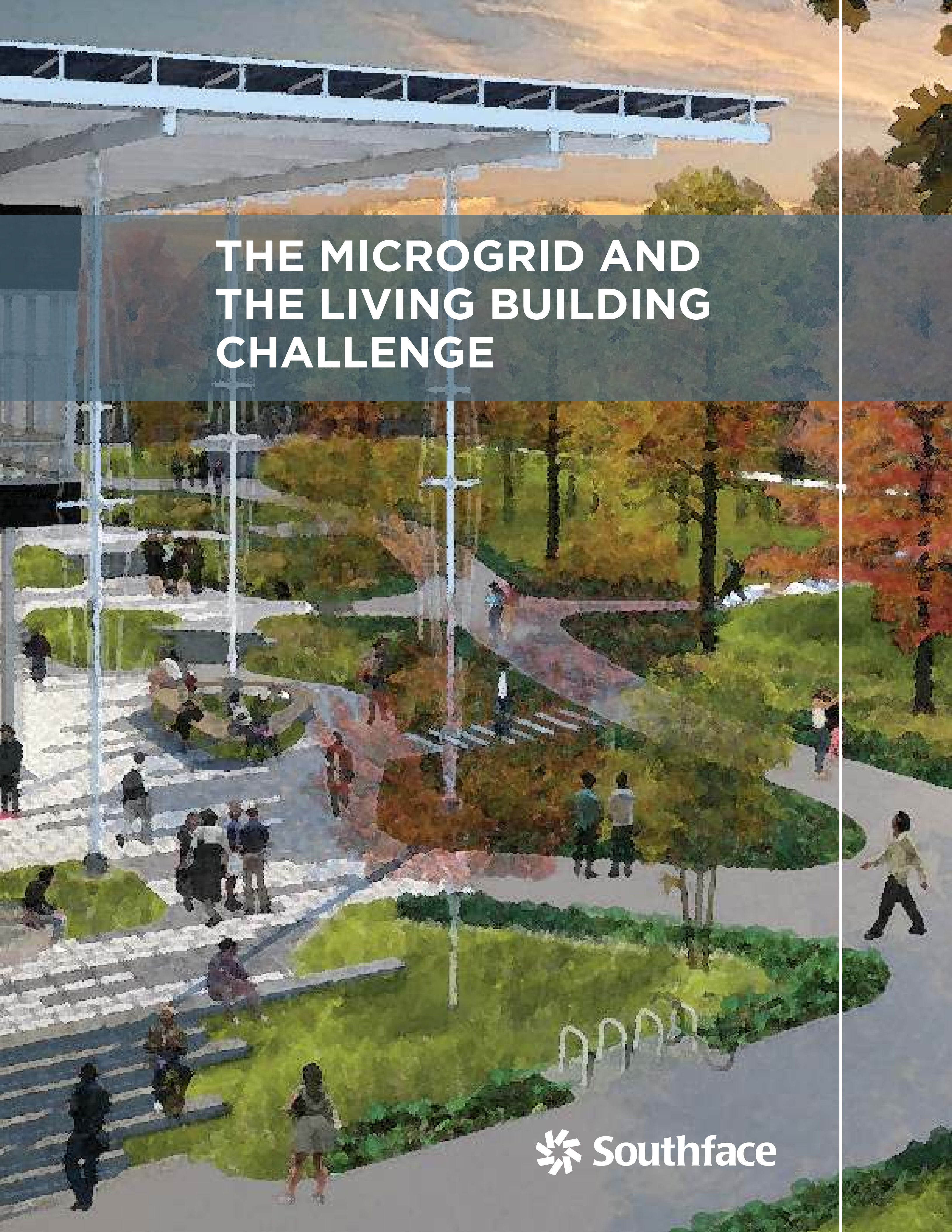
THE MICROGRID AND THE LIVING BUILDING CHALLENGE



Southface

THE MICROGRID AND THE LIVING BUILDING AT GEORGIA TECH

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LIVING BUILDING CHALLENGE 2.0

INTERNATIONAL LIVING FUTURE INSTITUTE

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The Southface vision is a regenerative economy, responsible resource use and social equity through a healthy built environment for all

THE MICROGRID AND THE LIVING BUILDING AT GEORGIA TECH

The Living Building at Georgia Tech will meet the requirements of the Living Building Challenge (LBC), an initiative of the International Living Future Institute (ILFI). The LBC is the most environmentally-beneficial and efficient standard in the building industry. As set forth by the ILFI the LBC provides a "regenerative design framework to create spaces that, like a flower, give more than they take."[1] Imagining the Living Building as a flower, the LBC outlines seven performance areas, or Petals:

- Place
- Water
- Energy
- Health & Happiness
- Materials
- Equity
- Beauty

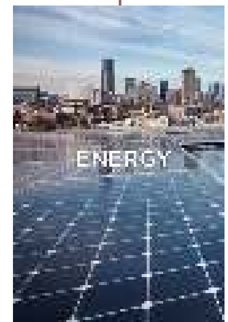
These seven Petals are further subdivided into a total of twenty Imperatives, each of which provides more detailed requirements focused on a specific area of influence. The Energy Petal, for example, includes a Net Positive Energy Imperative whereby "One hundred and five percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion."[2] This Imperative goes on to require an on-site energy storage solution as well.

