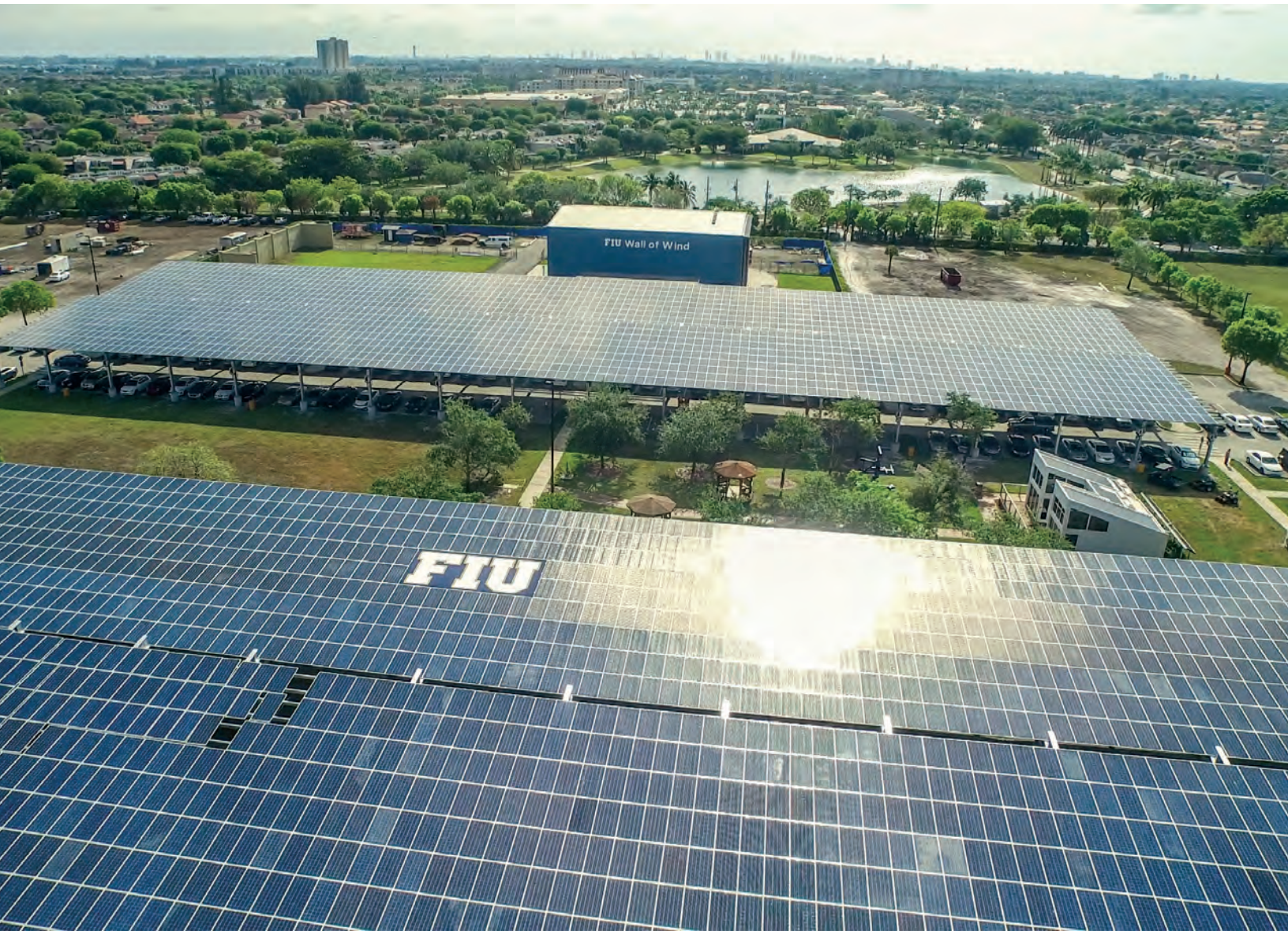
RESILIENT SOUTHEAST

Exploring Opportunities for Solar+Storage in Miami, FL



CleanEnergyGroup
Innovation in Finance, Technology & Policy

ABOUT THIS REPORT

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

ABOUT THIS REPORT SERIES

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

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

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DISCLAIMER

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COVER PHOTO:
1.4-MW solar array at FIU's College of Engineering and Computing. More than 4,400 solar panels on canopy-like structures provide clean electricity to FPL's grid and shade for about 400 parking spaces.
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Contents

Executive Summary

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

Miami ranked fourth for opportunities to deploy resilient solar and battery storage among the five southeastern cities evaluated in this report series

By exploring the opportunity for deployment of solar PV and battery storage systems for critical facilities in Miami, this report aims to answer the question: does solar paired with battery storage make economic sense for strengthening the resilience of Florida communities? Based on the results of detailed economic analyses of critical building types in Miami, the answer is yes, but only when the value of resilience is fully accounted for.

