Report Series Overview

RESILIENT SOUTHEAST

Exploring Opportunities for Solar+Storage in Five Southeastern Cities

CleanEnergyGroup
Innovation in Finance, Technology & Policy

ABOUT THIS REPORT

Resilient Southeast—Series Overview summarizes the key findings from a group 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 *Overview* report, the results for potential economic opportunities to install solar alone or solar+storage systems at four types of facilities in five southeastern cities are presented. The building types analyzed are facilities that could provide emergency services to surrounding communities during a disaster: a secondary school, a nursing home, a multifamily housing property, and a fire station. The five cities evaluated are: Atlanta, GA; Charleston, SC; Miami, FL; New Orleans, LA; and Wilmington, NC. This report also presents potential near-term opportunities for policies and regulatory changes that could advance resilient solar+storage development in these cities and concludes with a set of recommendations. Clean Energy Group partnered with Alliance for Affordable Energy, Catalyst Miami, Energy and Policy Institute, Southern Alliance for Clean Energy, Southern Environmental Law Center, Southface Institute, and Upstate Forever for this report series. 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 detailed reports for each of the five cities and a *Technical Appendix*, is available online at *www.cleanegroup.org/ceg-resources/resource/resilient-southeast*.

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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 throughout the Southeast, ensuring that residents have access to critical services in the event of an emergency.

The Resilient Southeast *report series details, for the first time ever, an exploration of the potential to deploy resilient solar+storage in cities across five southeastern states: Atlanta, GA; Charleston, SC; Miami, FL; New Orleans, LA; and Wilmington, NC.*

The *Resilient Southeast* report series details, for the first time ever, an exploration of the potential to deploy resilient solar+storage in cities across five Southeastern states: Atlanta, GA; Charleston, SC; Miami, FL; New Orleans, LA; and Wilmington, NC. Each of these cities has experienced a history of severe weather and extended power outages that have left vulnerable populations without access to resources when they are most in need of assistance.

Though utility-scale solar and, more recently, battery storage have begun to gain traction in parts of the Southeast, there has been much less progress in advancing distributed, customer-sited installations throughout the region. This report series aims to address this lack of progress by answering the question: does solar paired with battery storage make economic sense for strengthening the resilience of cities in the Southeast? Based on the results of detailed economic analysis of four critical building types in each city, the answer is yes.

Figure 1 summarizes the rankings of the five Southeastern cities ordered by the economic opportunity and policy and regulatory landscape to deploy solar+storage in each location. While some cities represent a clearer opportunity for investment in resilient solar+storage

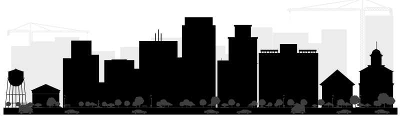
Solar panels on a commercial rooftop in Florida.
Photo: Creative Commons/Carol Berney

FIGURE 1

Summary of Results: Ranking the Opportunities for Resilient Solar+Storage in the Southeast

The five cities evaluated are ranked from best to worst based on detailed economic analyses of the economics of deploying solar and battery storage technologies at critical community facilities, and on a landscape review of the policy, regulatory, and market environment for solar and battery storage development across the Southeast.

#1 — Wilmington, NC



Wilmington ranked first with the strongest economics; solar+storage found to be a cost-effective solution for most facilities based on electric bill savings alone.

Opportunities	Barriers
• utility solar incentive • favorable net metering policies	• lack of certain financing options • little support for customer-sited battery storage

#2 — Charleston, SC

Charleston ranked a close second with good economic outcomes; solar+storage found to be a cost-effective solution for most facilities based on electric bill savings alone.

Opportunities	Barriers
• state solar tax incentive • favorable net metering policies	• lack of certain financing options • little support for customer-sited battery storage

#3 — Atlanta, GA

Atlanta ranked third with weaker solar economics; solar+storage found to be a cost-effective solution for some facilities based on electric bill savings alone.

Opportunities	Barriers
• strong potential for electric bill savings • variety of financing options for both solar and battery storage	• no net energy metering • lack of supportive incentives or policies

#4 — Miami, FL

Miami ranked fourth, with solar+storage only found to be a cost-effective solution when accounting for additional savings due to avoided power outages.

Opportunities	Barriers
• favorable net metering policies • financing options for both solar and battery storage	• low potential for electric bill savings • lack of supportive incentives or policies

#5 — New Orleans, LA

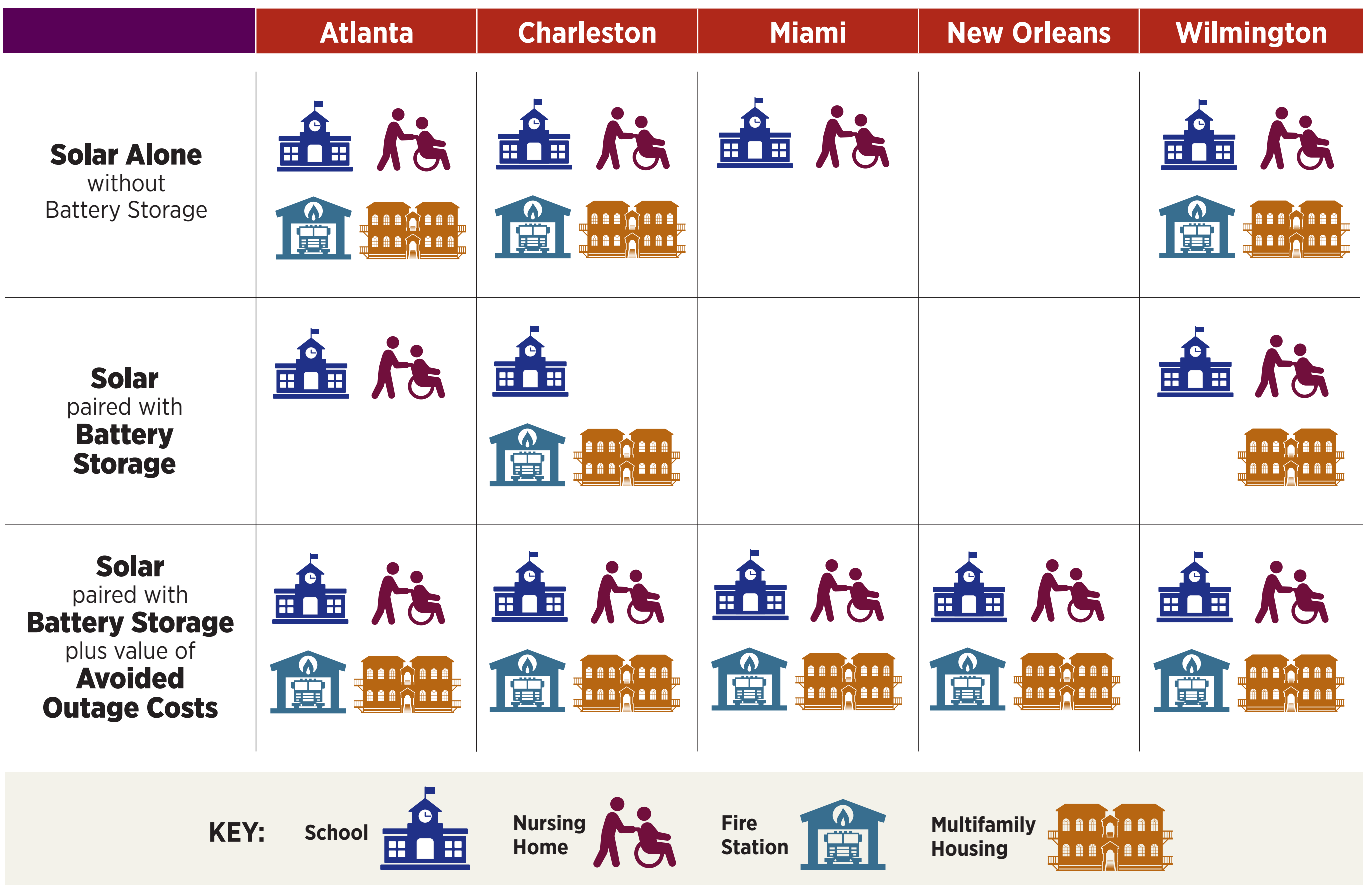
New Orleans ranked fifth with the weakest solar economics; solar+storage only found to be a cost-effective solution when accounting for additional savings due to avoided power outages.

Opportunities	Barriers
• favorable net metering policies	• low potential for electric bill savings • lack of supportive incentives or policies

FIGURE 2

What Works Where—Results of analysis by technology, building type, and location

Four critical community building types were evaluated across five cities to explore the economic opportunity for solar PV and battery storage in the Southeast. Solar alone, without storage, was found to be a positive investment for most building types across all locations except for New Orleans. Solar paired with battery storage, which can be configured to provide resilient backup power during grid outages, was also found to be economical for some building types in Atlanta, Charleston, and Wilmington, though the economics of the combined systems were not as strong as solar alone. When the economic benefit of increased resilience is factored in, by considering the value of avoided outage-related costs, solar paired with battery storage results in positive economics for the four building types in all five cities.



solutions than others, there is an economic case to be made for these technologies to strengthen the resilience of all the communities evaluated. However, challenges and barriers still remain that must be addressed to allow these types of resilient power systems to be widely adopted across the Southeast.

Figure 2 summarizes the findings of detailed economic evaluations for solar and battery storage at the four critical facilities analyzed in each location: a school, a nursing home, a multifamily housing property, and a fire station. Solar, without battery storage, was found to be a positive investment for all building types in Atlanta, Charleston, and Wilmington, and for two facilities in Miami. New Orleans was the only city where solar was not found to be a cost-effective solution for any of the buildings evaluated.

While the addition of battery storage for energy resilience often increases the expense of a project by more than can be offset through additional electric bill savings, combined solar+storage systems were still found to be economic options for three facility types in Charleston and Wilmington and two in

Atlanta, even without considering the value of increased energy resilience. When savings due to avoiding losses from power outages are factored into the economics, *solar paired with battery storage was found to make economic sense for all building types evaluated across all five cities*. This important finding makes a strong case for public investment in resilient solar+storage systems providing community services.

The analysis results for solar+storage in the Southeast 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 3**.