The Living Building at Georgia Tech is a transformational project funded by a donation from The Kendeda Fund. It is intended to educate and inspire others to incorporate sustainability in modern architecture and to share the best practices and lessons implemented during the design and construction process. The building will include state-of-the-art technologies in water and energy savings and non-toxic materials, as well as showcase Georgia Tech's commitment to sustainability by incorporating transit connections, urban agriculture and many other aspects of a regenerative green building design.

The Living Building will be unlike any other building on the Georgia Tech campus, allowing for unique opportunities in education, community and industry outreach. Naturally, policy and advocacy questions have emerged from the project team. As part of a comprehensive response to The Kendeda Fund's goal of transforming the building industry in the Southeast, Georgia Tech is partnering with Southface, a leading visionary in sustainable design in the South, on six critical components of the LBC process:

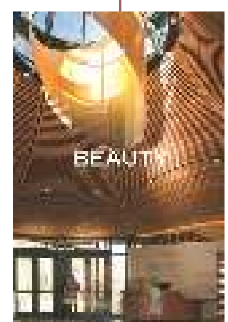
1. **Energy** – Evaluate financial incentives and key partnerships for solar and other renewable energy systems utilized for the project.
2. **Materials** – Assist in convening and with ongoing facilitation of an Industry Council to proactively work to change policy and market factors to encourage a materials economy that is non-toxic, ecologically regenerative, transparent and socially equitable.
3. **Water** – Support the work of Biohabitats and Georgia Tech in water policy research and discussions through attendance at key meetings with city, state, and / or regional governing bodies; consulting; and promoting the work done in water policy through this project.
4. **Communications** – Support the work of Georgia Tech, Southface, and other partners through identifying opportunities for engagement and publicizing selected opportunities.
5. **Education** – Evaluate the educational possibilities of this building from a design / programming standpoint and ongoing program opportunities.
6. **Equity** – Aid and support Georgia Tech in discussions around equity in the project; assist with evaluating options for the Equity Petal Imperatives.

This paper aims to explore and describe how the microgrid has the potential to play an innovative and pivotal role in addressing the Energy and Equity components of the LBC process. It also endeavors to highlight the potential of the microgrid in relation to another key aspect of the Living Building and the LBC process, Beauty.



Energy – The Energy Petal's intent is to encourage the exploration of the full potential of buildings designed to efficiently utilize renewable energy resources while advancing the use of technologies that sustain the importance of a safe, reliable and decentralized power grid. This paper will consider the Energy Petal by presenting research that addresses the role the microgrid can play in decentralizing and modernizing the power grid.

Equity – The Equity Petal seeks to establish that "we are all in this together" and to explore the role that built infrastructure can play in fostering an inclusive and restorative sense of community. Equity considerations in this paper will focus on the positive impact the public-purpose microgrid can have on communities vulnerable to energy insecurity, especially in the event of an unexpected or major power outage. Microgrids can educate communities about energy production and usage, enabling all citizens to engage more effectively with their energy needs and our energy system.



Beauty – The intent of the Beauty Petal is to reimagine the role beauty plays in conservation and preservation. The LBC recognizes beauty as a catalyst for caring, and for inspiring a better world. In this paper, the authors envision the Living Building's microgrid potential as a means to inspire those in the building to consciously visualize, connect with and appreciate the role localized energy generation can play in supporting more resilient communities.

It is important to note that scale jumping, or solutions beyond the project footprint, is also permitted by the LBC. This recognition that the ideal scale for solutions may extend beyond the boundary of the property invites one to consider the grid and the building's role in the surrounding community's energy system, which is an important consideration for both the Energy and Equity Petals. In an effort to contemplate the Living Building's ability to catalyze the microgrid conversation and further exploration of the microgrid opportunities at and around Georgia Tech this paper poses three key questions:

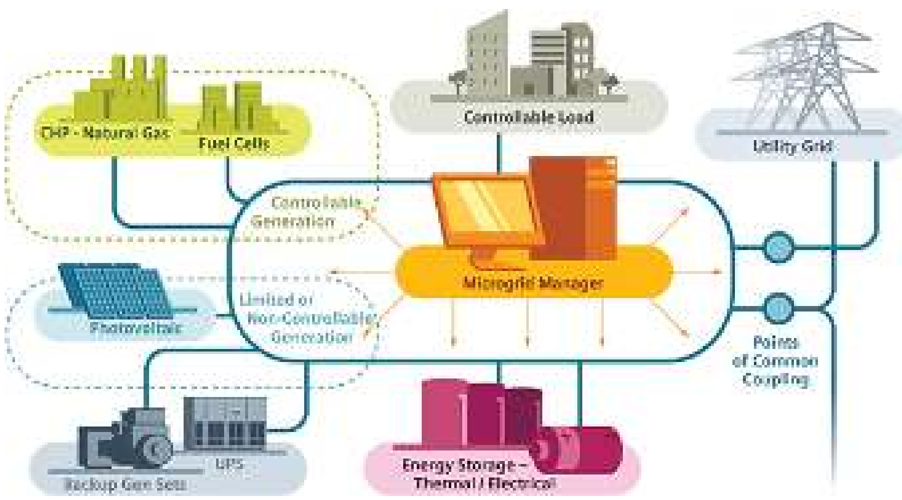
1. **Why consider it?** Could the Energy, Equity and Beauty Petals spark a new and more impactful conversation about the potential role of the microgrid in energy and community resilience?
2. **How could it work?** Are there relevant examples of operational microgrids elsewhere in the region or nation, supporting more resilient energy systems and communities?
3. **What next?** Could Georgia Tech and key partners conduct a feasibility study for campus or community microgrid development or expansion, involving the Living Building?