The findings show that significant challenges and barriers remain that must be addressed in order for these types of resilient power systems to be more economical and widely adopted. *Miami ranked fourth for opportunities to deploy resilient solar and battery storage among the five Southeastern cities evaluated in this report series.*

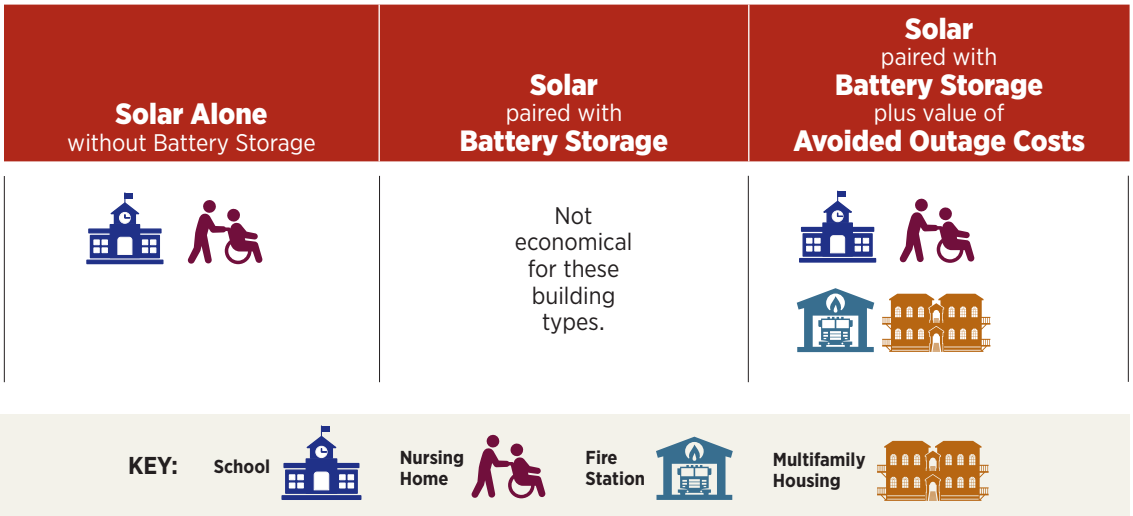
Figure 1 summarizes the findings of detailed economic evaluations for solar and battery storage at four critical facilities in Miami: a school, a nursing home, a multifamily housing property, and a fire station. As can be seen from the results, solar was found to be a positive investment for the school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

The analysis results and the overall landscape for solar+storage in Miami is dependent on a variety of factors, from net energy metering policies and utility electric rates to available incentives and financing options. These factors are summarized in **Figure 2**. Miami benefits from favorable state net-metering policies and access to a variety of financing options for both solar and battery storage, but Miami suffers from low potential for electric bill savings due to the structure of commercial utility rates and a lack of supportive incentives or policies. This creates a challenging environment for the development of resilient solar+storage projects.

FIGURE 1

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.

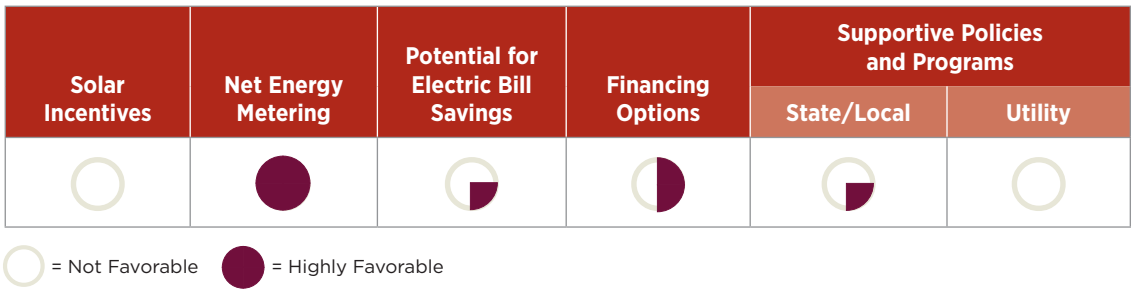


To address these challenges, this report presents potential near-term opportunities for policies and regulatory changes that could advance solar+storage development in Atlanta and concludes with a set of recommendations. Ongoing efforts led by the City of Atlanta to develop renewable energy targets and invest in battery storage are highlighted as potential opportunities. Recommendations include policy and programmatic changes, *such as incentive programs, demonstration projects, and carve-outs in disaster relief and mitigation funds, which have shown success in the Southeast and throughout the United States.*

FIGURE 2

Solar and Battery Storage Opportunity Landscape in 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.



Recommendations for Advancing Resilient Power in Miami

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

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

The Need for Resilient Power

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

Low-income households oftentimes don't have the means or ability to temporarily evacuate 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.

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

For first responders and healthcare providers, the implications of power outages can be immediate and life threatening, such as when communications are down at a fire station, or when a nursing home can't regulate room temperatures for vulnerable elderly residents. Designated emergency shelters, such as schools and multifamily housing complexes,

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

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.

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.

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

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

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

What is Resilient Power?

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

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

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

A Growing Need for Resilience in Florida

In the past decade, new weather patterns and intensified storms have forced the state government and local leaders in Florida to re-evaluate disaster preparedness and response. Back-to-back hurricanes resulted in two of the deadliest, most destructive, and expensive hurricanes on record. Health complications resulting from power outages and heavy flooding have emerged as major hurdles to emergency response. Power outages are leaving vulnerable populations in the dark and, in some cases, without air conditioning in extreme temperatures. Resilient power systems in critical community facilities could provide residents with access to safe spaces to seek shelter and support in the event of an emergency.