Wilmington and Charleston benefit from solar incentives that greatly improve overall system economics, but greater adoption of solar+storage is limited in both cities by a lack of certain financing options and little support for battery storage. Alternatively, Miami has the most favorable net energy metering policies for solar+storage but still ranks fourth in deployment opportunities due low potential for electric bill savings and a lack of supportive policies and programs. In Atlanta, strong potential for electric bill savings are countered by a lack of net metering. These combinations of positive and negative factors create a complex environment for the deployment of resilient solar+storage across the Southeast.

To address existing barriers, this report presents potential near-term opportunities for policy and regulatory changes that could advance solar+storage development in the Southeast and concludes with a set of recommendations. Innovations in project financing and supportive state and local government actions are highlighted as potential opportunities in certain cities. Recommendations include policy and programmatic changes, such as incentive programs, demonstration projects, and carveouts in disaster relief and mitigation funds, which have shown success to advance resilient power solutions.

FIGURE 3

Solar and Battery Storage Opportunity Landscape in the Southeast

The opportunity for customer-sited solar and battery storage development across the Southeast is highly dependent on a number of factors, such as policies, incentives, and utility electric rates. These and other factors were researched and ranked for each of the five cities evaluated in this report series—with scores ranging from little to no support for solar and battery storage to highly supportive.

	Solar Incentives	Net Energy Metering	Potential for Electric Bill Savings	Financing Options	Supportive Policies and Programs	
					State/Local	Utility
Atlanta	○	◔	◕	◕	◑	◑
Charleston	◑	◕	◕	◑	◑	◕
Miami	○	●	◔	◑	◔	○
New Orleans	○	◕	○	◔	◔	◔
Wilmington	◕	◕	◑	◑	◕	◕

○ = Not Favorable ● = Highly Favorable

Recommendations for Advancing Resilient Power in the Southeast

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

In 2018, Hurricane Florence made landfall near Wilmington as a Category 1 hurricane, leaving more than one million customers without power across North and South Carolina. That same year, Hurricane Michael ravaged Georgia as a Category 3 storm. Over 300,000 power outages were reported, and an estimated 200,000 Georgia homes and business remained without power in the following days. Hurricane Irma hit the Florida Keys as a Category 4 in September 2017. Over six million Florida residents lost power. The most expensive disaster in US history, Hurricane Katrina, devastated Louisiana in 2005. Nearly 900,000 customers, 42 percent of the state, were left without power. In some parts of New Orleans, power line repairs couldn't begin for two weeks following the storm, as crews had to wait for the water to drain.

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 during a disaster. 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 communities 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.

Apollo Elementary School in Titusville, FL lost power during Hurricane Irma and used a solar+storage system to power emergency lights and charge cell phones. This installation is part of the SunSmart Emergency Shelters Program.
Photo: Nick Waters, Florida Solar Energy Center.

Customer-sited solar PV combined with battery storage systems (solar+storage) can generate reliable and cost-effective backup power during an outage.

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.

City crew removes a tree from power lines in Atlanta, GA following Hurricane Irma in September 2017.
Photo: Creative Commons/Thomas Cizauskas

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 hampered 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.

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. After Hurricane Irma, 41 SunSmart schools relied on solar+storage to power emergency shelter operations.

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 providing electricity to a community room so residents can shelter 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.

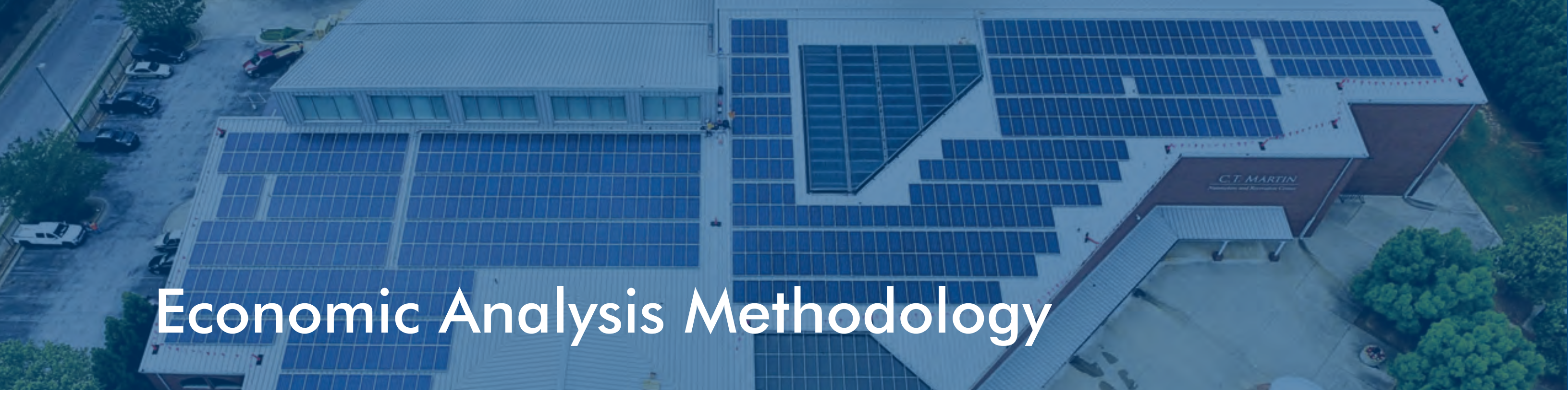
When the grid is operational, solar+storage can offset retail electricity rates and combat expensive demand charges to reduce electric bills.

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.



Economic Analysis Methodology

For this report series, Clean Energy Group partnered with the 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 five Southeastern cities: a secondary school serving as a community emergency shelter, a nursing home providing critical heath care services, a multifamily housing facility sheltering residents in place, and a fire station serving as critical first responders.[6]

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.[7,8]
2. **Resilient Scenario:** The resilient scenario evaluates a system configuration capable of providing onsite backup power to critical loads.[9] 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 nor 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.[10]

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. 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 that 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.[13] While nontaxable entities such as nonprofits and government cannot directly benefit from tax incentives, there are third-party leasing and ownership arrangements as well as tax equity partnerships that can pass along the incentive savings to these types of organizations.[12] In addition to federal tax incentives, the analysis assumes systems take advantage of any additional incentive programs and participate in net metering where available.

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. This analysis uses a methodology developed by the Lawrence Berkeley National Laboratory to estimate avoided outage costs.[13] The methodology assumes outage costs for small and large commercial customers, which likely underestimate the value of keeping potentially life-saving services up and running.

For more information about the methodology and assumptions used in this analysis, refer to the *Resilient Southeast—Technical Appendix*.[14]

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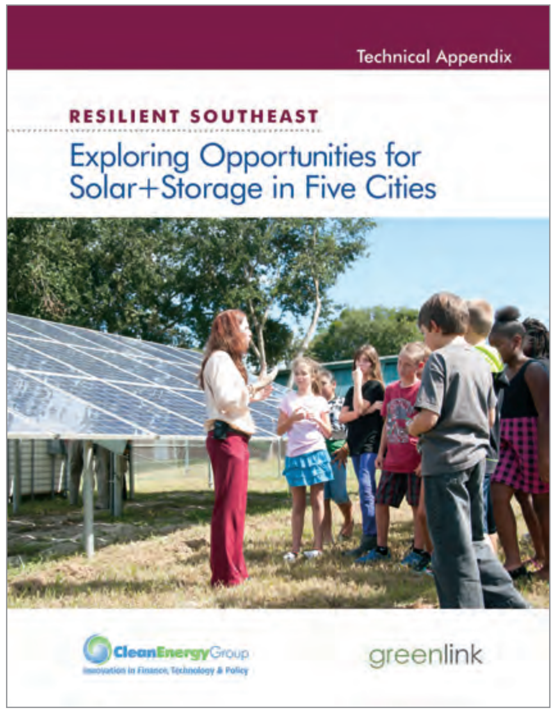


The *Resilient Southeast* report series includes a *Technical Appendix* report, which provides information about the methodologies used for the analyses and details the results for each of the five cities examined.

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).

Summary of Analysis Results

The following five sections summarize the solar and battery storage economic analysis modeling results and landscape review for each city, ranked from the best to worst opportunity for resilient solar+storage deployment. (See **Figure 1**, p. 4.)

To provide an example of how the report series approaches the analysis by facility type, the results for evaluations of solar and battery storage at a secondary school are provided for each city. For the Resilient Scenario, the schools were modeled to serve as temporary emergency shelters, providing basic services to surrounding communities by keeping a portion of the buildings, such as a gymnasium, auditorium, or cafeteria, powered during grid outages. This was modeled by assuming the schools would operate at 25 percent of normal load during a power outage.

More detailed results can be found in city-specific reports for each location as well as in the accompanying *Technical Appendix*, both available online at https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast.

Battery storage container at the McAlpine Creek solar+storage demonstration project, which provides resilient power to Fire Station 24 in Charlotte, NC.

Photo: Creative Commons/Duke Energy

#1 Wilmington, NC

Wilmington ranked first among the five cities evaluated based on the economic opportunity for solar+storage development. **Figure 4** summarizes the findings of detailed economic evaluations for solar and battery storage at Wilmington critical community facilities.

