaluations for solar and battery storage at four critical facilities in Charleston: a school, a nursing home, a multifamily housing property, and a fire station. Solar was found to be a positive economic investment for each of the four building types. With the addition of battery storage, resilient solar+storage remains an economical option for the school, fire station, and multifamily housing, based solely on electric bill savings. The added expense of battery storage makes the combined systems uneconomical for the nursing home facility when the value of resilience is not accounted for. However, when savings due to avoiding power outage are factored into the economics, *solar paired with battery storage was found to make economic sense for all building types evaluated*. This important finding makes a strong case for public investment in resilient solar+storage systems providing community services.

The analysis results and the overall landscape for solar+storage in Charleston is dependent on a variety of factors, from net energy metering policies and utility electric rates to available incentives and financing options. These factors are summarized in **Figure 2**. Charleston benefits from favorable state net metering policies and a state solar tax incentive; however, Charleston is limited by a lack of certain financing options and little support for customer-sited battery storage. This mix of factors creates and encouraging though still challenging environment for the development of resilient solar+storage.

FIGURE 1

What Works in Charleston—Results of analysis by technology and building type

Four critical community building types were evaluated to explore the economic opportunity for solar PV and battery storage in Charleston. Solar alone, without storage, was found to be a positive investment for all building types. Solar paired with battery storage, which can be configured to provide resilient backup power during grid outages, was also found to an economical option for a secondary school, fire station, and multifamily housing based on bill savings alone, and for a nursing home when factoring in savings due to avoided outage costs.



To address these challenges, this report presents potential near-term opportunities for policies and regulatory changes that could advance solar+storage development in Charleston and concludes with a set of recommendations. Ongoing efforts to institute local renewable energy goals and current negotiations with the regional electric utility, including a rate case and renewable energy project proposals, are highlighted as potential opportunities. Recommendations include policy and programmatic changes, *such as incentive programs, demonstration projects, and carve-outs in dis- aster relief and mitigation funds, which have shown success in the Southeast and throughout the United States.*

FIGURE 2

Solar and Battery Storage Opportunity Landscape in Charleston

The opportunity for customer-sited solar and battery storage development in Charleston is highly dependent on a number of state, regional, and local factors, such as policies, incentives, and utility electric rates. Charleston was found to have a predominately supportive mix of key factors, resulting in an encouraging landscape for deployment of resilient solar and battery storage.

Solar Incentives	Net Energy Metering	Potential for Electric Bill Savings	Financing Options	Supportive Policies and Programs	
				State/Local	Utility
◑	◕	◕	◑	◑	◕

○ = Not Favorable ● = Highly Favorable

Recommendations for Advancing Resilient Power in Charleston

The following recommendations represent proven and emerging actions that have been implemented to advance resilient solar+storage development in other states and municipalities:

- **Allocate grant funding for solar+storage demonstration projects.** Solar+storage demonstration projects can educate residents about resilient energy, spur market development, and provide communities with a valuable service.
- **Establish public technical assistance funding.** Many solar+storage project opportunities, particularly those in the public and nonprofit sectors, are never explored simply due to the prohibitive upfront cost of performing a technical and economic feasibility assessment.
- **Provide targeted incentives for battery storage.** Strong incentives, with carve-outs and/or added incentives to encourage equitable deployment in low-income and disadvantaged communities, can help catalyze battery storage installations while upfront technology prices continue to decline.
- **Establish energy storage procurement targets and goals.** Much in the way that Renewable Portfolio Standards have accelerated solar and wind development in many states across the country, several states have begun to implement utility procurement targets and goals for energy storage.
- **Create market opportunities for energy storage to provide grid services.** Establishing market-based revenue generating opportunities, such as frequency and voltage regulation and demand response, can greatly improve the economics of battery storage systems.
- **Include energy storage in state energy efficiency programs.** For states without ready funds to support new incentives for emerging technologies, established energy efficiency programs represent an opportunity to allocate existing funds to advance cost-effective energy storage solutions.
- **Include resilient power in disaster relief funding.** By including incentives and carve-outs for the installation of resilient solar+storage systems when implementing disaster relief and mitigation funds, states can prepare for the next storm as they recover from the last.

The Need for Resilient Power

As natural disasters increase in frequency and intensity, the impacts are more severe, and recovery times are extending. Underserved communities are often hit first and worst by natural disasters and extreme weather events. Vulnerable populations are disproportionately impacted and face increased risk as prolonged power outages become the norm post disaster.

Low-income households oftentimes don't have the means or ability to temporarily evacuate. Residents with physical disabilities or health issues must contend with mobility limitations and medical equipment requirements that make evacuation difficult or impossible. Even after the storm has passed, the aftermath can result in new complications for vulnerable populations and exacerbate existing ones. Already under-resourced areas face additional recovery challenges, including access to electricity, shelter, communications, medical attention, and basic necessities. Recovery is an uphill battle to regaining normalcy, and communities struggle with how to be better prepared in the future.

Community facilities such as nursing homes, schools, fire stations, and multifamily housing are increasingly turned to for emergency services, shelter, and/or access to electricity. Ensuring that these facilities can provide critical services in the event of an emergency will require investments in energy resilience.

For first responders and healthcare providers, the implications of power outages can be immediate and life threatening, such as when communications are down at a fire station, or when a nursing home can't regulate room temperatures for vulnerable elderly residents. Designated emergency shelters, such as schools and multifamily housing complexes, are handicapped without access to reliable backup power. When shelters aren't operational due to lack of electricity and therefore lack basic necessities, such as water pumping for sanitation, outages can quickly develop into a public crisis. Without access to a safe space with lighting and electrical charging for cell phones or medical equipment, residents are forced to search for needed shelter despite dangerous conditions.

Solar panels on the roof of the Beaufort Fire Station in Beaufort, SC.
Photo: Alder Energy Systems

Customer-sited solar PV combined with battery storage systems (solar+storage) can generate reliable and cost-effective backup power during an outage.[1] Solar+storage projects across the country are transforming community centers into emergency shelters and resilience hubs, and better preparing first responder

facilities. For example, Florida's SunSmart Emergency Shelters Program resulted in more than 100 solar+storage systems installed in school districts throughout the state.[2] During a grid outage, solar+storage powered SunSmart E-Shelters can provide a variety of emergency services, including sanitation, medical equipment, communications, charging, and food.

When the grid is operational, solar+storage can offset retail electricity rates and combat expensive demand charges to reduce electric bills.

In New York City, the Marcus Garvey Apartments, a 625-unit affordable housing complex, installed a solar+storage microgrid to reduce electricity costs, improve grid reliability, and provide backup power. During an outage, the microgrid can power essential loads up to 12 hours, including a community room for residents sheltering in place.[3]

In anticipation of grid shutoffs during wildfires, fire stations in Freemont California are investing in solar+storage, rather than diesel generators.[4] Three fire stations have already installed microgrids to ensure critical services remain operational in the event of a planned or unexpected outage.