HURRICANE IRMA

In September 2017, Hurricane Irma made landfall as a Category 4 hurricane in the Florida Keys with sustained winds over 100 mph. The hurricane went on to devastate communities across Florida. The Federal Emergency Management Agency (FEMA) estimates that one-fourth of homes in the Florida Keys were destroyed. Recovery efforts were hindered by the severe flooding as crews were forced to wait for waters to subside. Over 6.2 million Florida residents lost power.[6]

As the Governor ordered evacuations for more than six million residents, 260 state shelters opened across Florida, including medical special-needs shelters. Extended outages resulted in 911 calls in the days following the storm as residents suffered from heat-related medical complications.[7] Twelve elderly residents died from heat exposure after their nursing home in Hollywood Hills lost power and the air conditioning failed. There was no back-up generator and medically vulnerable residents were left in almost 100-degree temperatures.[8]

Damage from Hurricane Michael in Mexico Beach, FL, October 2018.
Photo: Creative Commons/ U.S. Coast Guard Petty Officer 3rd Class Hunter Medley

HURRICANE MICHAEL

A year after Hurricane Irma, another Category 4 hurricane demolished communities along the coast and Florida panhandle. Hurricane Michael wind speeds exceeded 150 mph and, despite an evacuation order for 375,000 people, many people opted to shelter in place.[9] Over 330,000 customers lost power and 6,700 people slept in 54 shelters, most of which were either churches or public schools. A week after the storm, 182,000 customers still remained without power and 2,000 people were still living in emergency shelters.[10] Rebuilding and recovery efforts are still underway in the hardest hit areas.

Critical facilities weren't prepared. Nine hospitals, five nursing homes, and fifteen assisted-living facilities were forced to close. An additional 20 hospitals and fifteen nursing homes were without electricity and relied on generators for power.[11] One 300-bed hospital was operating without water. Widespread outages resulted in downed 911 call centers.[12]

Florida's Solar and Storage Landscape

The solar industry is growing in Florida, but a lack of supportive regulatory policies has hindered the growth of battery storage. Despite a less than ideal regulatory environment, Florida ranks 8th in the country for state solar development. Solar generates just over one percent of the state's total electricity.[13] Florida does not have a Renewable Portfolio Standard and has not set any voluntary renewable energy or energy storage mandates or targets.[14] The state does not provide any solar or battery storage tax incentives.

Favorable net-metering policies have improved solar PV system economics for residential and commercial customers in Florida.

Favorable net-metering policies have improved solar PV system economics for residential and commercial customers in Florida. Investor-owned utilities are required to provide retail rate crediting to customers for exported solar energy to the grid. Excess energy is credited the following month at the retail rate and anything remaining at the end of the year is credited at an avoided-cost rate. There is no aggregated capacity limit for the amount of customer-owned distributed solar allowed to participate in net metering. Additionally, of the five states analyzed, Florida has the largest system capacity limit for solar PV. Customer-owned systems participating in the program can be up to two megawatts.[15]

FLORIDA POWER AND LIGHT

Despite supportive net-metering policies, progress for residential and commercial solar has been an uphill battle. 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.[16] However, Florida Power and Light (FP&L), the electric utility serving Miami customers, supported changes to the legislation that hindered rooftop solar development. The suggested alterations would have actually further restrained the solar industry by imposing excessive disclosure and paperwork requirements on solar developers. Ultimately, Amendment 4 passed without the onerous paperwork and disclosure requirements that were sought by the utility.[17]

Utility-scale solar installations have driven renewable energy growth in Florida, and FP&L has dominated utility project development. FP&L generated ten times more solar energy in 2018 than in 2016, and currently operates over 1,200 megawatts of utility-scale solar installations. By 2030, FP&L plans to reach 11,000 megawatts of solar capacity.[19] Distributed, customer-sited solar contributes significantly less to the FP&L portfolio, accounting for only 68 megawatts of installed capacity in 2017.

Battery storage development has lagged, but recent investments suggest that FP&L is increasingly interested in this market. A 50-megawattt battery storage pilot program approved in 2016 has resulted in 14 megawatts of installed solar+storage capacity already. 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.[20] As for distributed storage, FP&L has plans to launch a residential, utility-owned battery storage