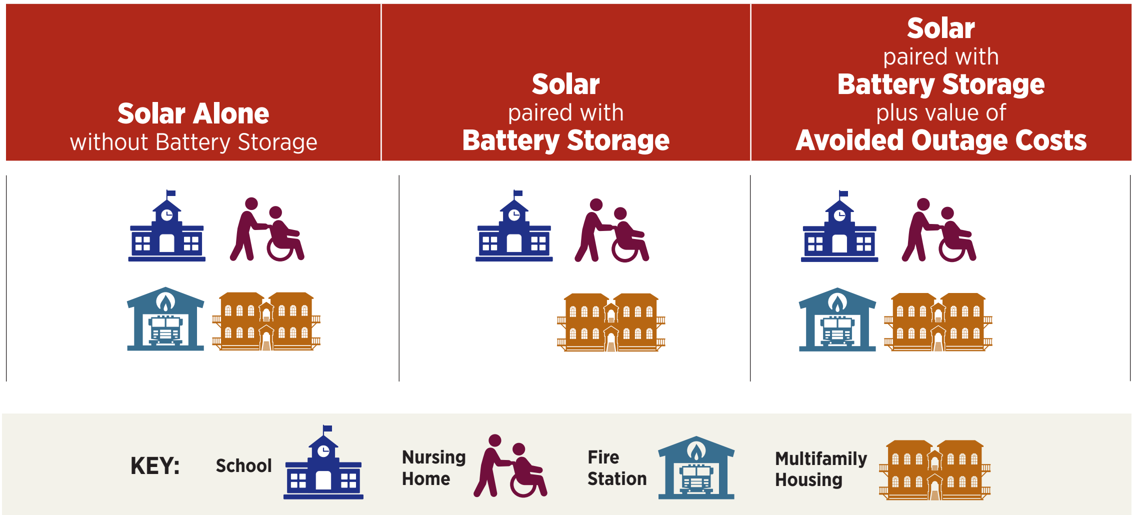
Economic outcomes were found to be positive for all building types across both scenarios in Wilmington, except for the fire station under the Resilient Scenario when avoided outage costs are not considered. These encouraging results are due in large part to a solar rebate program offered by the electric utility serving Wilmington, Duke Energy Progress.

The Economic Scenario analysis found that solar, without battery storage, would be the most economical option for all four building types in Wilmington, 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, nursing home, and multifamily housing property, despite the added cost of the battery system. Factoring in the additional value of avoided outage costs by powering critical loads during grid disruptions significantly improved the lifetime savings for all building types, resulting in positive economics for the solar+storage systems in all cases.

FIGURE 4

What Works in Wilmington—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 Wilmington. 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 be an economical option for a secondary school, nursing home, and multifamily housing based on bill savings alone, and for a fire station when factoring in savings due to avoided outage costs.



Three of the four solar+storage systems would be able to provide up to 12 hours or more of backup power to critical loads. High energy demands and constraints on system sizing limited backup power to a maximum of six hours at a time for the nursing home. 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.[15]

Figure 5 details the analysis results for a secondary school in Wilmington. For more details about the opportunity for solar+storage in Wilmington and to view the full analysis results for each building type, see *Resilient Southeast —Wilmington*.[16]

The most economical option for the school was found to be a 192-kilowatt solar system, with a simple payback period of a little over four years. Adding a 137-kilowatt-hour battery system to the solar system would provide up to 12 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, adding about two and a half years to the payback period. Incorporating avoided outage costs makes solar+storage an even more promising investment opportunity for the Wilmington school.

The favorable results for solar+storage in Wilmington are based on a number of policy, regulatory, and market factors, which are summarized in **Figure 6**.

Opportunities for deployment of customer-sited solar+storage in Wilmington include:

- **Utility Incentives.** Duke Energy Progress has a solar rebate program that provides commercial customers, such as for-profit multifamily housing providers and private nursing homes, with an incentive of $0.50

FIGURE 5

Results of Analysis for a Secondary School in Wilmington

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 Wilmington. Incorporating battery storage adds upfront costs, but the combined system provides up to 12 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)
192 kW	0 kWh	0 hours	$48,000	$472,400	4.4

Resilient Scenario

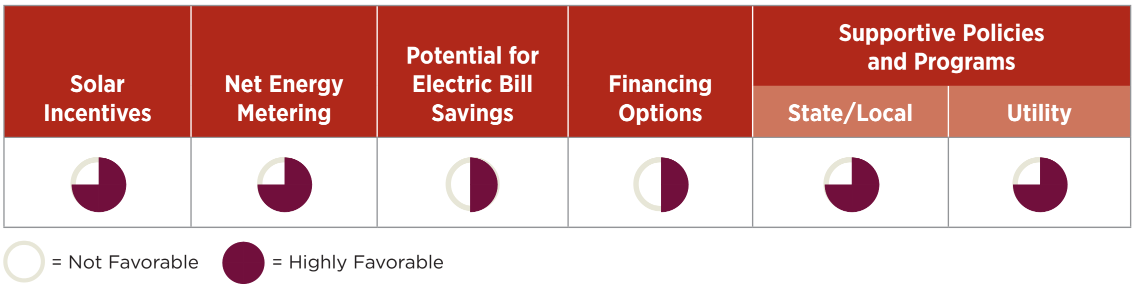
Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
192 kW	137 kWh	12 hours	$49,800	$361,900	7.0
		With Avoided Outage Costs	$54,900	$411,000	6.4

FIGURE 6

Solar and Battery Storage Opportunity Landscape in Wilmington

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



per watt, up to $50,000, for a solar PV system. Nonprofit customers, such as public schools and fire stations, can receive $0.75 per watt incentives through the program, up to $75,000.

- **Renewable Energy Goals.** Of the five Southeast cities analyzed in this series, North Carolina is the only state to have a Renewable Portfolio Standard (RPS).[17] The RPS mandates that North Carolina investor-owned utilities supply 12.5 percent of retail electricity sales by 2021 from renewable energy and energy efficiency measures. The RPS also includes a 0.2 percent solar target.

The utility solar incentive program and favorable net metering policies make solar PV more affordable, and therefore positively impacts the economics of resilient solar+storage systems in Wilmington. However, battery storage has yet to have access to the same level of support and benefits.

Barriers to customer-sited solar+storage in Wilmington include the following:

- **Net Metering Battery Restrictions.** Battery storage systems are eligible to participate in net metering but using batteries to lower electricity costs under time-varying electric rate tariffs is prohibited.[18] This restriction limits the value of battery storage to customers subject to time-of-use rates, negatively impacts system economics, and misses opportunities to add value to the grid through lowering energy use during periods of peak electricity demand.

- **Limited Customer-Sited Growth.** Utility-scale solar installations have driven statewide solar growth in North Carolina. By 2017, Duke Energy had over 2,000 megawatts of utility-scale solar installed in its North Carolina service territories but less than 200 megawatts of distributed solar capacity. Utility-scale battery storage has just started to gain traction in North

North Carolina following Hurricane Florence.
Photo: Creative Commons/NC National Guard

Carolina and behind-the-meter projects remain minimal, resulting in only one megawatt of installed battery storage capacity.[19]

- **Lack of Finance Options.** Third-party sales of solar energy are illegal in North Carolina, which is typically how third-party power purchase agreements (PPAs) are structured. Solar leasing, a popular financing option with no or little upfront costs, was not clearly made available until 2017 and is just now being offered into the market. Additionally, Property Assessed Clean Energy (PACE) financing has not been utilized in the state, despite the passing of PACE-enabling legislation.[20] 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.

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

Utility workers restore power after Hurricane Matthew in North Carolina. Photo: Creative Commons/Lance Cheung, USDA

North Carolina solar and battery storage markets could be completely reshaped by innovations in project financing and new market opportunities created through recently implemented legislation. The state's energy storage feasibility report, especially, could be a first step towards a more supportive regulatory environment for battery storage in North Carolina.

Emerging opportunities to advance customer-sited solar+storage in Wilmington include:

- **House Bill 589 Report: *Energy Storage Options for North Carolina.*** The North Carolina Policy Collaboratory released *Energy Storage Options for North Carolina* at the end of 2018. The report was mandated as part of House Bill 589 (HB589) to explore the potential value that energy storage could bring to both the grid and customers. Although a variety of energy storage technologies were evaluated, battery storage was determined to have the most deployment potential in the immediate future.[21]
- **Property Assessed Clean Energy Finance.** The North Carolina Building Performance Association introduced a commercial PACE bill in 2017, but it has yet to pass. The proposed bill would allow municipalities to setup local commercial PACE programs and has proven a successful financing mechanism for solar+storage projects in other states.[22] If passed, commercial PACE funds could help to spur more nonprofit and critical facility solar+storage installations in North Carolina.
- **North Carolina Utilities Commission.** The North Carolina Utilities Commission has multiple upcoming proceedings that could impact rate design, create mandates for solar and/or storage development, and increase financing options. Adjustments to rate design and setting solar and/or storage mandates could significantly impact the economics for behind-the-meter solar+storage in North Carolina.

#2 Charleston, SC

Charleston ranked a close second among the five cities evaluated based on the economic opportunity for solar+storage development. **Figure 7** summarizes the findings of detailed economic evaluations for solar and battery storage at Charleston critical community facilities.

Economic outcomes were found to be positive for all building types across both scenarios in Charleston, except for the nursing home under the Resilient Scenario when avoided losses from power outages are not considered. These positive results are largely a reflection of a South Carolina state tax incentive for solar PV, which helps position Charleston just below Wilmington as one of the top two economic opportunities evaluated for solar+storage development in the Southeast.

Like Wilmington, the Economic Scenario analysis found that solar, without battery storage, would be the most economical option for all four building types in Charleston when only electric bill savings are considered. Under the Resilient Scenario, solar+storage resulted in net savings for the secondary school, multifamily housing property, and fire station, based on electric bill savings alone. Factoring in the value of avoided outage costs dramatically improves the lifetime savings for all building types, resulting in positive economics for all the modeled solar+storage systems. All of the resilient solar+storage systems were able to provide up to at least 12 hours of backup power to critical loads.

Figure 8 details the analysis results for a secondary school in Charleston. For more

FIGURE 7

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.