In addition to increasing community resilience, solar+storage can reduce utility costs and provide system benefits to the grid. When the grid is operational, solar+storage can offset retail electricity rates and combat expensive demand charges to reduce electric bills.[5] However, the cost-effectiveness of solar+storage to support energy resilience remains out of reach for many property owners, particularly community facilities managed by public and nonprofit entities. Declining technology costs, combined with solar+storage enabling policies, programs and incentives, could change that.

What is Resilient Power?

First and foremost, resilient power is the ability to deliver continuous, reliable power even when the electric grid goes down for an extended period of time. Truly resilient power should be generated onsite, should not be dependent on supply chains that may be disrupted during catastrophic events, and should provide benefits throughout the year, not just during emergencies.

Fossil fuel generators, most often diesel generators, have historically been the default solution for backup power. They also have a history of failure when true emergencies arise, whether due to lack of maintenance, exhaustion of fuel supplies, or simple wear and tear during a prolonged outage. Because generators are designed for only one purpose, backup power, they sit idle most of the time, representing sunk costs with no associated savings or value streams.

Solar PV paired with battery storage represents a clean, reliable alternative to traditional generators, one that isn't prone to fuel supply disruptions and can deliver savings through the year. When the grid is running normally, a resilient solar+storage system produces energy to meet onsite electricity use, manages demand for grid electricity, and can even generate revenue by participating in utility and grid services programs. When there is a power outage, a resilient system disconnects from the grid and operates independently as a microgrid, a process known as islanding, powering critical loads until grid power is restored. This combination of savings and resilience benefits, along with falling technology costs, has led more and more building owners to consider and implement solar+storage as a cost-effective resilient power solution.

A Growing Need for Resilience in South Carolina

In the past decade, new weather patterns and intensified storms have forced the state government and local leaders in South Carolina to re-evaluate disaster preparedness and response. South Carolina experienced one the most damaging hurricanes on record, and winter weather conditions have become more frequent. Transportation concerns and heavy flooding have emerged as major hurdles to emergency response. Power outages are leaving vulnerable populations in the dark and, in some cases, without heating and cooling in extreme temperatures. Resilient power systems in critical community facilities could provide residents with access to safe spaces to seek shelter and support in the event of an emergency.

WINTER WEATHER

Severe winter weather events have increasingly impacted South Carolina. In January 2018, over five inches of snow fell in Charleston, making it the highest recorded snowfall since 1989. Over 3,500 people lost power in Charleston and the surrounding areas. Two warming shelters opened, one at a church and one at a convention center, as temperatures dropped below freezing and remained there. Later that year, another winter storm dropped freezing rain and unprecedented snowfall and resulted in over 85,000 power outages across the state. Schools without power had to close and restoration times lagged.[6]

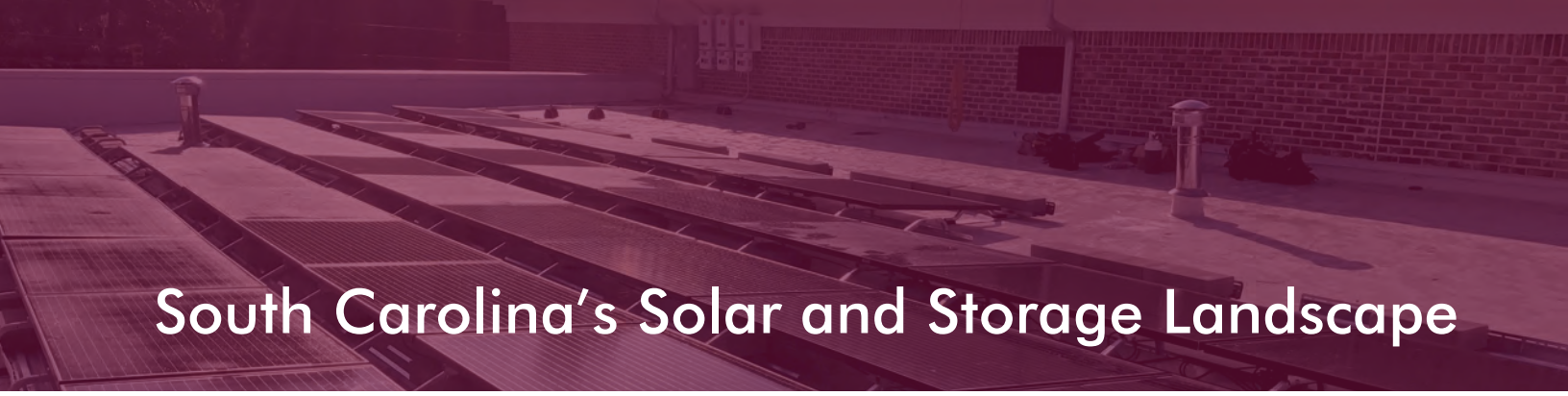
As heavy snowfalls and ice accumulations affect inland and Upstate communities, Charleston and other coastal cities combat heavy rainfalls and high windspeeds. Almost eight inches of rain fell in Charleston during a December 2018 storm, which is over two times the average total precipitation expected for the entire month. Widespread flooding in Charleston meant that pumps had to be utilized to drain flooded roadways as commuters were left stranded.[7]

HURRICANE FLORENCE

Hurricane Florence made landfall in South Carolina in September of 2018. The Category 1 hurricane had downgraded to a tropical storm before hitting the state, but wind speeds still reached 45 mph and resulted in nearly two feet of rain in some areas. More than 150,000 customers lost power in South Carolina and over 60,000 remained without power in the days following.[8,9] Storm Surge Warnings were in effect for communities along the coast and special medical-needs shelters opened to meet the needs of vulnerable populations. Critical medical facilities were forced to evacuate. One hundred fourteen healthcare facilities evacuated over 2,400 people and seven hospitals were closed.[10]

Resilient power systems in critical community facilities could provide residents with access to safe spaces to seek shelter and support in the event of an emergency.

Hurricane recovery has also been a slow and costly process for utilities. South Carolina Electric and Gas (SCE&G), the electric utility serving Charleston customers, spent $32 million after Hurricane Matthew in reported costs as it restored power to almost 300,000 customers. Renewable energy infrastructure has fared better than traditional power generation.[11] After Hurricane Florence, SCE&G reported no damage to the company's North Charleston solar site.[12] Sunrun, the largest provider of leased solar systems in South Carolina, similarly reported no major damages to customer-sited systems.[13]



South Carolina's Solar and Storage Landscape

A supportive regulatory environment has resulted in a growing solar industry in South Carolina, but battery storage development remains minimal. South Carolina ranks 18th in the country for state solar development. Only 0.75 percent of the state's total electricity is generated by solar.[14]

Of the five Southeast cities analyzed in this series, Charleston is the only city to benefit from a state solar tax credit.