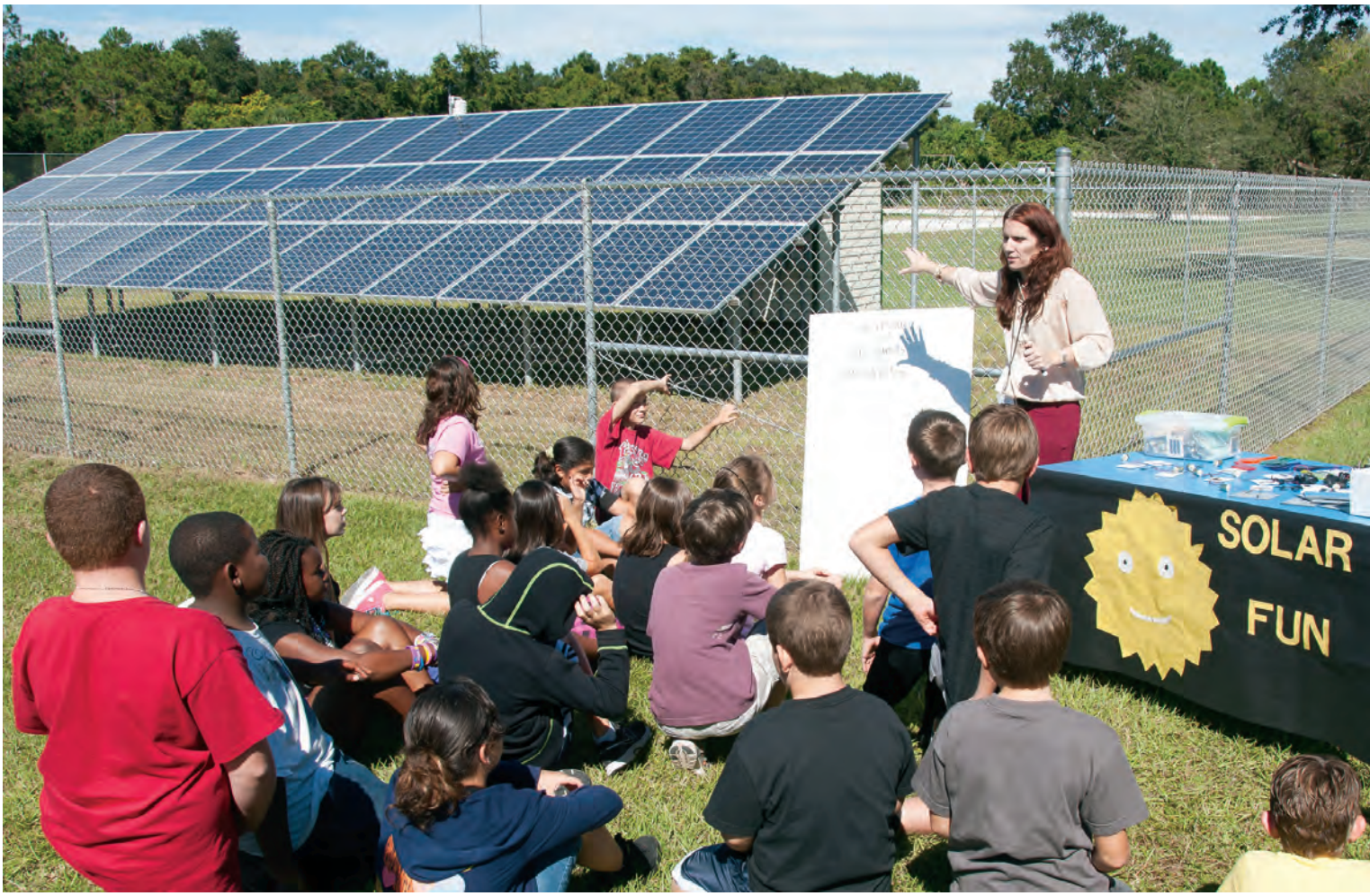
program in Palm Beach, though the combined capacity of the residential battery program will be under 100 kilowatts.[21] Both the residential program and upcoming 10 megawatts of battery storage projects do not currently include plans for solar PV.

FP&L customer-sited solar systems paired with battery storage are eligible to participate in net metering. Unlike some utilities, FP&L allows batteries that are part of a net-metered solar+storage system to be charged with electricity from both the solar PV system and the grid. FP&L does not offer any rebate programs for customers installing solar or battery storage systems.

FINANCE

Commercial and residential customers in Florida have access to property assessed clean energy or "PACE" financing, which allows property owners to repay their financial obligation for acquiring solar or other clean energy systems through an assessment attached to their annual property tax bill. There are currently two residential and five Commercial PACE (CPACE) programs active. CPACE programs also serve nonprofit partners. PACE provides low-interest financing and repayment periods that can extend upwards of 20 years for energy efficiency and renewable energy projects, including battery storage.[22] Loans are typically secured with a lien on the property and paid through an assessment on the customer's annual property tax bills. Florida CPACE issued loans totaling over $13 million in 2017. Loans covered a variety of energy projects in 79 buildings.[23] Although CPACE has traditionally been a popular option to finance energy efficiency improvements, battery storage projects have become more prevalent. CPACE funded its first solar+storage microgrid in 2017.[24]

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 Sun-Smart Emergency Shelters Program.
Photo: Nick Waters, Florida Solar Energy Center.



Despite PACE availability, finance remains a major barrier to solar+storage development. Solar leasing, a popular financing option with no or little upfront costs, was not made available for residential use until 2017 and is quickly gaining momentum. It is still illegal for a third-party to sell electricity to customers, which is typically how third-party power purchase agreements (PPA) are structured. Third-party PPAs are a popular financing option in parts of the country where they are available.[25]

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

Florida's solar leasing option is different in that customers pay a flat fee per month to a company to lease equipment, rather than purchase the electricity generated. Four solar PV equipment providers, including national companies like Tesla and Sunrun, have been approved by the Florida Public Service Commission to provide residential solar leases for equipment. Sunrun is also leasing battery storage. The battery is only offered by Sunrun as part of a solar+storage system and cannot be installed independent of a solar PV array.[26] 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 entering the Florida market.

A new FP&L program proposed for 2019 will circumvent customer financing for solar altogether. The "Solar Together" program will sell solar credits through a subscription program to commercial and residential customers. The program does not require that the customer own or install a renewable energy system. Participants are charged a monthly solar subscription fee to purchase solar from an FP&L owned and operated solar PV project. As time passes, solar credits gradually increase and further offset participant electric bill costs. FP&L anticipates that the solar credits will exceed the cost of subscription in under seven years. FP&L will retain control of solar generation assets. FP&L filed the program for approval from state regulators in March of 2019.[27] Since FP&L's program does not include installing customer-sited energy systems, customers will not have an opportunity to pair solar with onsite battery storage for resiliency benefits.