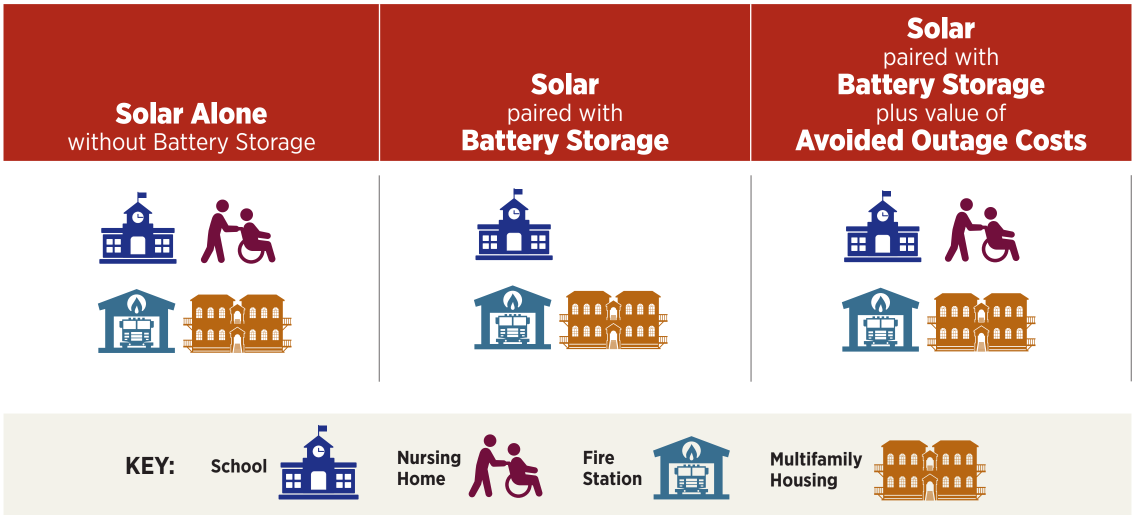


FIGURE 8

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

details about the opportunity for solar+storage in Charleston and to view the full analysis results for each building type, see *Resilient Southeast—Charleston*.[23]

The most economical option for the school was found to be a 191.7-kilowatt solar system. The solar system has a slightly longer simple payback period than the system modeled for the Wilmington school, six years versus four years for Wilmington. Incorporating a 137-kilowatt-hour battery system adds about three and a half years to the project payback period but still results in positive economics based on electric bill savings alone. The resilient solar+storage system provides up to 13 hours of backup power to enable the school to act as a temporary emergency shelter. When the value of avoided outage costs is factored in, the payback period drops below seven years.

The policy, regulatory, and market landscape influencing these economic results for Charleston facilities is summarized in **Figure 9**.

Opportunities for deployment of customer-sited solar+storage in Charleston include:

- **State Tax Incentives.** Of the five Southeast cities analyzed in this series, South Carolina is the only state to offer a solar tax credit. The tax credit can be applied to 25 percent of eligible project 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.
- **Renewable Energy Goals.** While South Carolina does not have a Renewable Portfolio Standard, it did adopt voluntary renewable energy goals and guidelines when the

FIGURE 9

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

state's *Distributed Energy Resource Program Act (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 state solar tax incentive and favorable net metering policies make solar PV more affordable, and therefore positively impacts the economics of resilient solar+storage systems in Charleston. However, battery storage has yet to have access to the same level of support and benefits.

Barriers to customer-sited solar+storage in Charleston include the following:

- **Net Metering Ambiguity.** Under South Carolina's net metering policies, qualifying "customer-generators" are defined as customer-owned or leased systems which generate electricity from a renewable energy resource. The definition is not conducive to batteries as storage technologies discharge electricity, rather than generate electricity. Although the current language does not outwardly prohibit battery storage, its ambiguity leaves room for challenges.
- **Limited Customer-Sited Growth.** Utility-scale solar installations have driven overall statewide solar growth. By 2018, utility-scale solar capacity reached 578 megawatts in South Carolina as distributed solar rose to 120 megawatts. While the

The state solar tax incentive and favorable net metering policies make solar PV more affordable, and therefore positively impacts the economics of resilient solar+storage systems in Charleston.

Flooding in South Carolina caused by Hurricane Florence in September 2018.

Photo: Megan Floyd, US National Guard

utility serving Charleston, South Carolina Electric & Gas, has installed more distributed solar than utility-scale, it has not installed, or initiated, any battery storage development.

- **Lack of Finance Options.** Third-party sales of solar energy are illegal in North Carolina, which is typically how third-party power purchase agreements are structured. Solar leasing was not clearly made available until 2017 and is just now being offered into the market. PACE financing is also not offered in South Carolina.

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

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

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

Emerging opportunities to advance customer-sited solar+storage in Charleston include:

- **The Energy Freedom Act.** *The Energy Freedom Act* builds on the renewable energy policies championed in 2014's *Act 236* by removing barriers and expanding access to customer-sited renewable energy resources. Currently under review in the Senate, House Bill 3659 (HB3659) eliminates capacity limits for both net metering and solar leasing and encourages utilities to provide community solar programs for commercial, nonprofit, and residential customers, as well as separate renewable energy programs for large customers. 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, not only 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.[24]

- **Expedited Interconnection.** If HB3659 is enacted, the South Carolina Public Utilities Commission will have authority over how quickly new solar+storage systems are brought online as the bill requires the Commission to oversee changes to interconnection standards for systems of 80 megawatts or less. Approving processes that expedite resilience projects for critical facilities could result in an uptick in solar+storage adoption among critical facilities.

#3 Atlanta, GA

With weaker solar economics, Atlanta ranked third among the five cities evaluated based on the economic opportunity for solar+storage development. **Figure 10** summarizes the findings of detailed economic evaluations for solar and battery storage at Atlanta critical community facilities.

Economic outcomes were found to be more positive for larger facilities in Atlanta. This is primarily a reflection of the lack of net metering policies in Georgia. Larger buildings with greater electricity demands were found to be better suited to maximize returns on solar investments by minimizing the amount of solar energy exported to the grid, which, in Atlanta, is compensated at a much lower price than retail electricity rates.

As with Wilmington and Charleston, the Economic Scenario found that, based on electric bill savings, solar alone would be the most economical option for all four building types in Atlanta. The larger buildings, the secondary school and nursing home, were still found to result in net savings under the Resilient Scenario when only electric bill savings are considered. For the smaller buildings, the multifamily housing property and fire station, the value of resilience must be accounted for in order to make solar+storage a positive investment option. This is due to the relatively weaker solar economics for these building types. Three of the four resilient solar+storage systems would be able to provide up to 12 hours or more of backup power to critical loads. High energy demands and constraints

FIGURE 10

What Works in Atlanta—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 Atlanta. 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 and nursing home based on bill savings alone, and for a fire station and multifamily housing when factoring in savings due to avoided outage costs.

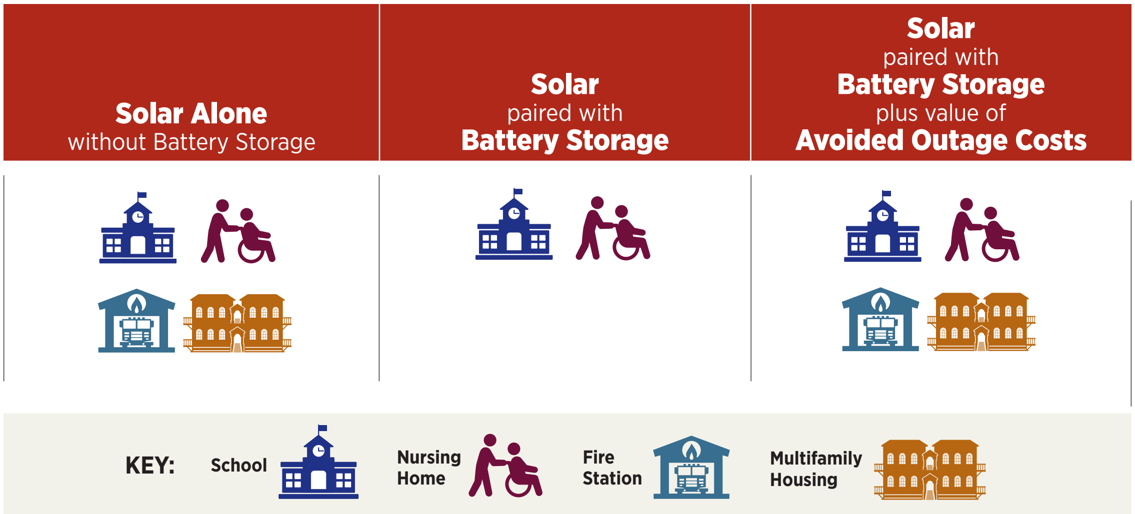


FIGURE 11
Results of Analysis for a Secondary School in Atlanta

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 Atlanta. Incorporating battery storage adds upfront costs, but the combined system provides up to 12 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)
90.9 kW	0 kWh	0 hours	$18,100	$131,800	6.8

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)
90.9 kW	45.7 kWh	12 hours	$18,500	$71,900	10.2
		With Avoided Outage Costs	$44,200	$300,100	4.1

on system sizing limited backup power to a maximum of nine hours at a time for the Atlanta nursing home.

Figure 11 details the analysis results for a secondary school in Atlanta. For more details about the opportunity for solar+storage in Atlanta and to view the full analysis results for each building type, see *Resilient Southeast—Atlanta*.[25]

The most economical option for the school was found to be a 90.9-kilowatt solar system, with a simple payback period of under seven years. Based on solar system sizing and the building's modeled load profile, the school would consume nearly all of the solar energy onsite, with very little exported to the grid. This high rate of direct solar energy consumption improves the economics of the system, since Georgia Power, the utility serving Atlanta, compensates solar energy exported to the grid at about one-third of the retail electricity rate paid by the school and other buildings evaluated. Adding a 45.7-kilowatt-hour battery system allows for up to 12 hours of backup power at the school and increases the payback period to about 10 years without accounting for the value of improved energy resilience. Avoided outage costs would more than double the annual savings delivered by the solar+storage system, resulting is a short payback period of just over four years, making resilient solar+storage an even more cost-effective solution than solar alone for the Atlanta school.

The policy, regulatory, and market landscape influencing these economic results for Atlanta are summarized in **Figure 12**.

Opportunities for deployment of customer-sited solar+storage in Atlanta include:

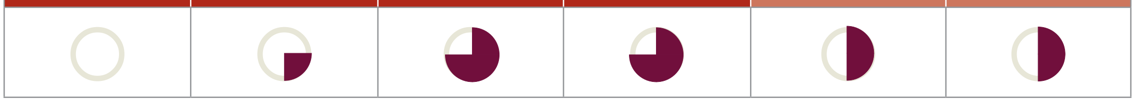
- **Financing Options.** In an effort to address financial barriers to customer-sited, behind-the-meter solar development, Georgia passed the *Solar Power Free-Market Financing Act of 2015* and opened the doors to third-party financing. Solar Energy Procurement

FIGURE 12

Solar and Battery Storage Opportunity Landscape in Atlanta

The opportunity for customer-sited solar and battery storage development in Atlanta is highly dependent on a number of state, regional, and local factors, such as policies, incentives, and utility electric rates. Atlanta was found to have a fairly even mix of supportive and unsupportive factors, resulting in a challenging but also 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

Agreements (SEPA) in Georgia act the same as a power purchase agreement (PPA) or solar leasing in other states, allowing property owners to finance solar at little to no up-front cost through a solar contractor. Residential and commercial property owners are eligible for the program.