Utility-scale solar installations have driven overall statewide solar growth. By 2018, statewide utility-scale solar capacity reached 578 megawatts while distributed solar rose to 120 megawatts. SCE&G had installed 53 megawatts of utility-scale solar and 72 megawatts of distributed solar capacity at that time. Recently, SCE&G has invested more heavily in utility-scale solar, which resulted in over 260 megawatts of utility-scale solar capacity installed by 2019.[15]

South Carolina does not have a Renewable Portfolio Standard (RPS) but did adopt voluntary renewable energy goals and guidelines when the *Distributed Energy Resource Program Act* 236 *(Act 236)* was passed in 2014. *Act 236* established a voluntary target for investor-owned utilities to reach two percent of aggregate generation capacity from renewable resources by 2021. The two percent goal is split between systems under one megawatt and projects between one megawatt and ten megawatts, and there is an option under the law for utilities to invest in an additional one percent of projects that are one to 10 megawatts in size. In the three years after *Act 236* passed, 173 megawatts of new solar came online, which is 16 times the solar capacity prior to 2014.[16]

South Carolina does not currently have any local or statewide battery storage targets or mandates.

Act 236 created more opportunities for solar PV by establishing new financing mechanisms and enhancing net metering policies. Prior to 2014, solar leasing was illegal and net metering incentives were in danger of being diminished. *Act 236* and related Public Service Commission rulings made solar leasing available, required investor-owned utilities to provide retail rate crediting to customers for exported solar energy, and locked in net metering incentives through 2025.[17] A two percent aggregated capacity limit was established for customer-owned distributed solar eligible for net metering and required that customer-owned systems participating in the program not exceed 20 kilowatts for residential systems and 1,000 kilowatts for non-residential.[18,19] Some South Carolina utilities have already hit the two percent cap, beyond which the utilities may, but are not required to, offer net metering. SCE&G is anticipated to reach its two percent cap in 2019, well before the 2021 target.

Although South Carolina's net metering and related distributed energy resource policies have successfully encouraged solar PV, they could do more to support battery storage growth and investments. Currently, "qualified customer-generators" are defined as customer-owned or leased systems that generate electricity from a renewable energy resource. The definition is not conducive to batteries because storage technologies discharge electricity, rather than generate electricity. Additionally, the list of eligible renewable energy resources does not include battery storage.[20] Although the current language does not outwardly

prohibit battery storage, its ambiguity leaves room for challenges.

Of the five Southeast cities analyzed in this series, Charleston is the only city to benefit from a state solar tax credit. The tax credit is 25 percent of eligible costs up to $3,500 or 50 percent of the taxpayer's liability, whichever is lower. In cases where the value of the tax credit exceeds $3,500, credits may be carried forward for up to 10 years. SCE&G previously offered a performance-based solar rebate for residential and nonprofit customers that amounted to four cents per kilowatt-hour.[21] That program has since ended. SCE&G does not currently provide a solar rebate for residential or commercial installations. Neither SCE&G nor the state provides a battery storage incentive of any kind.

Financing has been a major impediment to the residential and commercial battery storage market in South Carolina. Third-party sales of solar electricity are illegal and solar leasing, a popular financing option with no or little upfront costs, was only made available in 2014 after *Act 236* was passed. Solar leasing is different than third-party sales in that customers pay a flat fee per month to a company to lease equipment, rather than purchase the energy generated. The solar leasing market has grown exponentially. Almost 40 percent of all the solar systems installed in South Carolina are leased.[22]

Property Assessed Clean Energy (PACE) financing is not offered in South Carolina. PACE provides low-interest financing and repayment periods that can extend up to 20 years for energy efficiency and renewable energy projects, including battery storage.[23] Loans are typically secured with a lien on the property and paid through an assessment on the customer's annual property tax bills. Commercial PACE programs have proven successful as financing mechanisms for solar+storage projects in other states, including a microgrid in Connecticut that services mixed-income housing and retail space.[24]

SOUTH CAROLINA PUBLIC UTILITIES COMMISSION

The South Carolina Public Service Commission (SCPSC) regulates the three investor-owned utilities, including SCE&G. SCE&G serves approximately 720,000 customers in South Carolina and is the electric utility for Charleston.

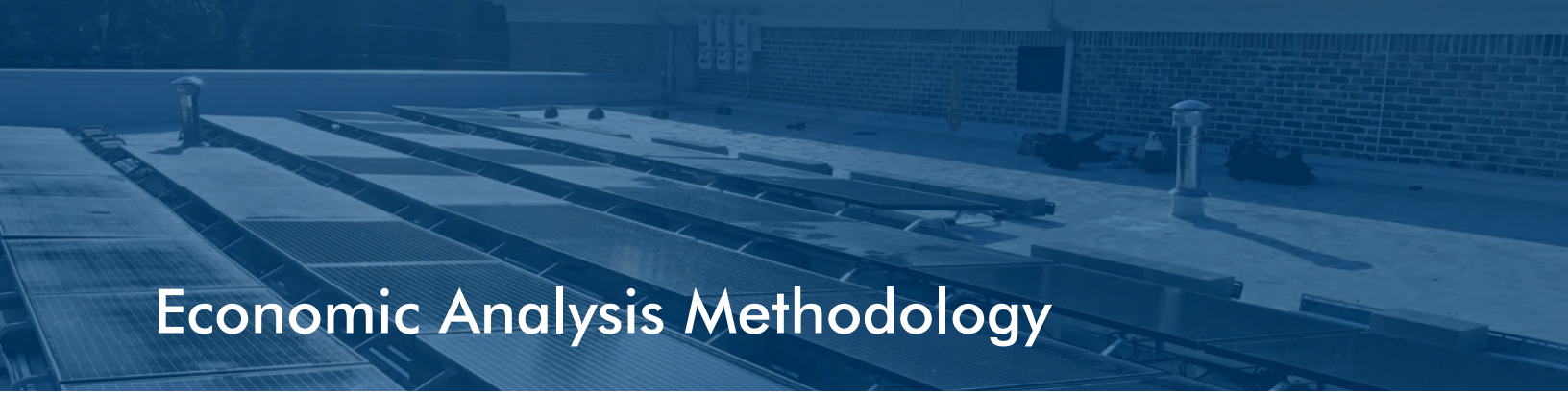
As the regulatory authority, SCPSC reviews plans to build new generation assets and must approve any proposed rate changes. SCPSC originally supported SCE&G's proposed nuclear plant expansion and approved the rate increases necessary to cover construction costs. The nuclear project was ultimately cancelled in 2017 after public outcry over rising project costs. Despite the cancellation, SCE&G customers will still pay $2.3 billion for the unfinished reactors. The fallout and ratepayer debt resulting from the nuclear proposal eroded customer trust in the utility and SCPSC.[25]

Community leaders are working to improve resiliency in order to better provide emergency services to the community in the future.

The SCPSC also determines incentive rates and oversees the clean energy development and programs of the investor-owned utilities. SCPSC oversaw the regulatory changes required by *Act 236*, including setting solar net metering rates and incentives.