MIAMI-DADE COUNTY

Cities in Miami-Dade County have emerged as clean energy leaders in Florida. The County, City of Miami, and City of Miami Beach were selected to join the Rockefeller Foundation's *100 Resilient Cities* initiative. The County's Sustainability Plan, *GreenPrint*, was published in 2010 along with a corresponding Climate Change Action Plan. Both plans highlight the importance of solar PV and outline specific solar demonstration projects. The County has already completed a solar feasibility report for county-owned buildings. Neither plan considers opportunities for battery storage.[28]

South Miami has also passed progressive renewable energy mandates. In 2017, South Miami became the first city in Florida to pass a law requiring that new buildings install solar.[29]

FLORIDA PUBLIC SERVICE COMMISSION

The Florida Public Service Commission (FPSC) regulates the investor-owned electric utilities in the state, including FP&L. FP&L is the largest utility in Florida and serves over 10 million people, including the City of Miami and Miami-Dade County. The FPSC is responsible for approving any new generation assets or programs, including those pertaining to clean energy development. The FPSC was responsible for the 2017 ruling that allowed for a solar developer to lease equipment in Florida, which opened the doors to solar leasing in the state.

BEHIND-THE-METER SOLAR+STORAGE

Through funds provided by the *American Recovery and Reinvestment Act of 2009*, Florida invested in resilient power technologies for critical facilities throughout Florida. Since 2010, the Florida SunSmart Emergency Shelter Program has installed solar+storage systems at over 100 public schools. Each school can shelter 100-500 people during an emergency. A typical system consists of a 10-kilowatt solar

Solar installation at the Douglas L. Jamerson, Jr. Elementary School in St. Petersburg, FL. This installation is part of the Sun-Smart Emergency Shelters Program.
Photo: Florida Solar Energy Center.

array and a 40-kilowatt-hour battery system. The systems sell power to the grid during normal operations and island from the grid to power critical loads in the event of an outage. People seeking shelter can go to a nearby school shelter to access services including phone charging stations. After Hurricane Irma, 41 of the 112 SunSmart schools relied on solar+storage to power emergency shelter operations.[30]

The University of Southern Florida partnered with Duke Energy and Tesla to install a solar+storage system on the University's parking garage. The system consists of a 100-kilowatt solar array and two 210-kilowatt-hour Tesla Powerpacks. In the event of an outage, solar+storage will power critical loads, including: lighting, elevator service, and electric vehicle charging.[31]

In Miami, an affordable housing developer has partnered with FP&L to submit plans for a solar+storage Metrorail project in the community of Coconut Grove. The proposed solar+storage system will consist of a 2-megawatt solar array and a 20-megawatt-hour battery. In the event of an outage, the Metrorail station will act as a resilience hub for the community and provide air conditioning and charging outlets.[32] County transit authorities are currently reviewing the project.

Duke Energy and the City of Orlando are working to install a solar+storage microgrid at the City's wastewater treatment facility. The microgrid will consist of one to three megawatts of solar PV and five to ten megawatts of battery storage. Duke Energy plans to finance the project and own and operate the facility. Solar+storage will improve resilience at the critical facility by providing a reliable emergency backup power resource in the event of an outage and Duke will benefit from using the batteries to provide valuable grid services. The program could build a foundation for future resiliency initiatives at other critical facilities, including fire stations and emergency shelters.[33]

Economic Analysis Methodology

For this report series, Clean Energy Group partnered with The Greenlink Group, an energy analysis firm based in Atlanta, 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 Miami: 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.[34]

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.[35,36]
2. **Resilient Scenario:** The resilient scenario evaluates a system configuration capable of providing onsite backup power to critical loads.[37] 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.[38]

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.[39] While nonprofit entities like municipalities cannot directly benefit from tax incentives, there are third-party leasing arrangements and tax equity partnerships that can pass along incentive savings to nonprofit organizations.[40] In addition to federal tax incentives, the analysis assumes

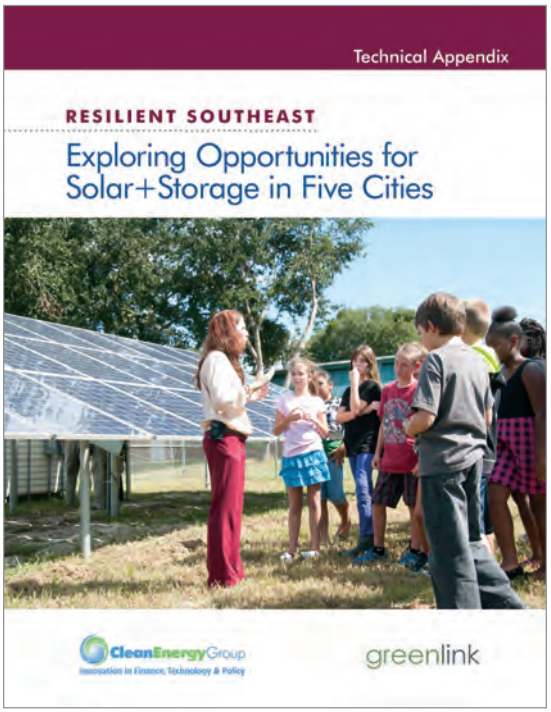
all solar systems participate in net energy metering, with exported generation credited back to the customer at the full retail rate.

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

When solar is paired with battery storage, the systems can be configured to deliver power to critical loads during a grid outage, thus avoiding some or all of these outage-related costs. This analysis uses a methodology developed by the Lawrence Berkeley National Laboratory to estimate avoided outage costs.[41] 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.

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

For more information about the methodology and assumptions used in this analysis, refer to the *Resilient Southeast—Technical Appendix*.[42]



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

Avoided Outage Costs: Calculating the Benefit of Energy Resilience

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

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

Analysis Results for Miami

Overall, the analysis results for the economics of solar+storage to support critical community facilities in Miami were not as strong as other cities evaluated in this report series. Miami ranked fourth out of the five cities evaluated based on the economic opportunity for solar+storage development.[43] See **Figure 3**.