- **Renewable Energy Requirements.** In 2016, the Georgia Public Service Commission (GPSC) required Georgia Power to increase electricity generated from renewable energy resources. Georgia Power's approved Integrated Resource Plan requires procurement of 1,600 megawatts of additional renewable resources by 2021. Of the 1,600 megawatts, 1,200 will be through the Renewable Energy Development Initiative, with 1,050 megawatts designated for utility scale development and 150 megawatts for distributed generation.[26] The first 976 megawatts installed have been solar PV. New project proposals can, but are not mandated to, include battery storage.[27]

Barriers to customer-sited solar+storage in Atlanta include the following:

- **Lack of Net Metering.** Of the five Southeast cities analyzed in this series, Atlanta is the only city where utilities are not required to provide solar net energy metering. In Georgia, a utility can voluntarily create a program to compensate residential and commercial distributed generation systems for exported energy but is not required to compensate customers at the full retail electricity rate. Georgia Power does offer a Solar Buy Back program, which compensates customers for energy generated by distributed solar systems.[28] Georgia Power offers a buy back purchase price of $0.032 per kilowatt-hour for solar energy exported from a commercial solar system, about one-third of the typical cost of electricity for commercial customers in Atlanta.

An employee of Georgia Power restores electricity in Atlanta following Hurricane Irma in September 2017.

Photo: Creative Commons/Thomas Cizauskas

Photo: iStockphoto/Jillian Cain

- **Limited Customer-Sited Growth.** Utility-scale solar installations have driven solar development and dominated the renewable energy landscape in Georgia. To date, utilities have completed more than 200 utility-scale solar projects, which exceed 1,300 megawatts of capacity. The residential and commercial sectors have not experienced the same growth, with a combined capacity of just over 62 megawatts.[29] Georgia Power has announced two customer-sited solar+storage projects that are currently in development.

Atlanta solar and battery storage markets could be completely reshaped by two upcoming Georgia Public Service Commission proceedings set for 2019: the Georgia Power Integrated Resource Plan (IRP) and a rate case. Additionally, renewable championing policies and finance mechanisms set forth by the City of Atlanta could spur municipal, residential, and commercial development and improve citywide resilience.

Emerging opportunities to advance customer-sited solar+storage in Atlanta include:

- **Georgia Public Service Commission.** Georgia Power filed its 2019 IRP and is set to file a rate case with the Georgia Public Service Commission in mid-2019. This will be Georgia Power's first rate case since 2013 and could potentially change electric rates that have been frozen since 2016.[30] The 2019 IRP proposes an additional 1,000 megawatts of renewable energy, however, only 50 megawatts of the new renewable development is earmarked for distributed generation, the majority is utility scale. The 2019 plan does include a 50-megawatt battery storage pilot program. The proposed storage systems would be both independently sited and installed at pre-existing solar facilities.[31]
- **City of Atlanta.** The City of Atlanta has emerged as a clean energy leader in both Georgia and the broader region. The City Council and Mayor's Office have set citywide renewable energy goals and committed to a 100 percent clean energy transition by 2035 for citywide operations and 2050 community-wide. Although the City has not set any specific targets for solar and storage adoption, the Mayor's clean energy plan, *Clean Energy Atlanta: A Vision for a 100% Clean Energy Future*, does highlight solar and storage in both long and short-term policy goals as a necessary component to reaching 100 percent clean energy reliance. City-owned buildings are identified as opportunities to improve resilience by replacing diesel generators with solar+storage, and Resilience Hubs are included as vehicles to demonstrate solar+storage feasibility. Atlanta has also approved bond programs for commercial and multifamily clean energy projects and launched its first solar energy program, Solar Atlanta. Through Solar Atlanta, solar systems will be installed on 24 municipal buildings, including fire stations.[32]
- **Property Assessed Clean Energy Financing.** Atlanta will be the first city in Georgia to take advantage of PACE financing. Atlanta's commercial PACE program, which is currently in development, will offer $500 million in bonds to finance energy efficiency and renewable energy projects, including solar and storage, for commercial and multifamily property projects.[33] Once launched, it will be the first PACE program in Georgia and only the second of its kind in the Southeast.

#4 Miami, FL

With challenging solar economics for some facilities, Miami ranked fourth among the five cities evaluated based on the economic opportunity for solar+storage development. **Figure 13** summarizes the findings of detailed economic evaluations for solar and battery storage at Miami critical community facilities.

Unlike in Wilmington, Charleston, and Atlanta, the Economic Scenario found that solar was only a cost-effective solution for two of the building types in Miami, the secondary school and nursing home. These results are a reflection of fairly low electricity rates for commercial customers in Miami, which makes the economic case for solar weaker than in the other three cities. Economic outcomes were found to be more positive for the larger facilities due to lower per-watt installation costs for larger solar systems and greater opportunities for larger energy users to reduce demand-related electric charges. Solar was not found to be an economical option for multifamily housing or the fire station.

When the buildings were analyzed under the Resilient Scenario, solar+storage was not found to be an economical option for any of the buildings based on electric bill savings alone. Factoring in the additional value of avoided outage costs dramatically improved the lifetime savings for all building types, resulting in positive economics for the solar+storage systems in all cases, with short simple payback periods of under three years for the larger building types. Due in part to recent prolonged outages from severe weather,

FIGURE 13

What Works in Miami—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 Miami. Solar alone, without storage, was found to be a positive investment for a secondary school and nursing home. Solar paired with battery storage, which can be configured to provide resilient backup power during grid outages, was not found to be an economical option based on bill savings alone. Factoring in savings due to avoided outage costs significantly improves the overall economics of solar paired with battery storage, resulting in positive economics for all building types.

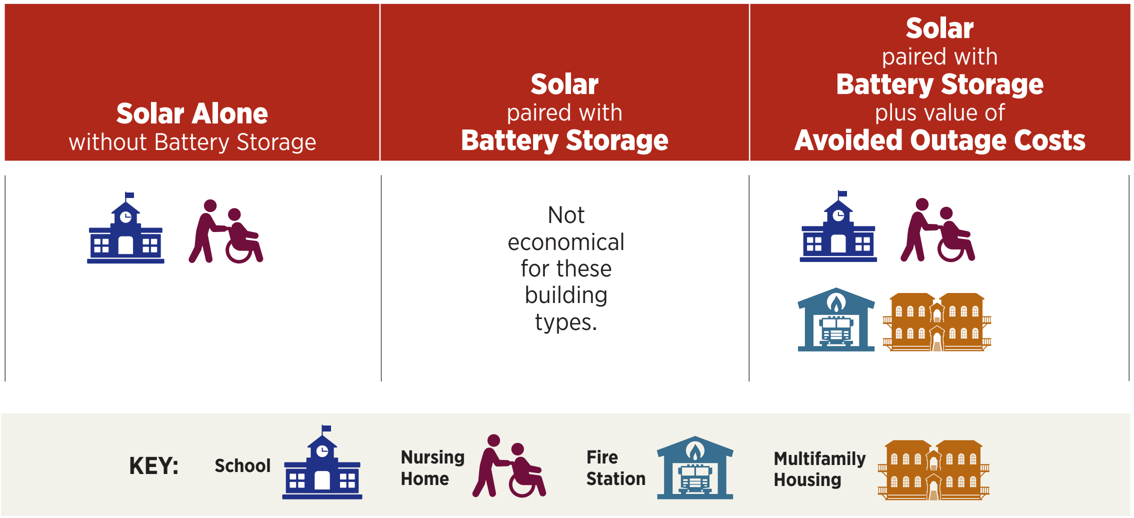


FIGURE 14
Results of Analysis for a Secondary School in Miami

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 Miami. Incorporating battery storage adds upfront costs, but the combined system provides up to 14 hours of backup power to a portion of the school that could serve as a temporary emergency shelter. 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)
40 kW	0 kWh	0 hours	$4,500	$8,800	12.2

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)
71.2 kW	45.7 kWh	14 hours	$7,900	(–$32,500)	18.2
			With Avoided Outage Costs		
			$53,900	$410,800	2.7

Miami customers had the highest avoided outage cost values of any of the locations evaluated.[34] Three of the solar+storage systems were able to provide up to 11 hours or more of backup power to critical loads. High energy demands and constraints on system sizing limited backup power to a maximum of seven hours at a time for the Miami nursing home.

Figure 14 details the analysis results for a secondary school in Miami. For more details about the opportunity for solar+storage in Miami and to view the full analysis results for each building type, see *Resilient Southeast—Miami.*[35]

The most economical option for the school was found to be a 40-kilowatt solar system. With a simple payback period of just over 12 years, the school was found to have the best economic case for solar of the four Miami building types evaluated. Adding a 45.7-kilowatt-hour battery system and increasing the solar system to 71.2 kilowatts—the maximum system size for the building given available roof space—would provide up to 14 hours of backup power to keep emergency services operational at the school. Due to fairly weak solar economics and the added expense of the battery storage system, solar+storage was not found to be an economical investment for the school based on electric bill savings alone. Because outage costs are so high for commercial customers in Miami, savings achieved through avoiding power outages for emergency loads were found to be more than five times greater than modeled electric bill savings. Including savings from avoided outage costs improved the economics of the system to the point that solar+storage becomes a positive investment opportunity for the school with an impressive simple payback period of only 2.7 years.

The policy, regulatory, and market landscape influencing these economic results for Miami are summarized in **Figure 15**.