BEHIND-THE-METER SOLAR+STORAGE

There are very few battery storage projects in South Carolina and SCE&G has not installed, or initiated, any battery storage development. In 2018, Duke Energy announced interest in building a microgrid for a civic center in Anderson County, South Carolina. The civic center acts as a critical facility in the event of an emergency. During Hurricane Irma, the civic center, which acted as shelter for evacuees, lost power for two hours. Community leaders are working to improve resiliency in order to better provide emergency services to the community in the future. Duke has identified some existing funding available for the project.[26]



Economic Analysis Methodology

For this report series, Clean Energy Group partnered with The Greenlink Group, an Atlanta-based energy analysis firm, to model the economics of solar and battery storage to achieve savings and to strengthen the energy resilience of four types of critical community facilities in Charleston—secondary schools serving as community emergency shelters, nursing homes providing critical heath care services, multifamily housing with residents sheltering in place, and fire stations serving as critical first responders.[27]

To understand the economic feasibility of solar and battery storage for different building types, the costs of the systems were evaluated against electricity bill savings over time.

While these building types do not represent a comprehensive list of critical facilities, they were selected as a proxy for four key areas of essential services: community safety and recovery, medical care, housing, and disaster response.

The analysis explores two modeling scenarios for the four building types:

1. **Economic Scenario:** The economic scenario evaluates the most cost-effective system configuration based on electric bill savings opportunities and available incentives. The objective of the economic scenario is to maximize net savings (net present value) over a 25-year period, the expected useful life of a solar PV system.[28,29]
2. **Resilient Scenario:** The resilient scenario evaluates a system configuration capable of providing onsite backup power to critical loads.[30] The objective of the resilient scenario is to model a solar+storage system that can keep critical services powered and operational for at least several hours during a grid outage.

In some cases, the **Economic Scenario** may find that neither solar or battery storage would result in net savings over time, in which case no system would be recommended. The **Resilient Scenario** requires that both solar and battery storage are modeled to support critical loads and may result in a system that does not achieve net savings over time. The **Resilient Scenario** only considers the cost of the solar and battery storage components of the system. It does not include any additional costs that may be associated with allowing the system to operate independent of the grid during an outage.[31]

To understand the economic feasibility of solar and battery storage for different building types, the costs of the systems were evaluated against electric bill savings over time. To accomplish this, hourly load profiles were developed to approximate how each building uses electricity throughout the year. These load profiles were then modeled against utility electric rate tariffs to determine electric bill savings the system could realize over 25 years of operation.

Incentives are also factored into the analysis. The model assumes all building types are able to take advantage of the federal investment tax credit (ITC) for solar and for battery storage when paired with solar.[32] While nonprofit entities like municipalities cannot directly benefit from tax incentives, there are third-party leasing arrangements and tax equity partnerships that can pass along incentive savings to nonprofit organizations.[33]

South Carolina is the only state explored in this report series that offers additional solar tax incentives. The analysis assumes all building types are able to take advantage of the

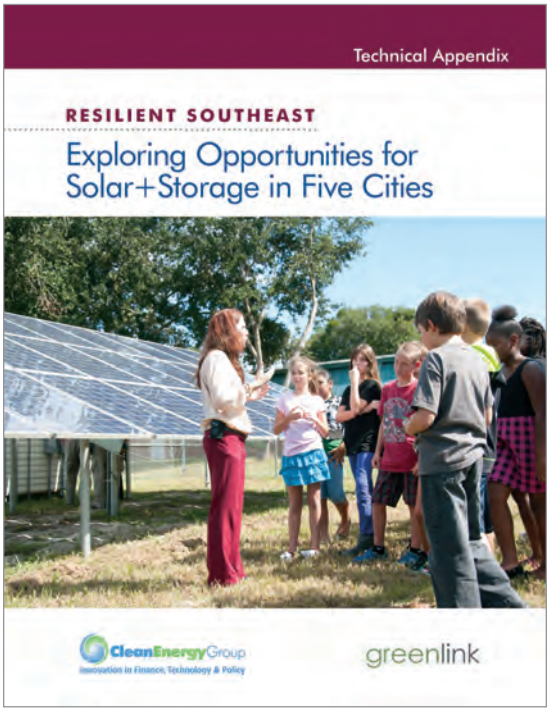
state tax credit for solar PV. In addition to tax incentives, the analysis assumes all solar systems participate in net energy metering, with exported generation credited back to the customer at the full retail rate.

Along with bill savings, the **Resilient Scenario** explores the value of savings due to avoiding the costs of power outages. These avoided outage costs represent the value of losses that would be incurred if a facility were to experience a power outage without a backup source of energy generation. For a business, this could include lost workforce productivity or losses due to interruption of services. For critical community facilities, outage-related costs could range from lost communications due to lack of cell phone charging or wireless connections to loss of life due to lack of medical care or disaster response services.

When solar is paired with battery storage the systems can be configured to deliver power to critical loads during a grid outage, thus avoiding some or all of these outage-related costs.[34] This analysis uses a methodology developed by the Lawrence Berkeley National Laboratory to estimate avoided outage costs. This methodology assumes outage costs for small and large commercial customers, which likely underestimate the value of keeping potentially life-saving services up and running.

Along with bill savings, the Resilient Scenario explores the value of savings due to avoiding the costs of power outages.

For more information about the methodology and assumptions used in this analysis, refer to the *Resilient Southeast—Technical Appendix*.[35]



The *Resilient Southeast* report series includes a *Technical Appendix* report, which provides information about the methodologies used for the analyses and details the results for each of the five cities examined.

Avoided Outage Costs: Calculating the Benefit of Energy Resilience

When a building loses power, organizations incur a variety of losses due to the interruption of basic services. When an organization provides services to the surrounding community, such as a shelter or health care provider, those losses can have widespread impacts, particularly during a crisis. Unfortunately, it can be challenging to assign a value to outage-related losses and the resulting benefits of avoiding an outage when a resilient power system delivers backup power.

The analyses in this report series use the Department of Energy's Interruption Cost Estimate (ICE) Calculator to calculate avoided outage costs (see *https://icecalculator.com*). The ICE Calculator, developed by Lawrence Berkeley National Laboratory, has been widely adopted by academics, analysts, and other national laboratories as a trusted methodology to estimate these types of costs. The ICE Calculator bases its outage valuation on two reliability indicators annually reported by utilities to the U.S. Energy Information Administration: System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI). These indicators measure the average length of a utility's annual outages (SAIDI) and how often those outages occur (SAIFI).

Analysis Results for Charleston

Overall, the analysis results for solar+storage to support critical community facilities in Charleston are promising. Charleston ranked second among the five cities evaluated based on the economic opportunity for solar+storage.[36] See **Figure 3**.

Economic outcomes were found to be positive for all building types across both scenarios, except for the nursing home under the Resilient Scenario when avoided outage costs are not considered. These encouraging results are due in large part to the South Carolina state tax incentive for solar PV. The tax incentive helps position Charleston as one of the top two cities with favorable economic opportunities for solar+storage development among the five cities evaluated in this series.[37]

The Economic Scenario analysis found that solar, without battery storage, would be the most economical option for all four building types in Charleston, based purely on electric bill savings with no consideration of improved energy resilience.

When the buildings were analyzed under the Resilient Scenario, solar+storage was still found to result in net savings for the secondary school, multifamily housing property, and fire station, despite the added cost of the battery system. Factoring in the additional value of avoided outage costs by powering critical loads during grid disruptions dramatically improved the lifetime savings for all building types, resulting in positive economics for the solar+storage systems.