WHY CONSIDER IT?

A variety of factors including extreme weather events, aging infrastructure and cybersecurity continue to bring attention to the importance of electricity grid resilience. In recent years an innovative and emerging solution to these challenges has arisen in the form of the microgrid. Both literally and figuratively the microgrid may provide an opportunity to extend the sustainable, regenerative design embodied by the LBC and the Living Building at Georgia Tech far beyond the bounds of the building itself.

The Microgrid

While one may think of a microgrid in simple terms as a distinct portion of the electricity distribution system that is capable of maintaining power in the event of a broader power failure, interrelated clean energy technologies (e.g., energy efficient heating and cooling, distributed solar photovoltaics and energy storage) as well as integrated energy services (e.g., grid management software and intelligent load devices) have made the microgrid much more than that. Further, while the US Department of Energy defines microgrids as "localized grids that can disconnect from the traditional grid to operate autonomously" [3] GTM Research has revised this definition to describe the microgrid as "an independently operable part of the distribution network including distributed energy sources, loads, and network assets that are controlled within clearly defined geographical boundaries and can operate in grid-connected or islanded mode." [4]



Example Microgrid (Source: Siemens Smart Grid Solutions)

Within the context of the GTM Research definition and with the LBC as the catalyst, Georgia Tech has an opportunity to leverage its existing energy and electricity distribution infrastructure, in concert with its decades-old partnerships with Southern Company and Georgia Power amongst others, to be at the forefront of non-military microgrid assessment, evaluation and development in the state.

Striving for a New Age of Design

Electricity generation originated with locally harvested energy, where wood and then coal were the initial preferred fuel sources. The emergence of coal and other fossil fuels ultimately gave rise to locally consumed but more centrally produced energy, spurring the design and development of the current power grid. This shift in the energy system was foundational to the economic growth experienced during the first Industrial Revolution in the late 18th and early 19th centuries and is, in large part, the energy system that remains in place in the United States today. Changing economics, technological advancements and environmental considerations, however, continue to pave the way for a new revolution involving a further shift in the energy system – one that begins to recognize, once again, the benefits of locally harvested energy.

The origin and evolution of the power grid and today's electricity transmission and distribution system can largely be traced back to the beginnings of a centralized energy system with increasingly distributed consumption. Ultimately, it may also be attributed to the war of currents in the late 1880s, and the scientific battle over the advantage of alternating current (AC), developed by Nikola Tesla, versus direct current (DC), developed by Thomas Edison.[5] Looking to the future, rapid advances in energy and energy-related technologies are helping to spur the continued evolution of the transmission and distribution system of today toward the electricity grid of tomorrow.

The nation's aging electric infrastructure provides an opportunity to begin to embark on the redesign and modernization of the grid to "make it 'smarter' and more resilient through the use of cutting-edge technologies, equipment, and controls that communicate and work together to deliver electricity more reliably and efficiently [which] can greatly reduce the frequency and duration of power outages, reduce storm impacts, and restore service faster when outages occur."[6] Grid modernization in turn is influencing the on-going evolution of the utility business model toward one that includes renewable energy resources, battery storage and behind-the-meter products and services designed to meet consistently increasing levels of customer engagement.

While microgrid technologies and the microgrid market are still developing and in some cases maturing the outlook for growth remains strong. In its latest report "Market Data: Microgrids," released in the first quarter of 2016, "Navigant Research concludes that the 'energy technologies, networks, and business models that underpin' what they call 'the Energy Cloud are poised for major growth in the coming decades,' with the 'poster child for this shift to localised, resilient power systems incorporating diverse distributed energy resources' being the microgrid."[7]

The research and consulting firm, GlobalData, shares this view. According to one of their Power Analysts, "The deployment of microgrids facilitates dynamic energy management and the ability to protect critical loads. Microgrids combined with distributed generation are acting as a game-changer in the electricity distribution system, as network downtimes, natural disasters, and possible external attacks are increasing the need for grid-connected facilities to become more independent. Indeed, the negative impact of extended power outages on the economy is expected to be eased with the adoption of microgrids."[8] The past fifteen years have proven that a large-scale failure in the nation's energy system, and specifically the nation's electricity grid or transmission and distribution infrastructure, is a materially significant and highly disruptive event. History along the East Coast of the United States, and recent history in the Southeast, further confirm this observation.

The past fifteen years have proven that a large-scale failure in the nation's energy system, and specifically the nation's electricity grid or transmission and distribution infrastructure, is a materially significant and highly disruptive event.