FIGURE 15
Solar and Battery Storage Opportunity Landscape in Miami

The opportunity for customer-sited solar and battery storage development in Miami is highly dependent on a number of state, regional, and local factors, such as policies, incentives, and utility electric rates. Miami was found to have a largely unsupportive mix of key factors, resulting in a challenging 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

Opportunities for deployment of customer-sited solar+storage in Miami include:

- **Favorable Net Metering Policies.** Florida has the most favorable net metering policies of the five cities analyzed in this report series. Along with full retail rate crediting for exported solar energy, the net metering program has no aggregated capacity limit for the amount of customer-sited solar allowed to participate and large systems, up to two megawatts in capacity, are eligible for net metering.[36] Unlike some utilities, Florida Power and Light (FP&L), the utility serving Miami customers, allows batteries that are part of a net-metered solar+storage system to be charged with electricity from both onsite solar and the grid.
- **Battery Storage Development.** Recent investments suggest that FP&L is increasingly interested in investing in battery storage. A 50-megawatt battery storage pilot program approved in 2016 has resulted in 14 megawatts of installed solar+storage capacity and another 10 megawatts of battery storage are planned to be in service in early 2019. FP&L also announced plans for what would be the largest battery storage installation in the world, a 409-megawatt battery storage system located at an existing solar PV plant.[37] As for distributed solar+storage: the Florida SunSmart Emergency Shelter Program installed solar+storage systems at over 100 public schools; University of Southern Florida partnered with Duke Energy and Tesla to install a solar+storage system on the University's parking garage; an affordable housing developer in Miami has partnered with FP&L to submit plans for a solar+storage Metrorail project in the community of Coconut Grove; and Duke Energy and the City of Orlando are working to install a solar+storage microgrid at the City's wastewater treatment facility.[38,39,40]

Florida residents donate supplies following Hurricane Irma.
Photo: Creative Commons/FEMA

Barriers to customer-sited solar+storage in Miami include the following:

- **Lack of Finance Options.** Solar leasing was not made available for residential customers in Florida until 2017. Four solar PV equipment providers have been approved by the Florida Public Service Commission to provide residential solar leases for equipment and at least one of these companies is also leasing battery storage. Although commercial and industrial customers could participate in solar leasing prior to the 2017 decision, market development was limited. Opening the residential market has resulted in major solar companies now entering the Florida market. It is still illegal for a third-party to sell electricity to customers in Florida through a power purchase agreement or similar arrangement.

Opening the residential market has resulted in major solar companies now entering the Florida market.

- **Lack of Supportive Policies.** In 2015, an effort to pass third-party-owned solar didn't gather enough votes in the state legislature. Two years later a pro-solar bill was introduced, Amendment 4, which sought to support commercial and industrial rooftop solar customers by prohibiting property tax on solar panels installed at a facility.[41] However, FP&L supported changes to the legislation that hindered rooftop solar development. The suggested alterations would have further restrained the solar industry by imposing excessive disclosure and paperwork requirements on solar developers.
- **Limited Customer-Sited Growth.** Utility-scale solar installations have driven renewable energy growth in Florida, and FP&L has dominated utility project development. FP&L currently operates over 1,200 megawatts of utility-scale solar installations. As of 2017, distributed, customer-sited solar accounted for only 68 megawatts of installed capacity.[42]

Two upcoming Florida Public Service Commission proceedings and a Florida Supreme Court case set for 2019 could have widespread implications on the renewable energy industry in Florida.

Emerging opportunities to advance customer-sited solar+storage in Miami include:

- **Florida Public Service Commission.** The Florida Public Service Commission (FPSC) is set to make a decision in May 2019 as to whether a reduced tax burden should equate to FP&L reducing customer electric rates. The Florida Public Counsel filed a petition that the tax breaks should result in a $750 million customer reimbursement. FP&L argues that it used tax savings to cover Hurricane Irma expenses.[43] Ultimately, any change to rate structures will have a direct impact on the economics of solar+ storage for FP&L customers. Another utility, Gulf Power, has issued a proposal to the FPSC to increase residential and commercial energy rates in order to recoup disaster expenses incurred after Hurricane Michael. Although the FPSC has approved similar rate hikes in the past, the ruling could reaffirm the FPSC's stance on rate increases for storm recovery or indicate a shift to reconsidering how utilities can recoup recovery expenses and/or spend recovery funds.[44]
- **Florida Supreme Court.** An upcoming Florida Supreme Court hearing could strengthen the renewable energy industry in Florida.[45] The Florida Supreme Court is set to rule on whether a proposed amendment to deregulate Florida's electricity market and promote competition among electricity providers can move forward to a ballot measure.[46] If the ballot measure is approved, ratepayers would have full retail choice, meaning that electric rates would not be determined by the FPSC, that residents would be able to exercise utility choice, and that customers would have the option to generate more of their energy through solar.[47] FP&L and other utilities are fighting the measure.[48]

#5 New Orleans, LA

With challenging solar economics for commercial customers, New Orleans ranked fifth among the five cities evaluated based on the economic opportunity for solar+storage development. **Figure 16** summarizes the findings of detailed economic evaluations for solar and battery storage at New Orleans critical community facilities.

Overall, the analysis resulted in poor economic outcomes for solar and battery storage in New Orleans. Unlike the other cities, the Economic Scenario analyses for New Orleans found that solar would not be a cost-effective solution for any of the buildings evaluated. These discouraging results are primarily due to the design of electric rate tariffs offered by the utility serving New Orleans customers, Entergy New Orleans. In addition to low energy charges for all commercial customers evaluated, similar to Miami, large electricity users face a fixed monthly demand charge of more than $500 for the first 50 kilowatts of energy demand. Because the charge is structured as a fixed fee, larger commercial customers, like a school or nursing home, are charged $500 each billing period regardless of whether their demand is below 50 kilowatts for that period. This further undercuts the bill savings that solar and battery storage can achieve.

Like Miami, solar+storage under the Resilient Scenario was also not found to be an economical option for any of the New Orleans buildings based on electric bill savings alone. However, accounting for the value of avoided outage costs once again improves the lifetime savings for all building types to the point that

FIGURE 16

What Works in New Orleans—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 New Orleans. Neither solar alone nor solar paired with battery storage, which can be configured to provide resilient backup power during grid outages, was found to be an economical option based on bill savings alone. Factoring in savings due to avoided outage costs significantly improves the overall economics of solar paired with battery storage, resulting in positive economics for all building types.

Solar Alone without Battery Storage	**Solar** paired with **Battery Storage**	**Solar** paired with **Battery Storage** plus value of **Avoided Outage Costs**
Not economical for these building types.	Not economical for these building types.	

KEY: School, Nursing Home, Fire Station, Multifamily Housing

FIGURE 17
Results of Analysis for a Secondary School in New Orleans

Based on modeling of utility bill savings and available incentives, solar PV and battery storage were not found to be economical options for a secondary school in New Orleans. When modeled for resilience, the resulting combined solar and battery storage system provides up to 14 hours of backup power to a portion of the school that could serve as a temporary emergency shelter. 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)
0 kW	0 kWh	0 hours	$0	$0	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)
115.7 kW	91.3 kWh	14 hours	$7,800	(–$143,600)	33
		With Avoided Outage Costs	$31,000	$6,900	10.8

resilient solar+storage becomes a positive investment option in all cases analyzed. The fire station was found to have the best economic outcome, with a simple payback period of less than seven years when resilience benefits are considered. All of the resilient solar+storage systems were found to provide up to 12 hours or more of backup power to critical loads during a grid outage.

Figure 17 details the analysis results for a secondary school in New Orleans. For more details about the opportunity for solar+storage in New Orleans and to view the full analysis results for each building type, see *Resilient Southeast—New Orleans*.[49]

As with all building types evaluated in New Orleans, rate design and a lack of opportunity for significant electric bill savings results in solar PV being an uneconomical option for the school. Installing a 115.7-kilowatt solar system paired with a 91.3-kilowatt-hour battery storage system would provide up to 14 hours of electricity to power emergency operations at the school. The resilient solar+storage system was only found to be a cost-effective solution for the New Orleans school when factoring in the added value of avoided outage costs. Incorporating these additional savings results in marginally positive economics for the solar+storage system, with a simple payback period of 10.8 years.

The policy, regulatory, and market landscape influencing these economic results for New Orleans are summarized in **Figure 18**.

Opportunities for the development of customer-sited solar+storage in New Orleans include:

- **New Orleans City Council.** New Orleans is a unique case in the Southeast in that the New Orleans City Council regulates the investor-owned utility serving the city, Entergy New Orleans. In 2018, the New Orleans City Council created a new subcommittee, the Smart and Sustainable Cities Committee,

FIGURE 18
Results of Analysis for a Secondary School in New Orleans

The opportunity for customer-sited solar and battery storage development in New Orleans is highly dependent on a number of state, regional, and local factors, such as policies, incentives, and utility electric rates. New Orleans was found to have a largely unsupportive mix of key factors, resulting in a challenging 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

with a focus on developing new technologies to improve both quality of life and sustainability for residents, businesses, and visitors. The Committee is seen by the Council as a platform for progressive policies and technologies to improve resilience and sustainability challenges.

- **Battery Storage Development.** While there has been little solar+storage deployment in New Orleans to date, a new affordable housing project shows promise of future customer adoption of the technologies. An affordable housing developer has partnered with Entergy New Orleans to build a resilient affordable housing complex for veterans, low-income, elderly, and disabled residents. The project at the 50-unit facility will include 450 solar panels and a battery storage system. The facility has been designed to be net-zero emissions, meaning it will produce as much energy as it consumes. The construction of the complex has already begun, and it is anticipated to open in the fall of 2019.[50]

Barriers to customer-sited solar+storage in New Orleans include the following:

- **Low Potential for Bill Savings.** As noted in the economic analysis results, the design of electric rate structures for commercial customers in New Orleans makes it difficult for solar and battery storage investments to be cost-effective based solely on electric bill savings. Commercial customers are charged increasingly lower electricity rates as they use more energy, creating a disincentive to reduce consumption through solar or efficiency measures. The additional demand-based fixed charges applied to larger customers further limits the potential for solar and battery storage to effectively reduce electric bills.
- **Lack of Finance Options.** Third-party solar leasing, where customers pay a monthly fee to lease solar equipment,

A temporary emergency shelter is set up at the Baton Rouge River Center in Baton Rouge, LA in August 2016 as flooding pushed residents from their homes.
Photo: Spc. Garrett L. Dipuma, US Army National Guard

is available in Louisiana, but it is illegal for a third-party to sell electricity to a customer. PACE financing is also not offered in New Orleans. The Louisiana legislature has enabled PACE, and the City of New Orleans took steps to implement the program. However, the City was unable to secure a participating lending institution and therefore PACE remains unavailable.