All of the solar+storage systems were able to provide up to 12 hours of backup power to critical loads. These backup power durations could be extended by careful management of critical loads and, during multiday extended outages, some level of backup power would be available on days when there was sufficient solar energy from the PV panels to recharge the battery system.[38]

FIGURE 3
Summary of Results: Ranking the Opportunities for Resilient Solar+Storage in Charleston

	Opportunities	Barriers
Charleston, SC 	**Charleston ranked a close second of the five cities evaluated, with good economic outcomes; solar+storage was found to be a cost-effective solution for most facilities based on electric bill savings alone.**	
	• state solar tax incentive • favorable net metering policies	• lack of certain financing options • little support for customer-sited battery storage

Charleston School

The analysis results for a secondary school in Charleston are summarized in **Figure 4**. The most economical option for the school was found to be a 191.7-kilowatt solar system, which is the largest rooftop system the building could host given space constraints.[39]

In an emergency situation, the school was modeled to serve as a temporary emergency shelter, providing basic services to the surrounding community by keeping a portion of the building, such as its gymnasium, auditorium, or cafeteria, powered during grid outages. This was modeled by assuming the school would operate at 25 percent of normal load during a power outage.

Adding a 137-kilowatt-hour battery system to the solar system would provide up to 13 hours of backup power to keep emergency services fully operational at the school. While the battery system increases costs by more than it would offset through additional electric bill savings, the combined solar+storage system remains a cost-effective solution for the school, with a simple payback period of less than ten years. Incorporating avoided outage costs further improves the economics of solar+storage.

FIGURE 4

Results of Analysis for a Secondary School in Charleston

Based on modeling of utility bill savings and available incentives, solar PV was found to be the most economical option for a secondary school in Charleston. Incorporating battery storage adds upfront costs, but the combined system provides up to 13 hours of backup power to a portion of the school that could serve as a temporary emergency shelter; and it still results in net savings over time. Factoring in the value of avoided outage costs significantly improves the overall economics of the resilient power system.

Economic Scenario

Most economical system based on available savings and incentives

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
191.7 kW	0 kWh	0 hours	$39,000	$316,200	6.0

Resilient Scenario

Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
191.7 kW	137 kWh	13 hours	$39,100	$171,100	9.7
			With Avoided Outage Costs		
			$57,100	$345,100	6.7

Charleston Nursing Home

The analysis results for a nursing home in Charleston are summarized in **Figure 5**. The most economical option for the nursing home was found to be a 55-kilowatt solar system. The nursing home is subject to the SCE&G Medium General Service rate tariff, which, at less than 6 cents per kilowatt-hour, has much lower energy charges than the school or multifamily housing property. As a result, the economic case for solar is not as strong for the nursing home.

In an emergency situation, the nursing home was modeled to provide essential services to its residents, such as the continued operation of medical devices, refrigeration of medicines, and heating and cooling, to keep residents comfortable during shorter outages and allow for more time to safely evacuate residents during a prolonged outage. This was modeled by assuming the nursing home would operate at 20 percent of normal load during a power outage.

Adding a 91.3-kilowatt-hour battery system and increasing the solar system to 103.7 kilowatts—the maximum system size for the building given available roof space—would provide up to 12 hours of backup power to keep essential services operational at the nursing home. Due to weaker solar economics and the added expense of the battery storage system, solar+storage was not found to be an economical investment for the nursing home based on electric bill savings alone. Factoring in avoided outage costs more than doubles the annual savings the system can achieve, making solar+storage a positive investment for the nursing home with stronger economics than installing solar PV at the facility without battery storage.

FIGURE 5

Results of Analysis for a Nursing Home in Charleston

Based on modeling of utility bill savings and available incentives, solar PV was found to be the most economical option for a nursing home in Charleston. Incorporating battery storage adds upfront costs, but the combined system provides up to 12 hours of backup power to a portion of the nursing home providing medical care and emergency services to residents. Factoring in the value of avoided outage costs significantly improves the overall economics of the resilient power system, resulting in net savings over time.

Economic Scenario

Most economical system based on available savings and incentives

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
55 kW	0 kWh	0 hours	$5,400	$22,900	9.9

Resilient Scenario

Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
103.7 kW	91.3 kWh	12 hours	$11,200	(–$49,800)	18.6
			With Avoided Outage Costs		
			$30,200	$107,800	6.9

Charleston Multifamily Housing

The analysis results for a multifamily housing property in Charleston are summarized in **Figure 6**. For simplicity, only the common area loads of the property were considered in the analysis. These areas include hallways, offices, outdoor and emergency lighting, laundry rooms, and community spaces.

A 12-kilowatt solar system was found to be the most economical option for the multifamily housing property. Due to higher electric rates, multifamily housing was found to have the best solar economics of all four building types, with just over a five-year simple payback period.

During an outage, the model assumes the property's common areas continue to operate at 100 percent of normal load, keeping these shared areas fully powered to give residents that may be sheltering in place access to electricity and critical services such as clean water, heating and cooling, device charging, and communications. These services are particularly important for vulnerable populations like elderly residents, those with disabilities, and low-income residents with fewer resources to relocate and less access to transportation in times of emergency.

Boosting the solar system to its maximum size of 15.3 kilowatts and adding a 9.8-kilowatt-hour battery system would provide up to 15 hours of backup power to the multifamily housing common areas. While the battery system increases costs by more than it would offset through additional electric bill savings, the combined solar+storage system remains a cost-effective solution for the property, with a simple payback period of nine years. Incorporating avoided outage costs further improves the economics of solar+storage.

FIGURE 6

Results of Analysis for a Multifamily Housing Property in Charleston

Based on modeling of utility bill savings and available incentives, solar PV was found to be the most economical option for a multifamily housing property in Charleston. Incorporating battery storage adds upfront costs, but the combined system provides up to 15 hours of backup power to the common area spaces of the property, giving residents access to basic services and electricity when sheltering in place during an emergency; and it still results in net savings over time. Factoring in the value of avoided outage costs significantly improves the overall economics of the resilient power system.

Economic Scenario

Most economical system based on available savings and incentives

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
12 kW	0 kWh	0 hours	$2,400	$21,700	5.1

Resilient Scenario

Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
15.3 kW	9.8 kWh	15 hours	$2,900	$14,800	9.0
			With Avoided Outage Costs		
			$4,300	$28,600	6.0

Charleston Fire Station

The analysis results for a fire station in Charleston are summarized in **Figure 7**. The most economical option for the fire station was found to be a 10-kilowatt solar system. The fire station is on the same electric rate tariff as the nursing home, with low energy rates and the highest demand charge rate of any of the utility tariffs evaluated in this report series, at $19 per kilowatt. These factors reduce the economic case for solar at the property.

As a critical first responder, the model assumes the fire station must remain fully powered during an emergency, so 100 percent of normal load is modeled as the building's critical load during grid disruptions.