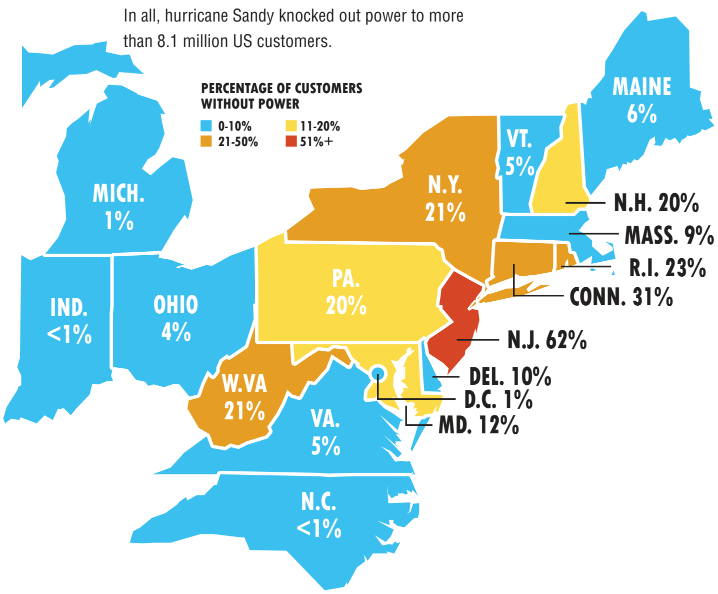
Lessons from History

Energy security for the United States and other nations has clear economic, environmental and health impacts. The past fifteen years have proven that a large-scale failure in the nation's energy system, and specifically the nation's electricity grid or transmission and distribution infrastructure, is a materially significant and highly disruptive event. In August of 2003 an isolated incident in western New York touched off a series of power failures and cascading blackouts in the eastern interconnection that left parts of Canada as well as eight states in the Northeast and Midwest without electricity. Major metropolitan areas including New York City, Cleveland, Detroit and Toronto went dark.

Aside from the estimated economic losses of approximately $6 billion,[9] communities and individuals suffered real impacts to their health and well-being. One individual reportedly collapsed and died at street level after walking down eighteen flights of stairs in an attempt to exit an office building. Additionally, emergency rooms were reported to have been flooded with patients suffering from heat-related ailments. There were also an unusual number of pedestrian related accidents reported due to traffic light outages.[10] Less than ten years later in October of 2012 Hurricane Sandy made landfall leaving more than 8.1 million people without power and more than 100 people dead.[11]

Power outages after Sandy

In all, hurricane Sandy knocked out power to more than 8.1 million US customers.



STATE	CUSTOMER OUTAGES
1.New Jersey	2,498,447
2. New York	1,967,874
3. Pennsylvania	1,267,512
4. Connecticut	626,440
5. Maryland	311,020
6. Massachusetts	298,072
7. Ohio	254,207
8. West Virginia	212,183
9. Virginia	182,811
10. New Hampshire	141,992
11. Rhode Island	116,308
12. Maine	90,727
13. Michigan	68,619
14. Delaware	45,137
15. Vermont	17,959
16. Indiana	7,537
17. North Carolina	4,005
18. District of Columbia	3,583

SOURCE: US Department of Energy

Figure 1: Power Outages After Sandy (Source: U.S. Department of Energy)

Four years after Sandy struck the Northeast Hurricane Matthew made landfall in the Southeast leaving more than 40 people dead[12] and plunging millions of people in the region into darkness. Florida Power & Light reported 1.2 million outages while Duke Energy reported 1.36 million people without power. In some cases these outages lasted up to a week after landfall.[13]

In response to events such as these and the anticipation of intensified weather fueled by changes in climate, large regulated investor-owned utilities (IOUs) in the United States continue to upgrade the transmission and distribution infrastructure. Many of the upgrades include physical modifications to reinforce the broader power grid, commonly referred to as "system hardening."[14] While these measures may be an effective way to increase the resilience of the grid, utilities are beginning to explore and demonstrate how the microgrid can play a cost-effective, key role in achieving the same.

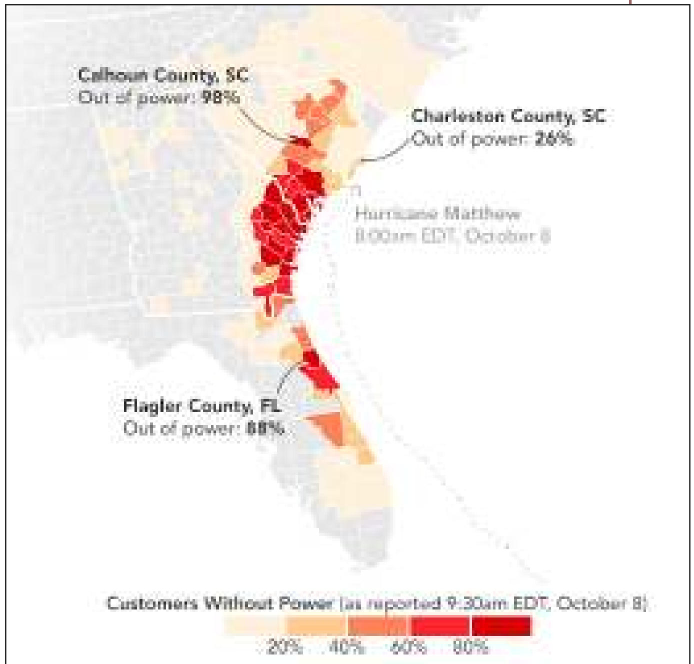


Figure 2: Hurricane Matthew– Customers Without Power (Source: NASA)

Extreme weather events and natural disasters intensified by climate change pose a significant risk of increased, large scale power system failures.