All the building types evaluated in this report are subject to the same electric rate tariff, which has a low energy charge of less than 5 cents per kilowatt hour and a moderate demand charge of about $11 per kilowatt. The low energy charge rate makes the economics of solar particularly challenging. Economic outcomes were found to be more positive for the larger facilities, such as the school and nursing home, due to lower per watt installation costs for larger solar systems and greater opportunity to reduce demand charges.

The Economic Scenario analysis found that solar, without battery storage, would be the most economical option for the secondary school and nursing home, based purely on electric bill savings with no consideration of improved energy resilience. Solar was not found to be an economical investment 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 by powering critical loads during grid disruptions dramatically improved the lifetime savings for all building types, resulting in positive economics for the solar+storage systems in all cases. Due in part to recent prolonged outages from severe weather, Miami customers had the highest avoided outage costs of any of the locations evaluated.[44]

Three of the four solar+storage systems analyzed 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 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.[45]

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

	Opportunities	Barriers
Miami, FL 	**Miami ranked fourth out of the five cities evaluated; solar+storage was only found to be a cost-effective solution when accounting for additional savings due to avoided costs of power outages.**	
	• favorable net metering policies • financing options for both solar and battery storage	• low potential for electric bill savings • lack of supportive incentives or policies

Miami School

The analysis results for a secondary school in Miami are summarized in **Figure 4**. 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 building types evaluated.

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

Adding a 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 fully operational at the school.[46] Due to the 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 critical loads were found to be more than five times greater than modeled electric bill savings. Including savings from avoided outage costs improved the economics to the point that solar+storage becomes a positive investment opportunity for the school with an impressive simple payback period of less than three years.

FIGURE 4

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 Nursing Home

The analysis results for a nursing home in Miami are summarized in **Figure 5**. The most economical option for the nursing home was found to be a 25-kilowatt solar system. While still a positive investment, solar represents only a marginally cost-effective solution for the nursing home.

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

Boosting the solar to its maximum size of 112.7 kilowatts and adding a 91.3-kilowatt-hour battery system would provide up to seven hours of backup power to keep essential services operational at the nursing home. Due to marginal solar economics and the added expense of the battery storage system, solar+storage was not found to be an economical option for the nursing home based on electric bill savings alone.

Again, the high cost of outages in Miami results in significantly greater savings for the nursing home than electric bill reductions, with annual solar+storage savings increasing by a factor of seven when avoided outage costs are considered. Like the school, including avoided outage costs makes solar+storage a positive investment for the nursing home, with a simple payback period of less than three years.

FIGURE 5

Results of Analysis for a Nursing Home in Miami

Based on modeling of utility bill savings and available incentives, solar PV was found to be the most economical option for a nursing home in Miami. Incorporating battery storage adds upfront costs, but the combined system provides up to 7 hours of backup power to a portion of the nursing home providing medical care and emergency services to residents. Factoring in the value of avoided outage costs significantly improves the overall economics of the resilient power system, resulting in net savings over time.

Economic Scenario

Most economical system based on available savings and incentives

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
25 kW	0 kWh	0 hours	$2,500	$1,400	13.6

Resilient Scenario

Solar paired with battery storage to deliver reliable onsite emergency power

Solar	Battery Storage	Backup Power	1st Year Savings	Net Lifetime Savings (25-year NPV)	Simple Payback (years)
112.7 kW	91.3 kWh	7 hours	$11,900	(–$78,600)	20.7
			With Avoided Outage Costs		
			$89,700	$670,800	2.8

Miami Multifamily Housing

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

Solar PV was not found to be an economical option for the multifamily housing property based on electric bill savings. This is due to a combination of low rates for electricity and higher installation costs for smaller solar systems.

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

Installing a 10-kilowatt solar system paired with 9.8 kilowatt-hours of battery storage would provide up to 15 hours of backup power to the multifamily housing common areas. The solar+storage system was found to have a poor economic return without accounting for savings due to avoided outage costs. Incorporating avoided outage costs triples the annual savings delivered by the solar+storage system, resulting in positive economics and a simple payback period of less than eight years for the multifamily housing property.

FIGURE 6

Results of Analysis for a Multifamily Housing Property in Miami

Based on modeling of utility bill savings and available incentives, solar PV and battery storage were not found to be economical options for a multifamily housing property in Miami. When modeled for resilience, the resulting combined solar and battery storage system provides up to 15 hours of backup power to the common area spaces of the property, giving residents access to basic services and electricity when sheltering in place during an emergency. 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)
10 kW	9.8 kWh	15 hours	$1,000	(–$12,200)	26.9
			With Avoided Outage Costs		
			$3,400	$11,100	7.6

Miami Fire Station

The analysis results for a fire station in Miami are summarized in **Figure 7**. The combination of low electricity rates and higher installation costs also make solar an uneconomical option for the fire station based on electric bill savings.

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

Installing a 13.6-kilowatt solar system paired with 9.8 kilowatt-hours of battery storage would provide up to 11 hours of backup power to the fire station. The economics of solar+storage are somewhat stronger for the fire station than for multifamily housing, but the system was still not found to be an economical solution based on electric bill savings alone. As with the other building types evaluated, the high cost of outages makes solar+storage a positive investment for the fire station when savings from avoided outage costs are included. Accounting for avoided outage costs results in a five-year simple payback period for the solar+storage system.