Boosting the solar system to its maximum size of 13.6 kilowatts and adding a 9.8-kilowatt-hour battery system to the solar system would provide up to 12 hours of backup power to the fire station. Even with weaker solar economics than the school and multifamily housing, solar+storage remains a cost-effective solution for the fire station. Because the fire station and nursing home are both subject to high utility demand charges, battery systems at the facilities were found to deliver significant additional savings by reducing demand throughout the year. Incorporating avoided outage costs further improves the economics of solar+storage, resulting a simple payback period of six years and stronger economics than only installing solar PV.

FIGURE 7

Results of Analysis for a Fire Station in Charleston

Based on modeling of utility bill savings and available incentives, solar PV was found to be the most economical option for a fire station in Charleston. Incorporating battery storage adds upfront costs, but the combined system provides up to 12 hours of backup power to keep the station fully operational during an emergency; and it still results in net savings over time. Factoring in the value of avoided outage costs significantly improves the overall economics of the resilient power system.

Economic Scenario

Most economical system based on available savings and incentives

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
10 kW	0 kWh	0 hours	$1,200	$6,500	8.6

Resilient Scenario

Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
13.6 kW	9.8 kWh	12 hours	$1,800	$1,600	13.3
			With Avoided Outage Costs		
			$4,100	$23,100	6.0

Opportunities for Solar and Storage in Charleston

South Carolina solar and battery storage markets could be completely reshaped by innovations in project financing and new market opportunities created through proposed legislation.

STATE POLICY

Proposed legislation, *The Energy Freedom Act of 2019,* champions renewable energy development in South Carolina by altering existing policies and programs that limit renewable energy growth, including battery storage. To promote the legislation and build public awareness, advocacy organizations partnered to create a 100 Day Energy Coalition and together launched the *100 Day Clean Energy Agenda*. The 100-day timeline corresponds with anticipated net metering program deadlines. Duke Energy's net metering program expired March 15, 2019; applications submitted after March 15 are on a waitlist pending the South Carolina Legislatures decision on *The Energy Freedom Act*. SCE&G's current net metering program will end in May 2019. If passed, *The Energy Freedom Act* will extend the net metering programs for each of the investor-owned utilities until June 1, 2021. The *Agenda* highlights proposed changes to customer solar programs and campaigns for the removal of net metering and solar leasing caps.[40]

The Energy Freedom Act benefits from bipartisan support. The House version of the bill, House Bill 3659 (HB3659), passed the House Labor, Commerce and Industry Committee unanimously. On April 10, 2019 the Senate Judiciary Committee approved the bill. HB3659 is currently pending a full Senate vote.

ENERGY FREEDOM ACT 2019

The *Energy Freedom Act* builds on the renewable energy policies championed in *Act 236* of 2014 by removing barriers and expanding access to customer-sited renewable energy resources. HB3659 eliminates both net metering and solar leasing capacity limits and encourages utilities to provide community solar programs for commercial, nonprofit, and residential and low-income customers, as well as separate renewable energy programs for large customers. Utilities will also be prohibited from charging non-solar customers to make up for utility revenues lost due to net metering customers who interconnect after June of 2021. Under the current law, utilities in South Carolina can recover lost revenue for net metering. Any proposed new fees specific to solar customers would require SCPSC approval. HB3659 also empowers the SCPSC to propose changes to utility Integrated Resource Planning (IRP), such as requiring utilities to meet future energy needs through competitive Request for Proposal (RFP) processes that allow for bids from renewable energy developments.

The SCPSC could spur solar+storage development by requiring utilities to carve-out incentives for battery storage systems and mandate more favorable net metering terms.

Some HB3659 proposed changes to the IRP process have already been approved by the SCPSC as part of the SCE&G/Dominion merger.[41] Other proposed amendments aim to allow further renewable energy investments in the state, by allowing independent clean power providers to contract with businesses, requiring utilities to buy lower-cost solar energy from independent producers, and expanding access to solar for low-income residents through community solar programs.

Although HB3659 focuses on building the solar PV market, opportunities for battery storage are also addressed. The bill proposes changing the definition of "customer generators," which is referenced in multiple bills pertaining to rules and regulations governing distributed energy resources, to include systems that discharge electricity from a renewable energy resource, in addition to those that generate electricity. The updated language includes energy storage as an eligible renewable energy resource and allows for battery storage to participate in net metering as long as the storage system is charged solely from an onsite renewable energy resource.[42]

SOUTH CAROLINA PUBLIC SERVICE COMMISSION

The SCPSC is reviewing SCE&G's 2019 IRP, which was submitted in February of 2019.[43] Utility-scale solar led the utilitiy's renewable energy development projections. SCE&G reported over 5,100-megawatts of "In-Progress" and "Suspended" utility-scale solar projects in the interconnection queue. The IRP does not include any completed or pending battery storage projects and does not provide a plan for future battery storage development, but it does include battery storage in several modeling scenarios. Battery storage is referenced as a technology in need of further monitoring of industry and technology developments. By contrast, in IRP's for Duke Energy Corporation's South Carolina subsidiaries, Duke Energy Progress and Duke Energy Carolinas, installed solar capacity is planned to grow from 1,200 megawatts to 3,400 megawatts by 2033, and battery storage is projected to make up 4 percent of new capacity by adding 300 megawatts of battery storage.[44]

A battery storage system located in a low-income housing rental property for resilient power and cost savings. This installation was supported by Clean Energy Group's Resilient Power Project. Photo: Clean Energy Group

If HB3659 is enacted, the SCPSC will be responsible for its implementation. The SCPSC will have authority over how quickly new systems are brought online as HB3659 requires the SCPSC to oversee changes to interconnection standards for systems 80 megawatts or less. Approval processes that expedite resilience projects for critical facilities could result in an uptick in solar+storage adoption at those facilities. Additional HB3659 utility requirements, including filing new net metering tariffs and creating a voluntary renewable energy program, could result in more accessible and affordable renewable energy opportunities for customers. How beneficial these changes are in transforming the market will depend on the SCPSC. The SCPSC could spur solar+storage development by requiring utilities to carve-out incentives for battery storage systems and mandate more favorable net metering terms.

The SCPSC is currently reviewing a Duke Energy proposal to increase fixed rates for customers served by its South Carolina subsidiaries. The ruling could have implications on future utility rate proposals as well. Although SCE&G rates are fixed until 2021, Dominion Energy is already planning to file proposed rate changes for 2021 onward. In either case, the SCPSC's ruling will have a direct impact on solar and storage by affecting the cost effectiveness of systems.

Recommendations

The results of the analysis illustrate a promising environment for resilient solar+storage development in Charleston. The results were encouraging, with positive economic outcomes for solar+storage at three of four critical facility types, based on electric bill savings alone; and positive economics for all facilities are realized when considering avoided outage costs.

This outcome was in large part due to the South Carolina state tax incentive for solar PV. Enabling policies and programs, such as energy resilience carve-outs in federal disaster funding and targeted incentive programs, could contribute to a more robust solar+storage industry and accelerate the deployment these technologies for critical facilities.