Progressive renewable energy goals and a motivated local government could help prioritize solar+storage development in New Orleans. Upcoming New Orleans City Council hearings could also have widespread implications on the renewable energy industry.

Emerging opportunities to advance customer-sited solar+storage in New Orleans include:

- **City of New Orleans.** The City of New Orleans has emerged as a clean energy leader in Louisiana. In 2017, the City pledged to cut greenhouse gas emissions in half by 2030. The pathway to a clean energy transition was outlined in the report, *Climate Action for a Resilient New Orleans*.[51] In the plan, city-owned buildings are identified as opportunities to incorporate rooftop solar. The plan also established a target to install over 255 megawatts of solar, which would equate to 20 percent of the City's potential rooftop solar capacity, by 2030. The report includes references to battery storage and microgrids as necessary technologies for improving resiliency and reducing emissions.
- **New Supportive Policies.** Community and advocacy organizations are currently encouraging the New Orleans City Council to adopt a Renewable Portfolio Standard for the City. Thirty-six organizations signed on to a petition for New Orleans to adopt a Renewable Portfolio Standard, which was submitted it to the Council in mid-2018. In response, the Council has opened a Renewable Portfolio Standard rulemaking, that would position the city to have a target in place by the end of 2019. The Council is also in the middle of a rate case proceeding with Entergy New Orleans.

Photo: iStockphoto/poweroffforever

Recommendations

The results of the economic analyses were noteworthy, with solar+storage representing an economical solution for at least half of the facilities evaluated in three cities—Atlanta, Charleston, and Wilmington—based only on electric bill savings. When the additional value of avoided outage costs is accounted for, resilient solar+storage was found to be a cost-effective solution in all cases evaluated. Still, many challenges and barriers need to be addressed to enable greater deployment of resilient solar+storage across the Southeast.

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:

- **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. In the Southeast, Florida has already built resilient community facilities that can withstand prolonged outages through the SunSmart Emergency Shelter Program, installing over 100 solar+storage systems in schools that can now serve as shelters in the event of a disaster. Maryland and Massachusetts have all 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. [52]

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.

- **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

Solar panels on the roof of the Atlanta Community Food Bank.
Photo: Atlanta Community Food Bank

and critical community facilities across the country.[53] The Atlanta-based nonprofit, Southface, also provides technical assistance and solar access support to Georgia's nonprofits, communities of faith, and multifamily affordable housing, through the Solar for Underserved Markets program.[54]

- **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.[55] Twenty-five percent of SGIP's funding is dedicated to projects in low-income and disadvantaged communities.[56] The Solar Massachusetts Renewable Target (SMART) program includes incentives for solar installations that incorporate a battery storage component. States that already have a tax incentive, like South Carolina, could expand the program to include 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.[57] 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

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.

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. PJM covers a small portion of northeast North Carolina and Louisiana falls within the Midcontinent Independent System Operator (MISO) transmission territory. These regional organizations have begun to lay out changes to their market rules and regulations that could open up new revenue opportunities for energy storage, however, most of the Southeast falls outside of the jurisdiction of any RTO or ISO and is not subject to these orders. Utilities throughout the Southeast 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.[58]

- **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.[59] 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. The five states included in this report allocated more than $460 million in electric efficiency program spending in 2017.[60]

- **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.[61] Disaster mitigation and recovery initiatives are supported through this funding source. States in the Southeast impacted by Florence have the opportunity to commit a portion of their funds to solar+storage installations in critical facilities.

Established energy efficiency programs represent an opportunity to allocate existing funds to advance cost-effective energy storage solutions.

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

Conclusion

There is little debate over the need for stronger energy resilience in locations prone to severe weather and power outages such as much of the Southeast. While diesel generators have served as the go-to resource for onsite backup power for decades, it is time to explore and embrace new 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.

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.

Currently, the opportunity for resilient solar+storage development in the Southeast is encouraging but can be a challenge due to a lack of supportive policies, a focus on utility-scale development, 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. The findings and recommendations presented here are meant to start a conversation about the steps that Southeastern cities and states could take to ensure a more resilient future for their residents before the next storm strikes.

Rooftop solar array at the Faith Community Church in Greensboro, NC.
Photo: NC Warn

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.

2 Clean Energy Group. SunSmart Emergency Shelters Program. *Featured Resilient Power Installations*. March 31, 2015. *https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/sunsmart-emergency-shelters-program*.

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 page: *Featured Resilient Power Installations*. 2017. *https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/marcus-garvey-apartments*.

4 To read more about the Fremont Fire Stations: Stark, Kevin. "This East Bay Energy Startup Is Building Microgrids for California's Fire Stations." *GTM*[2]. *January 15, 2019. https://www.greentechmedia.com/articles/read/startup-microgrids-fire-stations*.

5 Demand charges, which are typically only applied to commercial customers, are typically billed based on the highest rate of electricity consumption a customer experiences during a billing period, measured in kilowatts. This highest level of demand is known as peak demand. For more information about demand charges and how energy storage can lower peak demand, see Clean Energy Group and National Renewable Energy Laboratory. "An Introduction to Demand Charges." August 2017. *https://www.cleanegroup.org/wp-content/uploads/Demand-Charge-Fact-Sheet.pdf*.

6 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.

7 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.

8 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.

9 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.

10 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.

11 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.

12 For more information about solar and battery storage third-party ownership financing structures, see: Milford, Lewis and Robert Sanders. "Owning the Benefits of Solar+Storage: New Ownership and Investment Models for Affordable Housing and Community Facilities." *Clean Energy Group*. February 15, 2018. *https://www.cleanegroup.org/ceg-resources/resource/owning-the-benefits-of-solar-storage*.

13 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 March 22, 2019. *https://icecalculator.com/home*.

14 More detailed analysis results are available in the *Resilient Southeast - Technical Appendix*. April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-technical-appendix.*

15 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.

16 "Resilient Southeast—Wilmington: Exploring Opportunities for Solar+Storage in Wilmington, NC." April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-wilmington*.

17 South Carolina has a voluntary Renewable Portfolio Standard.

18 Time-of-use (TOU) rates charge customers different prices for electricity depending on the time of day, with higher-priced peak periods and lower-priced off-peak periods. Due to this restriction, battery storage cannot store energy from off-peak times to discharge during peak times, thus offsetting the higher energy costs associated with peak electricity pricing.

19 Maloney, Peter. "North Carolina energy storage market could exceed 1 GW by 2030, says study by universities." *Utility Dive*. December 6, 2018. *https://www.utilitydive.com/news/north-carolina-energy-storage-market-could-exceed-1-gw-by-2030-says-study-b/543722*.

20 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.

21 To read the entire Energy Storage Options for North Carolina Report visit: NC State Energy Storage Team. "Energy Storage Options for North Carolina." Energy Policy Council Joint Legislative Commission on Energy Policy. December 3, 2018. *https://energy.ncsu.edu/storage/wp-content/uploads/sites/2/2019/02/NC-Storage-Study-FINAL.pdf*.

22 The first Commercial PACE funded microgrid in the country serves a 285-unit mixed-income housing and retail development in Hartford, Connecticut. Solar and storage adds resilience to the development in the event of a natural disaster and helps to reduce electric bills by lowering demand-related charges. In its first year of operation, the microgrid generated over $300,000 in electric bill savings. To read more, visit: Better Buildings. "Commercial PACE Financing for Micro-grid in Mixed-Use Building." United States Department of Energy. Accessed April 3, 2019. *https://betterbuildingsinitiative.energy.gov/implementation-models/commercial-pace-financing-microgrid-mixed-use-building*.

23 "Resilient Southeast—Charleston: Exploring Opportunities for Solar+Storage in Charleston, SC." April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-charleston*.

24 To review Senate Bill 332, visit *https://www.scstatehouse.gov/sess123_2019-2020/bills/332.htm.*

25 "Resilient Southeast – Atlanta: Exploring Opportunities for Solar+Storage in Atlanta, GA." April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-atlanta*.

26 News Release. "Commission Approves Agreement on Georgia Power Integrated Resource Plan; Increases Renewable Energy Resources; Approves Capitalization of Costs for Early Development of Stewart County Nuclear Power Facility." *Georgia Public Service Commission*. July 28, 2016. *http://www.psc.state.ga.us/GetNewsRecordAttachment.aspx?ID=635*.

27 Georgia Power. "Georgia Power seeks 540 MW of new large-scale renewable generation." *CISION PR Newswire*. December 10, 2018. *https://www.prnewswire.com/news-releases/georgia-power-seeks-540-mw-of-new-large-scale-renewable-generation-300762895.html*.

28 Georgia Power. "Solar Buy Back." Accessed March 22, 2019. *https://www.georgiapower.com/company/energy-industry/energy-sources/solar-energy/solar/solar-buy-back.html*.

29 Southface. "Georgia Energy Data." Accessed March 22, 2019. *http://www.georgiaenergydata.org/solarmap*.

30 Coastal Courier. "Georgia Power vows flat rates through 2019." May 6, 2016. *https://coastalcourier.com/news/business-news/georgia-power-vows-flat-rates-through-2019*.

31 To read Georgia Power's full 2019 Integrated Resource Plan, visit: State of Georgia. "2019 Integrated Resource Plan, Docket Number 42310, Document Filing #175473." *Georgia Public Service Commission*. January 31, 2019. *http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=175473*.

32 News Release. "Mayor Kasim Reed Launches the City of Atlanta's First Solar Energy Program." *City of Atlanta, GA.* November 23, 2015. *https://www.atlantaga.gov/Home/Components/News/News/4058/672?arch=1&npage=2&seldept=19*.

33 Pyzyk, Katie. "Atlanta to offer property owners $500M in bonds for clean energy projects." *Smart Cities Dive*. October 24, 2017. *https://www.smartcitiesdive.com/news/atlanta-to-offer-property-owners-500m-in-bonds-for-clean-energy-projects/507944*.

34 Miami's high avoided outage costs are largely a reflection of prolonged outages experienced by Florida Power & Light customers during the 2017 hurricane season.