FIGURE 7

Results of Analysis for a Fire Station in Miami

Based on modeling of utility bill savings and available incentives, solar PV and battery storage were not found to be economical options for a fire station in Miami. When modeled for resilience, the resulting combined solar and battery storage system provides up to 11 hours of backup power to keep the station fully operational during an emergency. 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)
13.6 kW	9.8 kWh	11 hours	$1,400	(–$11,300)	22.1
			With Avoided Outage Costs		
			$6,300	$35,500	5.0

Opportunities for Solar and Storage in Miami

Two upcoming Florida Public Service Commission proceedings and a Supreme Court case set for 2019 could have widespread implications on the renewable energy industry in Florida. Efforts at the county level could also have important impacts.

FLORIDA PUBLIC SERVICE COMMISSION

As the regulatory authority, the FPSC sets utility rates and incentives and must approve any proposed rate changes. 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.

The FPSC is set to make a decision in May 2019 on whether a reduced tax burden should equate to FP&L reducing customer electric rates. The Florida Office of Public Counsel, a state office that advocates on behalf of utility consumers, and business groups 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. Ultimately, any change to rate structure will have a direct impact on the economics of solar+storage for FP&L customers.

FPSC is also set to review the Florida Energy Efficiency and Conservation Act (FEECA), which incentivizes and promotes energy efficiency and demand-side renewable energy. The next FEECA proceeding, conducted every five years, is currently underway. FPSC has the opportunity to include the cost effectiveness of solar+storage and to consider ways to promote resilience across the state of Florida.

STATE POLICY

An upcoming Florida Supreme Court hearing could further strengthen the renewable energy industry in Florida.[47] The Florida Supreme Court is set to rule on if a proposed amendment to deregulate Florida's electricity market and promote competition among electricity providers can move forward to a ballot

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

Photo: iStockphoto/Jillian Cain

measure.[48] 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.[49] FP&L and other utilities are fighting the measure.[50]

Miami Beach and the City of Miami partnered to develop a resilience strategy, but they have yet to fully embrace a 100 percent renewable energy future.

MIAMI-DADE COUNTY

Recent negotiations between the County and FP&L to negotiate FP&L's franchise fee ended in 2018, when FP&L abruptly exited negotiations and opted to remove the franchise fee entirely. The fee, which is charged to customers living in Miami-Dade County but outside of city limits, brought in $27 million to the County in 2018 alone. Now that the franchise arrangement is set to end after 2020, advocacy organizations are asking the County to use the opportunity to increase renewable energy power generation and supportive programs, including installation of a solar+storage microgrid at a County-owned facility to serve as an emergency relief center for a low-income community.

Local groups are also advocating for Miami Dade County to commit to 100 percent renewable energy by 2050. Other cities in Florida have already committed to the 100 percent renewable goal, including Orlando and West Palm Beach. Miami-Dade County, the City of Miami Beach, and the City of Miami partnered to develop a resilience strategy, but they have yet to fully embrace a 100 percent renewable energy future. If the County was to develop a renewable energy transition, battery storage or solar could be incentivized through rebates, targets, and/or demonstration projects.

Recommendations

The results of the analysis illustrate a challenging environment for resilient solar+storage development in Miami. While the analysis found positive solar+storage economics for all facilities when considering avoided outage costs, only two of four critical facilities had positive solar economic outcomes based on electric bill savings alone.

This outcome is in large part due to the low FP&L electricity charges. Enabling policies and programs, such as energy resilience carve-outs in federal disaster funding and state targeted incentive programs, could contribute to a more robust solar+storage industry and accelerate the deployment these technologies for critical facilities.

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

- **Allocate grant funding for solar+storage demonstration projects.** Solar+storage demonstration projects can educate residents about resilient energy, spur market development, and provide communities with a valuable service. Florida has already built resilient community facilities that can withstand prolonged outages through the SunSmart Emergency Shelter Program. Florida's SunSmart Emergency Shelter Program installed solar+storage systems in over 100 schools that can now serve as shelters in the event of a disaster. Maryland and Massachusetts have all also implemented 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.[51]

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

Florida can build on past success by promoting resilient power in additional critical facilities. After Hurricane Irma, nursing homes and assisted living facilities are required to install alternative power sources to use in the event of an outage, as well as to dedicate space to accommodate fuel onsite. However, current program guidelines do not promote solar+storage as a reliable power solution. With over 40 percent of nursing homes still needing time to meet the requirements, Florida has an opportunity to allocate grant funding to help nursing homes access solar+storage for their facilities.[52] Legislation was introduced in 2018 to establish a disaster resilience pilot program for critical facilities in Florida. The $10 million initiative would have funded solar+storage projects in facilities used to support emergency operations and provide community services in the event of an emergency or natural disaster.[53] Although the bill failed to pass, it indicated bipartisan interest in implementing clean

Solar rooftop system on the South Concourse of the Orange County Convention Center.
Photo: NREL/Orange County Convention Center

energy technologies for disaster preparedness and mitigation initiatives.

- **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, supported by multiple foundations, has supported dozens of solar+storage project evaluations for affordable housing and critical community facilities across the country.[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. Twenty-five percent of SGIP's funding is dedicated to projects in low-income and disadvantaged communities.[55] The Solar Massachusetts Renewable Target (SMART) program includes incentives for solar installations that incorporate a battery storage component.[56] The SMART program also aims to develop markets in underserved communities by including additional incentives for solar projects serving low-income communities and community shared solar projects.

- **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 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. Florida does not fall within the jurisdiction of any RTO or ISO and is not subject to these orders. However, utilities like FP&L 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]

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

- **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. Florida allocated $190.3 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.