Closer to Home

Focusing specifically on the Southeast Hurricane Katrina in 2005 and Hurricane Matthew in 2016 might arguably be considered early warning signs for Georgia that should not be ignored. Extreme weather events and natural disasters intensified by climate change pose a significant risk of increased, large scale power system failures. Most recently Hurricanes Harvey and Irma have demonstrated and reinforced the magnitude of this risk to the state and region. Upon landfall in August-September 2017, each of these storms left millions on the U.S. mainland without power for prolonged periods of time.[15,16]

It is a long held and generally accepted principle that diversification minimizes risk. Today's fuel mix and generation technologies offer a significant diversity of electricity supply options, while the diversity of electricity transportation options remains limited. Microgrid systems in combination with distributed energy resources (DERs) such as electric vehicle (EV) charging equipment, distributed solar photovoltaic (PV) and energy storage[17] have significant potential to mitigate risk by introducing location-based diversity to previously centralized electricity supply options as well as transportation flexibility in the distribution of that electricity to the point or points of use. As a result they present a unique opportunity to improve the reliability and resilience of the electricity grid and the nation's aging energy infrastructure. In addition, by decreasing local distribution network energy loss through reductions in the distance between energy generation and energy consumption,[18] microgrid systems have the potential to increase efficiency while reducing emissions as well.

In many instances the microgrid is defined at the building level, where a specific and select number of buildings (energy demand or load) and associated generation assets (energy generation or supply) are interconnected. Extending this concept further, the microgrid can also be defined at the community level and designed more broadly to serve multiple buildings or facilities over a wider geographic area. Georgia and the City of Atlanta currently have no community-scale, publically available microgrids. This leaves residents and weather refugees who may come to Atlanta without access to the added energy security a microgrid may provide in the event of a larger system failure.

The City of Atlanta has a growing population of 5.8 million.[19] Including the number of hurricane evacuees who may travel to Atlanta during major storm events the City becomes a critical place of shelter for citizens in need. According to the Federal Emergency Management Agency (FEMA) 100,000 New Orleans residents evacuated to Atlanta during Hurricane Katrina[20] with just under 30,000 of these evacuees filing for aid as of September 23, 2005.[21]

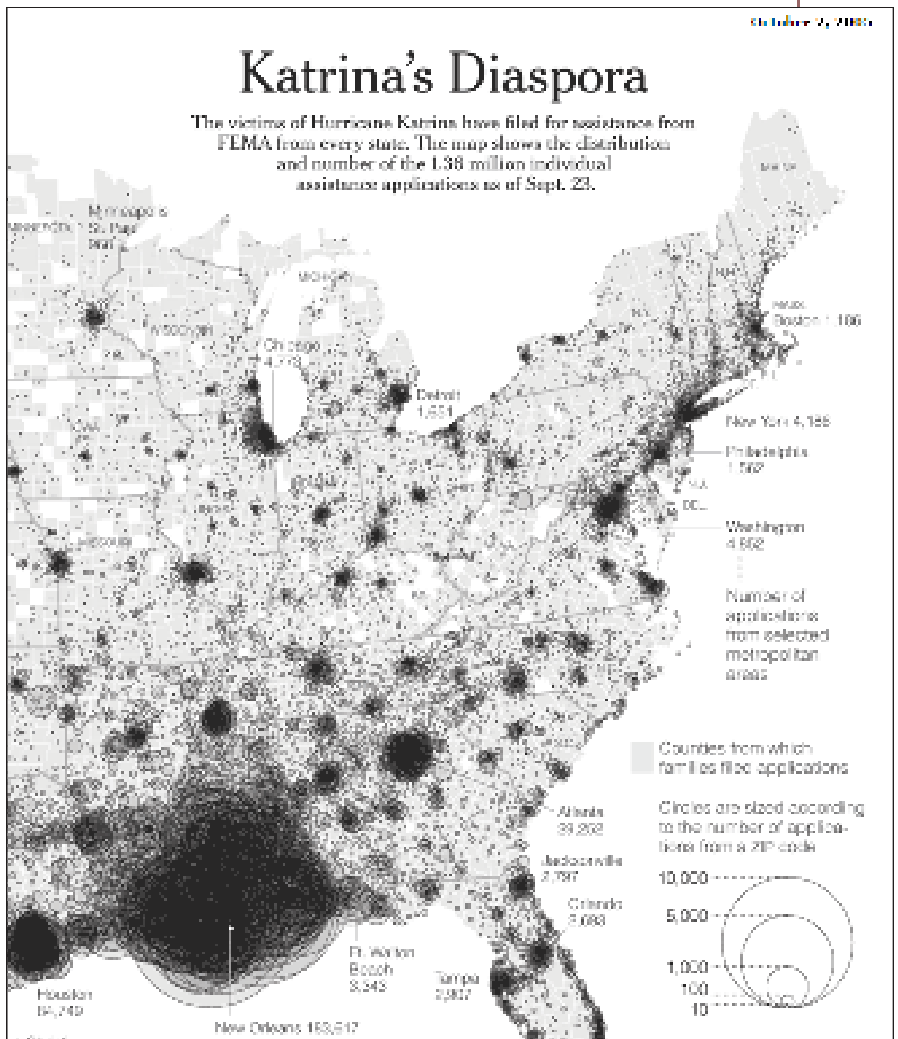


Figure 3: Katrina's Diaspora (Source: The New York Times)