35 "Resilient Southeast – Miami: Exploring Opportunities for Solar+Storage in Miami, FL." April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-miami*.

36 DSIRE. "Net Metering: Program Overview." *North Carolina Clean Energy Technology Center.* Accessed March 26, 2019. *http://programs.dsireusa.org/system/program/detail/2880*.

37 Kenning, Tom. "Florida utility plans world's largest battery combined with solar." *Energy Storage News*. March 28, 2019. *https://www.energy-storage.news/news/florida-utility-plans-worlds-largest-battery-combined-with-solar*.

38 Lambert, Fred. "Tesla deploys Powerpacks to protect the University of South Florida against blackouts." *Electrek.* September 15, 2018. *https://electrek.co/2018/09/15/tesla-powerpacks-protect-university-of-south-florida-blackouts*.

39 Harris, Alex. "Powered by the sun and a 'monster' battery. It's the Metrorail station of the future." *Miami Herald.* September 19, 2018. *https://www.miamiherald.com/news/local/community/miami-dade/article218125440.html*.

40 Burger, Andrew. "Duke Energy and Orlando Discussing Microgrid at Wastewater Treatment Plant." *Microgrid Knowledge.* January 22, 2019. *https://microgridknowledge.com/duke-energy-orlando-discussing-microgrid-wastewater-treatment-plant*.

41 Walton, Robert. "Florida lawmakers pass bill to eliminate property taxes on solar panels." *Utility Dive*. May 5, 2017. *https://www.utilitydive.com/news/florida-lawmakers-pass-bill-to-eliminate-property-taxes-on-solar-panels/442051*.

42 Conrad, Roger and Great Speculations. "NextEra Energy: Best in Class, But at A Price." *Forbes*. January 30, 2019. *https://www.forbes.com/sites/greatspeculations/2019/01/30/nextera-energy-best-in-class-but-at-a-price/#85982c64a2d5*.

43 Heroux Pounds, Marcia. "FPL opposes review of its rates amid push for customers' bills to be trimmed." *South Florida Sun Sentinel.* January 22, 2019. *https://www.sun-sentinel.com/business/fl-bz-fpl-fights-rate-challenge-20190122-story.html*.

44 Saunders, Jim. "Gulf Power wants customers to pay surcharge for Hurricane Michael recovery." *Pensacola News Journal.* February 7, 2019. *https://www.pnj.com/story/news/2019/02/07/gulf-power-customers-may-face-costs-hurricane-michael-recovery/2802041002*.

45 Gross, Samantha J. "Shop for electricity? Florida voters could decide in 2020." *Miami Herald.* January 24, 2019. *https://www.miamiherald.com/news/politics-government/state-politics/article225004695.html*.

46 The ballot measure would only apply to investor owned utilities.

47 The ballot measure proposes a similar structure to the deregulated utility market in Texas. To learn more, visit: ElectricChoice.com. "The Ultimate Guide to Texas Electricity Deregulation." *Eisenbach Consulting, LLC.* Accessed March 26, 2019. *https://www.electricchoice.com/blog/guide-texas-electricity-deregulation*.

48 Heroux Pounds, Marcia. "FPL tackles hot topics: growth, rates and proposed deregulation." *South Florida Sun Sentinel.* January 25, 2019. *https://www.sun-sentinel.com/business/fl-bz-fpl-parent-fourth-quarter-20190124-story.html*.

49 "Resilient Southeast—New Orleans: Exploring Opportunities for Solar+Storage in New Orleans, LA." April 25, 2019. *https://www.cleanegroup.org/ceg-resources/resource/resilient-southeast-new-orleans*.

50 Larino, Jennifer. "See plans for a new $7.4 million affordable housing complex for veterans off Broad Street." *NOLA.com, The Times-Picayune.* January 18, 2019. *https://www.nola.com/business/2019/01/see-plans-for-a-new-74-million-affordable-housing-complex-for-veterans-off-broad-street.html*.

51 To read *Climate Action for a Resilient New Orleans,* visit: City of New Orleans. "Climate Action for a Resilient New Orleans." *Office of Resilience & Sustainability.* July 2017. *https://www.nola.gov/nola/media/Climate-Action/Climate-Action-for-a-Resilient-New-Orleans.pdf*.

52 To learn more about the Massachusetts Community Clean Energy Resiliency Initiative visit: Massachusetts Department of Energy Resources. "Community Clean Energy Resiliency Initiative Project Implementation and Technical Assistance." March 24, 2015. *https://www.mass.gov/files/2017-07/resilency-poster-3-24-15.pdf*.

53 Clean Energy Group. "Featured Resilient Power Installations." Accessed March 22, 2019. *https://www.cleanegroup.org/ceg-projects/resilient-powerproject/featured-installations*.

54 To learn more about Southface's technical assistance program, visit: Arora, Shan. "Solar for Georgia's Nonprofits Challenges and Opportunities." Southface. May 2018. *https://www.southface.org/solar-forgeorgias-nonprofits*.

55 California Public Utilities Commission. "Self-Generation Incentive Program." Accessed March 22, 2019. *http://www.cpuc.ca.gov/sgip*.

56 To read more about Massachusetts SMART program visit: Mass.gov. "Solar Massachusetts Renewable Target (SMART)." Commonwealth of Massachusetts. Accessed March 22, 2019. *https://www.mass.gov/solarmassachusetts-renewable-target-smart*.

57 Spector, Julian. "New York City Sets the First Citywide Energy Storage Target." GTM2. September 27, 2016. *https://www.greentechmedia.com/articles/read/newyork-city-becomes-first-to-set-citywide-energy-storagetarget*.

58 For more information on market opportunities for energy storage, see: Mullendore, Seth. "Energy Storage and Electricity Markets: The value of storage to the power system and the importance of electricity markets in energy storage economics." Clean Energy Group. August 12, 2015. *https://www.cleanegroup.org/ceg-resources/resource/energy-storage-and-electricitymarkets-the-value-of-storage-to-the-power-systemand-the-importance-of-electricity-markets-in-energystorage-economics*.

59 Olinsky-Paul, Todd. "Storage: The New Efficiency, How States can use Energy Efficiency Dollars to Support Battery Storage and Flatten Costly Demand Peaks." Clean Energy Group. April 4, 2019. *https://www.cleanegroup.org/ceg-resources/resource/energystorage-the-new-efficiency*.

60 Berg, Weston et al. "The 2018 State Energy Efficiency Scorecard." (Research Report U1808.) American Council for an Energy-Efficient Economy. October 4, 2018. *https://aceee.org/research-report/u1808*.

61 American Geosciences Institute. "FAA reauthorization bill passes with riders for disaster policy reform, Hurricane Florence funding, and geospatial data." October 5, 2018. *https://www.americangeosciences.org/policy/news-brief/FAA-reauthorization-bill-passes-with-riders-for-disaster-policy-reform-hurricane-florence-funding-and-geospatial-data*.

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*

ALLIANCE FOR AFFORDABLE ENERGY

The Alliance for Affordable Energy safeguards Louisiana's future by protecting consumers' right to an affordable, equitable, and environmentally responsible energy system. We are committed to promoting a new vision for energy policy in Louisiana, from an "energy state" to a "clean energy" leader in the South. Serving as both a consumer advocate and public health advocacy organization, our policy work meets at the crossroads of social justice, sustainable economic development, and environmental protection. *www.all4energy.org*

CATALYST MIAMI

Catalyst Miami, founded in 1996, is a nonprofit 501(c)(3) organization in Miami-Dade County. Catalyst Miami's mission is to identify and solve issues adversely impacting Miami's low-income communities. To achieve our mission, we identify and launch innovative strategies to help people and communities thrive and to create a more equitable and caring society. We work through a network of partner organizations, linking people with financial education, healthcare information, public benefits, and educational and economic opportunities.

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*

ENERGY AND POLICY INSTITUTE

The Energy and Policy Institute is a watchdog organization that exposes attacks on renewable energy and counters misinformation by fossil fuel and utility interests. *www.energyandpolicy.org*

SOUTHFACE INSTITUTE

Southface Institute, a nonprofit 501(c)(3) organization, is a leader in sustainable advocacy, building, planning and operations across the U.S. With a mission to create a healthy and equitably built environment for all, Southface's consulting services, workforce development, research and policy practices are supporting better homes, workplaces and communities. Experts in the fields of resource efficiency, building tech and organizational sustainability since 1978, Southface is committed to building a regenerative economy to meet tomorrow's needs today. *www.southface.org*

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 nonprofit 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

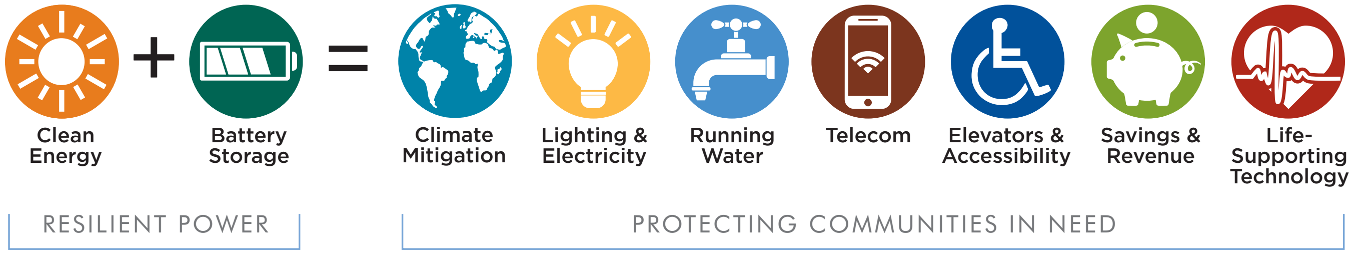
Founded in 1998 with offices in Greenville and Spartanburg, Upstate Forever focuses work in ten South Carolina counties; Abbeville, Anderson, Cherokee, Greenville, Greenwood, Laurens, Oconee, Pickens, Spartanburg and Union. Upstate Forever also operates an accredited land trust as well as a Clean Water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

RESILIENT SOUTHEAST

Report Series Overview

RESILIENT POWER

A project of Clean Energy Group



www.resilient-power.org

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