Conclusion

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

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

Currently, the opportunity for resilient solar+storage development in Miami can be a challenge due to a lack of supportive policies, the design of commercial utility electric rate tariffs, and the sometimes prohibitive upfront cost of battery systems. Policies and programs that recognize and reward the true value of resilient solar+storage could drastically change that dynamic.

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

Photo: iStockphoto/frankreporter

ENDNOTES

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

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34 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.

35 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.

36 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.

37 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.

38 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.

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

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

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

45 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.

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

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ORGANIZATION DESCRIPTIONS

CLEAN ENERGY GROUP

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

CATALYST MIAMI

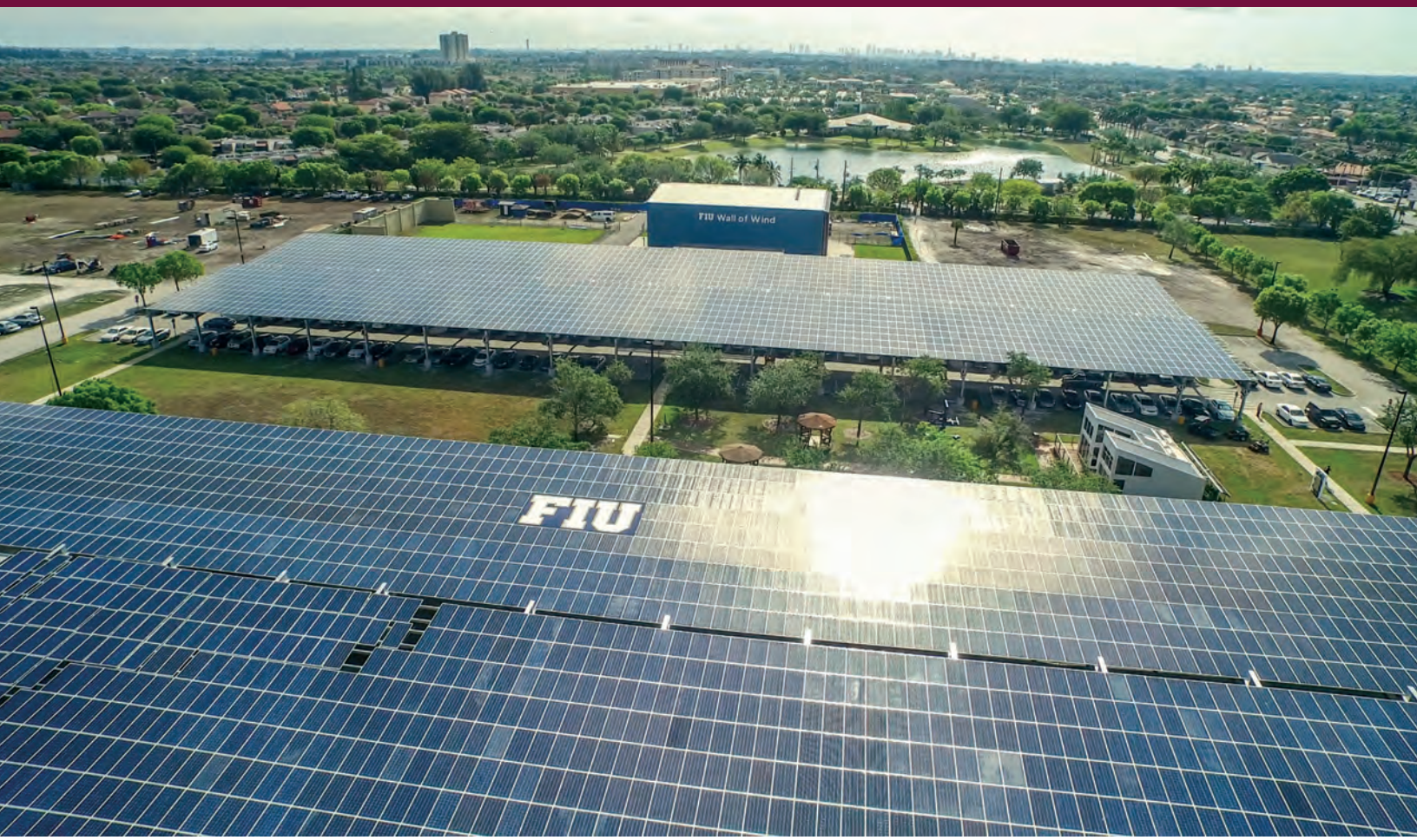
Catalyst Miami, founded in 1996, is a nonprofit 501(c)(3) organization in Miami-Dade County. Catalyst Miami's mission is to identify and solve issues adversely impacting Miami's low-income communities. To achieve our mission, we identify and launch innovative strategies to help people and communities 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*



RESILIENT POWER

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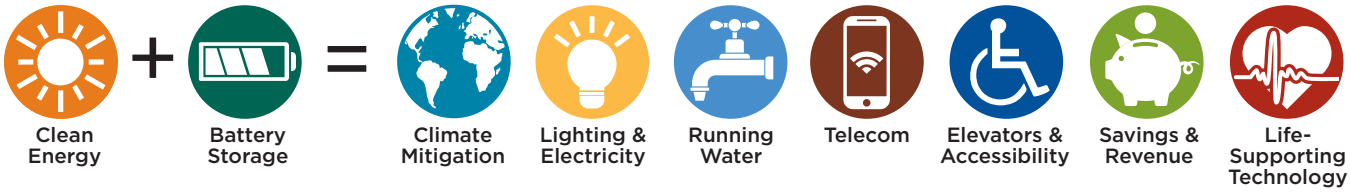

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