Likewise, during Hurricane Matthew, Atlanta provided numerous residents of Southeastern coastal regions with shelter.[22] This trend appears poised to continue. Climate change in the Southeast is projected to cause heat stress, sea level rise, droughts,[23] unusually heavy rain events and intensified hurricane activity.[24] Recent storm events in 2017 have provided ample evidence of this. In the Gulf of Mexico, prior to Hurricane Harvey, scientists documented record high sea surface temperatures that did not drop below 73 degrees Fahrenheit during the previous winter.[25] Sea surface temperatures affect the formation and strength of hurricanes, as well as increase the amount of evaporation which can partially explain the unusually high downfall of rain.[26]

As most states in the Southeast have significant stretches of coastline along the Gulf of Mexico or the Atlantic Ocean, inland cities like Atlanta will continue to provide refuge for extreme weather evacuees. Although Atlanta is not directly impacted by rising sea levels, severe weather can and does impact the reliability and resilience of electricity distribution in the City through an increase in the number of storm-related power outages.[27] Against this backdrop the LBC enables the ability to envision a microgrid on the Georgia Tech campus that could double as a community microgrid when needed. Starting with the design and construction of the Living Building as microgrid-ready,[28] the LBC at Georgia Tech has the real potential to have a lasting impact not only on the future trajectory of energy reliability and resilience in Atlanta but also on the health, safety and well-being of Atlanta residents or others in need in the event of a larger system outage in the city, state or region in the years ahead.

Equity and Energy Access

The community microgrid is also sometimes referred to as the public purpose microgrid. The public purpose microgrid seeks to increase access to a more reliable, resilient electrical grid for a large number of people, and specifically those who are without energy security. Energy security as defined by the International Energy Agency means to have "uninterrupted availability of energy sources at an affordable price" and "the ability of the energy system to react promptly to sudden changes in the supply-demand balance."[29] Low income households or those with less than or equal to eighty percent of area median income are often defined as energy insecure. These households also have a high energy burden as they spend a greater percentage of their annual income to pay their utility bills than households identified as moderate or high income.[30]

Advocates for energy justice seek to increase the energy security of low income households, and lessen their energy burden. In this regard energy justice has an important role to play in supporting the value of the public purpose microgrid to the energy insecure, by identifying and highlighting the health and mental impacts of energy insecurity for "vulnerable populations like children, the elderly, and racial/ethnic minorities."[31] The public purpose microgrid presents the very real opportunity to connect critical energy infrastructure to vulnerable communities, enabling these communities to benefit from more equitable energy access in the event of a larger system failure or outage.

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HOW COULD IT WORK?

Compelling examples of the community or public purpose microgrid exist throughout the United States. These examples can be expected to increase as the electric utility industry continues to transform and innovative solutions like the microgrid continue to lead the way to an energy future that customers want. A future that is increasingly cleaner and more connected, with affordable and reliable electricity for all.

Connecting Neighbors and Neighborhoods

The Brooklyn Microgrid project[32] is one such example. It is community driven, served by Consolidated Edison (ConEd) and aims to "create a local energy network with a focus on:

- Working with community leaders, utilities and technology partners to identify the best fit for distributed energy resources and critical infrastructure upgrades
- Developing locally generated energy that provide resiliency for emergency needs of local communities
- Reducing customer costs and promoting clean, renewable electricity, energy efficiency and energy storage options within my community
- Managing these distributed energy resources for times of power outages and emergencies to protect my community and local economy
- [Identifying and creating] new financial incentives and business models to drive community involvement and jobs, boosting the local economy"[33]

Of note the transactions within this local energy network are underpinned by blockchain, a digital ledger where Bitcoin[34] is the currency.

In April 2017 at The Business of Blockchain conference, sixty-nine percent of consumers reported to Accenture, a technology consulting firm, that they were "interested in having an energy-trading marketplace."[35] LO3 Energy, an energy technology company, has introduced such a marketplace via the Brooklyn Microgrid project. Using blockchain the communities involved in the Brooklyn Microgrid project (https://www.brooklyn.energy/) can trade the energy they produce between neighbors and neighborhoods via an open source software platform called TransActive Grid.[36] Lawrence Orsini, the founder of LO3 Energy, hopes that blockchain and microgrid initiatives similar to the Brooklyn Microgrid will continue to push the utility business model to "evolve."[37]

Another example is the Chicago Bronzeville project. This initiative is being developed in partnership with the local electric utility, Commonwealth Edison (ComEd), and the local university, Illinois Institute of Technology (IIT). Together they will create the first microgrid cluster in the country.[38] IIT currently has a microgrid that will eventually share power with the microgrid in Bronzeville. This microgrid utilizes battery storage, natural gas, rooftop solar PV, wind generators and a control unit that monitors load data. IIT's microgrid has saved the university $1 million annually while also decreasing their carbon emissions by seven percent.[39]

ComEd's Chicago Bronzeville project will develop a cluster of microgrids in various areas to address diverse energy needs. The 12 megawatt (MW) microgrid at IIT will join the 10 MW microgrid in Bronzeville which will deploy solar plus storage and service 800 customers. The Bronzeville community was selected as the preferred community for the project largely because of its proximity to critical facilities like police headquarters and medical centers.