The following recommendations represent proven and emerging actions that have been implemented to advance solar+storage development in other states and municipalities:

- **Allocate grant funding for solar+storage demonstration projects.** Solar+storage demonstration projects can educate residents about resilient energy, spur market development, and provide communities with a valuable service. Florida has already built resilient community facilities that can withstand prolonged outages through the SunSmart Emergency Shelter Program. This has installed solar+storage systems in over 100 schools that can now serve as shelters in the event of a disaster. Maryland and Massachusetts have also implemented resilient power initiatives worth considering. The Maryland Energy Administration's new Resilience Hub Program provides $5 million in incentives to support solar+storage installations in community resilience hubs serving low-income communities. The Massachusetts Community Clean Energy Resiliency Initiative has helped municipalities avoid future outages by providing grants to install solar+storage in community facilities such as hospitals, first responders, community centers, and high schools.[45]

Enabling policies and programs, such as energy resilience carve-outs in federal disaster funding and targeted incentive programs, could contribute to a more robust solar+storage industry and accelerate the deployment these technologies for critical facilities.

Flooding caused by Hurricane Joaquin in areas surrounding Charleston, SC, in October 2015.
Photo: Stephen Lehmann, US Coast Guard

- **Establish public technical assistance funding.** Many solar+storage projects are never explored simply due to the prohibitive upfront cost of performing a technical and economic feasibility assessment. This is a barrier particularly for public and nonprofit organizations, which may not have the same access to resources as large private companies. To help communities and organizations understand the benefits and limitations of resilient solar+storage projects, states and municipalities should consider establishing public funding programs to help organizations obtain objective information about whether projects will work for their communities. These programs should be targeted to assist projects providing critical services to vulnerable populations. Clean Energy Group's Technical Assistance Fund, leveraged by multiple foundations, has supported dozens of solar+storage project evaluations for affordable housing and critical community facilities across the country.[46]

Flooding in South Carolina caused by Hurricane Florence in September 2018.
Photo: Megan Floyd, US National Guard

- **Provide targeted incentives for battery storage.** States with strong incentives in place are unsurprisingly leading in battery storage installations. To help ensure equitable deployment of resources, leading states have also begun to include carve-outs and/or added incentives for storage development in low-income and disadvantaged communities. In 2018, California acted to extend its successful behind-the-meter battery storage incentive program, the Self-Generation Incentive Program (SGIP), through 2025. The extension will result in an additional $830 million to support customer-sited battery storage projects. SGIP has helped establish California as the nation's leader in commercial battery storage installations. Twenty-five percent of SGIP's funding is dedicated to projects in low-income and disadvantaged communities.[47] The Solar Massachusetts Renewable Target (SMART) program includes incentives for solar installations that incorporate a battery storage component.[48] The SMART program also aims to develop markets in underserved communities by including additional incentives for solar projects serving low-income communities and community shared solar projects. A similar incentive could be developed for South Carolina's state tax incentive to encourage the inclusion of battery storage with solar PV, as the federal solar investment tax credit does when storage is charged by onsite solar.

- **Establish energy storage procurement targets and goals.** Much in the way that Renewable Portfolio Standards have accelerated solar and wind development in many states across the country, several states have begun to implement utility procurement targets and goals for energy storage. California adopted the first state energy storage mandate in 2010, requiring the state's three investor-owned utilities to procure 1.3 gigawatts of energy storage by 2020. Importantly, California established deployment targets for both grid energy storage and distributed customer-sited energy storage and placed limitations on utility ownership, ensuring a diverse and competitive market. State

storage targets and mandates have been more recently implemented across the Northeast, with Massachusetts, New York, and New Jersey all setting ambitious energy storage deployment goals. In 2016, New York City established the first citywide storage goal of 100 megawatt-hours by 2020, along with an expanded solar target of 1,000 megawatts by 2030.[49] Any determined goals or targets should be legally enforceable to ensure that battery storage development is a priority, rather than a symbolic gesture.

- **Create market opportunities for energy storage to provide grid services.** PJM, the regional transmission organization (RTO) serving the mid-Atlantic region from Washington, DC to Chicago, created one of the biggest markets for energy storage in the country by recognizing the unique abilities of storage to serve as a fast-response resource for frequency regulation. PJM took these steps to comply with Federal Energy Regulatory Commission (FERC) Order 755. FERC Order 841, which is currently being implemented, requires all RTOs and independent system operators (ISOs) to take similar actions to allow for energy storage participation in grid services markets. South Carolina does not fall within the jurisdiction of any RTO or ISO and is not subject to these orders. However, utilities like SCG&E can take similar actions by creating market opportunities for battery storage to provide valuable services such as frequency and voltage regulation and demand response. Establishing new revenue generating opportunities can greatly improve the economics of battery storage systems.[50]

- **Include energy storage in state energy efficiency programs.** Massachusetts recently became the first state in the country to approve energy storage as an eligible technology under its Three-Year Electric & Gas Energy Efficiency Plan.[51] For states without ready funds to support new incentives for emerging technologies, established energy efficiency programs represent an opportunity to allocate existing funds to advance cost-effective energy storage solutions. South Carolina utilities allocated $29.8 million in electric efficiency program spending in 2017.[52]

- **Include resilient power in disaster relief funding.** After Hurricane Maria, the government of Puerto Rico proposed that federal Community Development Block Grant Disaster Relief funds include over half a billion dollars for resilient infrastructure investments. $436 million will translate to solar+storage incentives for resilient energy and water installations, $75 million for Community Resilience Centers, and $100 million for a revolving loan fund to spur private industry development by reducing credit risk faced by contractors. By requiring incentives and carve-outs for the installation of resilient solar+storage systems, Puerto Rico is preparing for the next storm as they recover from the last. In addition to FEMA disaster funding, states impacted by Hurricane Florence are anticipated to receive an additional $1.68 billion in federal assistance. The funds will be allocated to the Department of Housing and Urban Development and used for the Community Development Fund for long-term disaster recovery.[53] Disaster mitigation and recovery initiatives are supported through this funding source. South Carolina has the opportunity to commit a portion of their funds to solar+storage installations in critical facilities.

For states without ready funds to support new incentives for emerging technologies, established energy efficiency programs represent an opportunity to allocate existing funds to advance cost-effective energy storage solutions.

Conclusion

There is little debate over the need for stronger energy resilience in locations prone to severe weather and power outages, such as Charleston. While diesel generators have served as the go to resource for onsite backup power for decades, it is time to explore and embrace cleaner, more efficient technologies that can do more than sit around waiting for the next emergency. As the findings detailed in this report suggest, solar+storage can provide a clean, cost-effective alternative to traditional backup generators—one that delivers benefits throughout the year.

Solar+storage can provide a clean, cost-effective alternative to traditional backup generators—one that delivers benefits throughout the year.

Currently, the opportunity for resilient solar+storage development in Charleston is positive but existing challenges include a lack of supportive policies and the sometimes prohibitive upfront cost of battery storage. Policies and programs that recognize and reward the true value of resilient solar+storage could drastically change that dynamic.

The results detailed in this report support the need for evaluation and implementation of new supportive policies, programs, and regulations to advance resilient, customer-sited solar+storage in Charleston. The findings and recommendations presented here are meant to start a conversation about the steps that Charleston and the state of South Carolina could take to ensure a more resilient future for its residents before the next storm strikes.