It is important to note that the Brooklyn Microgrid and Chicago Bronzeville projects are just two examples of the real potential of the microgrid. ConEd and the State of New York as well as ComEd and IIT are joining a number of other energy and utility companies, research institutions and local governments around the United States who are demonstrating increasing interest in the role microgrids can play in providing energy security for vulnerable communities and in powering critical infrastructure.

Connecting to the Broader Community

During Hurricane Sandy, Princeton University's microgrid system provided refuge from the storm for the surrounding community. While the rest of the area was without power, emergency services workers and community residents in need of warmth, electricity and wireless internet service[40] were able to benefit from Princeton's microgrid system. Princeton University's twenty plus year old microgrid is underpinned by a gas-turbine and a solar farm than can produce 15 MW of electricity.

After Hurricane Sandy New York City established a program to increase the development of microgrids in the state of New York. Microgrids are an important component of the state's Reforming the Energy Vision Strategy, which seeks to establish a more resilient and reliable electric grid that will run on 50% of renewable energy by 2030.[41] The aforementioned Brooklyn Microgrid project is conceived within this vision. While the political structure of Georgia differs from that of New York and different market as well as policy pathways will need to be explored to advance the development of non-military microgrids in the state, the importance and potential of the community or public purpose microgrid still stands – it creates the opportunity for increased grid efficiency, flexibility and resilience as well as the potential to provide electricity to those who need it most when the conventional grid cannot.

Leveraging the LBC at Georgia Tech to spur a conversation about the design and development of a broader campus microgrid could benefit both the university and the Atlanta community in the event of a major power outage due to Georgia Tech's breadth of facilities and proximity to critical infrastructure (hospitals, major highways and other universities). Georgia Tech also has the potential, through the inspiration and imperative of the LBC, to explore the development of a community or public purpose microgrid that could extend to the surrounding area and enable energy resilience for adjacent communities of mixed income.

Connecting to the Beauty of Energy

Through the exploration of the microgrid and the microgrid potential of the Living Building at Georgia Tech, the LBC also presents a unique opportunity to facilitate a deeper understanding of energy interconnections through architecture, and to connect its occupants with energy creation, distribution and use. Could the Living Building be designed to build awareness of clean energy sources and clean energy infrastructure through provision of its on-site solar energy and storage system? Perhaps the building can provide its occupants with the ability to explore clean, resilient energy interconnections by making its electrical systems more visible and explaining these aspects of the building mechanics through interpretative displays set against the backdrop of its microgrid potential.

According to Michael Faraday, a 19th century British scientist in the field of electromagnetism and electrochemistry, "Electricity is often called wonderful, beautiful; but it is so only in common with the other forces of nature. The beauty of electricity or of any other force is not that the power is mysterious, and unexpected, touching every sense at unawares in turn, but that it is under law, and that the taught intellect can even govern it largely."[42] The Living Building has the unique potential to raise awareness of electricity, and reintroduce the beauty of electricity, to all those who pass through its doors. Electricity is fundamental to our modern society, yet many are unaware of how energy is generated and distributed. The generation of electricity and transport of electrons into our homes, offices, appliances and devices can be put forth as something beautiful and intersected with architectural beauty as a means to educate and connect people to this centrally important underpinning of our modern economy and society – energy.

The Living Building has the unique potential to raise awareness of electricity, and reintroduce the beauty of electricity, to all those who pass through its doors.

Perhaps allowing visitors to the Living Building to see energy from the perspective of its creation, transport and storage as well as its consumption could allow for a more compelling conversation to take root about electricity and its role in a sustainable future. Coupled with an interpretive explanation of the building's microgrid potential individuals of all backgrounds could understand and engage with energy in new ways. How can electricity be generated from different sources and distributed or stored in a building or buildings for different uses? How does that distributed energy system manifest itself in and across buildings, facilities and a community? Microgrids can connect buildings able to self-generate with those that are not; microgrids can power critical facilities and keep the lights on locally when they would otherwise go out; and this is just the beginning of the conversation.

WHAT NEXT?

While the design, development and deployment of a microgrid is a complex undertaking that is not without its challenges further examples of microgrid projects elsewhere in the country have demonstrated that none of these challenges are insurmountable. Additional examples of established or in progress microgrid projects include:

- Alabama Power Company's "Smart Neighborhood" – Birmingham-area community microgrid powered by a community solar garden, local battery storage and backup generation.[43]
- sonnenCommunity[44] – Phoenix-area community microgrid in Arizona featuring a network of rooftop solar PV and on-site battery storage systems.[45]
- Dell Children's Medical Center – Texas-based critical facility combined heat and power microgrid in partnership with Austin Energy.[46]
- New York University – Campus microgrid with an output capacity of 13.4 MW using 5.5 MW gas turbines and a 2.4 MW steam turbine.[47]
- University of California at San Diego – Campus microgrid provides electricity through solar plus storage, a fuel cell and a cogeneration plant.[48]

Real and Perceived Challenges

Each of the microgrid projects mentioned has a lot to offer the customer, the community and the utility. Consumers can take more control of their energy consumption and costs through improved access to their own data. The community can gain access to more reliable and resilient energy infrastructure for critical facilities as well as area homes and businesses. Utilities can take an innovative approach to grid modernization while at the same time working to capture the benefits of improved energy security, increased integration of renewables and DERs, and the opportunity to reduce peak loads as well as lower operational costs.

While changing market conditions and rapidly evolving energy systems technologies continue to drive the exploration and implementation of the microgrid forward in regions across the country policymakers must continue to "play a vital role in accelerating the development and deployment of microgrids by removing obstacles that are often the result of outdated regulatory models."[49] The "Smart Neighborhood" now under construction in Alabama is evidence of this, and the key role policymakers must play in enabling local utilities and their partners to move forward with innovative community microgrid projects. This bold move by Georgia's neighbor and a sister utility of Georgia Power are promising. The timing is right for the Living Building at Georgia Tech to play a part in inspiring, and perhaps being part of, the same.

Policymakers must continue to "play a vital role in accelerating the development and deployment of microgrids."

Understanding that a broader campus or community microgrid may be beyond the reach of the current scope and timeline for the Living Building at Georgia Tech the microgrid is nonetheless an important consideration within the overall effort and intent of the LBC to design for the future. Multiple signs continue to point to a decentralized energy future with the microgrid expected to be a key ingredient in the growth of DERs.[50] Given the solar PV and storage elements of the Living Building's design the opportunity if not the need to take future microgrid considerations into account is a compelling one.

The National Renewable Energy Laboratory published a fact sheet titled *Microgrid-Ready Solar PV* describing important planning considerations for such projects, including but not limited to inverters, system supervisory controls, energy storage equipment and communications cabling.[51] Other forward looking project planning considerations may include a local area microgrid feasibility or suitability study, whereby the microgrid potential of the Living Building in conjunction with the neighboring buildings, energy assets and critical facilities in and around the university community would be assessed.

Evaluating the Landscape

Examples of existing energy assets on the Georgia Tech campus include but are not limited to 614 kW of solar PV spread across multiple buildings and facilities[52] as well as the natural gas powered Holland Plant.[53] The Living Building will add to this portfolio. It is also the authors' understanding at the time of writing that a campus microgrid is actively being developed around the CODA building and the Georgia Tech Hotel and Conference Center. As a leading research institution with existing energy assets and established energy infrastructure the university is extremely well positioned to consider a broader, future microgrid that includes and leverages the Living Building.

Georgia Tech's strategic partnerships with key utility, energy and cleantech industry players as well as strength of thought leadership further support this positioning. One need only look to the Center for Distributed Energy,[54] Strategic Energy Innovation Center[55] and National Electric Energy Testing Research and Applications Center[56] for examples of the University's demonstrated track record of energy innovation. With so many of the key ingredients already in place all that is needed to prompt the further exploration of a broader campus or community microgrid project is a spark – a spark the LBC and the Living Building at Georgia Tech are uniquely poised to provide.

It is important to note, however, that the opportunity to design and develop a campus or community microgrid is not Georgia Tech's or the Living Building's alone. It is also a tremendous opportunity for the local electric utility, in this instance Southern Company and Georgia Power, to take an active role in partnering with a leading research institution in the Southeast to explore the future of the electric grid and electricity distribution systems innovation. The microgrid has the real potential to become a critical component of the utility's ability to innovate and provide ancillary services at the grid edge as it seeks to explore[57] and implement new business models[58] for a distributed energy future.

Coupled with the broader campus and community benefits contemplated earlier a microgrid spurred by the LBC has the opportunity to provide a much needed win-win scenario in the State's current energy and energy policy landscape. Georgia Power can bolster its already strong track record of serving the customer and the community by providing a reliable, safe supply of electricity in a rapidly evolving world[59] while partnering with Georgia Tech and others to play a leadership role in the national effort to mitigate emerging threats to our energy infrastructure such as those posed by a rapidly changing climate[60] and continuing geopolitical uncertainty (e.g., cyberwarfare).[61]

Continuing the Conversation

The ILFI and the LBC envision making the world a better place through regenerative, sustainable design. Extending these principles beyond the Living Building to a broader campus or community microgrid could provide the opportunity to deliver on both the promise and potential of the LBC across the Energy, Equity and Beauty petals as considered in this paper. It could also spur a timely conversation with the local electric utility, policymakers and the Atlanta community about the future of our energy system in Georgia. Through the LBC the ILFI, The Kendeda Fund and Georgia Tech have planted the seed of a flower that will blossom on Georgia Tech's campus as the Living Building. With care and attention this flower has the potential to fulfill the Energy, Equity and Beauty Petal imperatives and to embody the principles needed to inspire future innovators and leaders in sustainable design in both the built environment and across our energy landscape.

Revisiting the three key questions posed at the outset:

1. **Why consider it?** To ignite a conversation around the microgrid as an important enabling component of energy, equity and beauty in the built environment.
2. **How could it work?** To learn from others, draw from knowledge and experience, and expand as well as leverage existing partnerships among established thought leaders in the Southeast.
3. **What next?** To continue the journey initiated by ILFI and The Kendeda Fund through the consideration of a new or expanded microgrid inspired by the LBC at Georgia Tech.

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