Flooding from Hurricane Joaquin in Charleston, SC, October 2015.
Photo: US Department of Agriculture

ENDNOTES

1 Customer-sited solar PV and battery storage refers to what are often called behind-the-meter systems. This means that the systems are installed on the customer side of the utility meter, so that solar generation and energy discharged from a battery meet onsite needs for electricity before any excess electricity is exported to the utility grid. In contrast, a front-of-the-meter system exports electricity directly onto the utility grid.

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3 A microgrid is essentially a small self-contained electricity grid with onsite generation that can operate independently of the utility grid. While microgrids may be grid-connected or completely off-grid, they all have the ability to continue providing power to select onsite loads in the event of an outage, even if utility service is interrupted. To learn more about the Marcus Garvey Apartments microgrid, visit Clean Energy Group's Featured Installation page: SunSmart Emergency Shelters Program. *Featured Resilient Power Installations*. 2017. *https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/marcus-garvey-apartments.*

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13 Ibid.

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27 The Greenlink Group has performed more than a dozen analyses on the economics of solar, battery storage, and the combination of the two in the Southeast.

28 Net present value (NPV) is defined as the difference between the present value of economic benefits and the present value of expenses over the life of the system. Future benefits and expenses are discounted over time. A positive NPV indicates that it would be economically beneficial to install the system, whereas, a negative NPV would indicate that the system would not result in net savings over time. In cases where no solar or battery storage system would result in a positive NPV, the most economic scenario is assumed to be the business-as-usual case where no solar or storage system is installed.

29 The battery storage portion of any modeled system is assumed to have a useful life of 15 years based on expected operation. The analysis assumes replacement of the battery storage system and inverter after year 15 for any system that incorporates battery storage. Replacement costs are included in all NPV calculations.

30 Critical loads may represent anything from emergency lighting and cell phone charging to medical devices and air conditioning depending on the services provided by a facility. For simplicity, this analysis assumes critical loads are represented by the normal building load or a specified percentage of normal building load depending on the building type.

31 Additional costs associated with making a system able to disconnect from the grid and operate independently can vary widely depending on the project. Added expenses may include additional hardware components, such as a transfer switch or critical load panel; software components; electrical design complexity, such as isolating critical loads; and permitting costs. These factors must all be considered when determining the full cost of a solar and battery storage system designed to deliver backup power.

32 According to guidance issued by the Internal Revenue Service, battery storage is eligible for the ITC when paired with and at least 75 percent charged by onsite solar. The analysis assumes the solar and battery storage systems are DC connected, with no ability for the storage system to be charged by the grid. This means that the battery storage system is 100 percent charged by onsite solar and, therefore, eligible to take advantage of the full 30 percent ITC incentive.

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34 Lawrence Berkeley National Laboratory and Nexant, Inc. "The Interruption Cost Estimate (ICE) Calculator." *Transmission Permitting and Technical Assistance Division of the U.S. Department of Energy's Office of Electricity (OE) Delivery and Energy Reliability,* Contract No.: DE-AC02-05CH11231. Accessed April 9, 2019. *https://icecalculator.com/home.*

35 More detailed analysis results are available in this report series' *Resilient Southeast - Technical Appendix,* available at *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast*.

36 Ibid.

37 Ibid.

38 It is important to note that the backup power values do not represent the maximum total hours the system could power critical loads during an extended outage, just the number of hours the solar and battery storage system could support those loads before the batteries were depleted. When sufficient solar is available to recharge the batteries, the system could again provide backup power.

39 The analysis assumes that approximately 40 percent of a building's rooftop space is available for the economically viable installation of solar panels. The remaining 60 percent of roof space is considered unavailable due to a variety of factors including: roof penetrations, such as venting; rooftop equipment, like water tanks and air conditioning; and building code offset requirement. 40 percent of rooftop space is considered the upper boundary for solar system sizing. In practice, there are other options for expanding solar system sizing, such as parking lot canopies, ground-mount systems, and elevated rooftop systems, however, these options are not considered in this analysis.

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ORGANIZATION DESCRIPTIONS

CLEAN ENERGY GROUP

Clean Energy Group (CEG) is a leading national, nonprofit advocacy organization working on innovative policy, technology, and finance strategies in the areas of clean energy and climate change. CEG promotes effective clean energy policies, develops new finance tools, and fosters public-private partnerships to advance clean energy markets that will benefit all sectors of society for a just transition. CEG created and manages The Resilient Power Project (*www.resilient-power.org*) to support new public policies and funding tools, connect public officials with private industry, and work with state and local officials to support greater investment in power resiliency, with a focus of bringing the benefits of clean energy to low-income communities. *www.cleanegroup.org*

THE GREENLINK GROUP

Greenlink is an Atlanta-based energy research and consulting firm equipped with sophisticated analytical technologies and deep industry knowledge in the clean energy space, receiving accolades from MIT and Georgia Tech, among others. Greenlink provides the evidence and expert analysis needed to evaluate the most pressing issues faced by today's energy market, namely the integration of a wide range of clean energy options, such as energy efficiency in buildings, demand side management, and centralized and distributed renewable resources. *www.thegreenlinkgroup.com*

SOUTHERN ALLIANCE FOR CLEAN ENERGY

The Southern Alliance for Clean Energy is a nonprofit organization that promotes responsible energy choices that work to address the impacts of global climate change and ensure clean, safe and healthy communities throughout the Southeast. *https://cleanenergy.org*

SOUTHERN ENVIRONMENTAL LAW CENTER

Southern Environmental Law Center is a non-profit environmental organization dedicated to the protection of natural resources, communities, and special places in a six-state region of the Southeast. SELC partners with over 150 national and local groups to achieve its goals and works in all three branches of government. *www.southernenvironment.org*

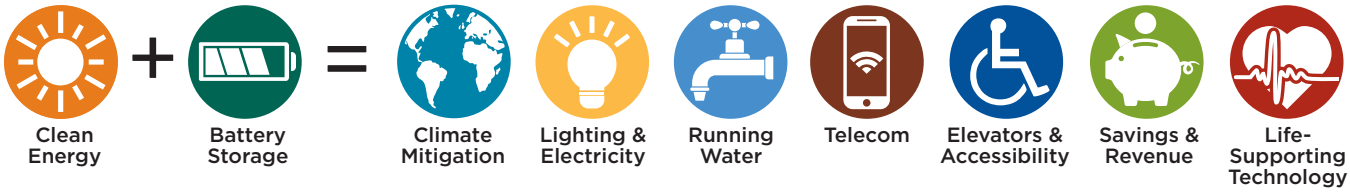
UPSTATE FOREVER

Founded in 1998 with offices in Greenville and Spartanburg, Upstate Forever focuses work in ten South Carolina counties; Abbeville, Anderson, Cherokee, Greenville, Greenwood, Laurens, Oconee, Pickens, Spartanburg and Union. Upstate Forever also operates an accredited land trust as well as a Clean Water Program, a Land Planning and Policy Program, and an Energy and State Policy Program.*www.upstateforever.org*

Charleston

RESILIENT POWER

A project of Clean Energy Group



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