Islands of Light:

Microgrids and Fracturing a Public Good

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Master of Environmental Policy and Planning 2018

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ABSTRACT

Climate-linked extreme weather events, aging infrastructure, and structural underinvestment contribute to increased vulnerability of urban populations to crises from interrupted electricity service. Microgrids – small-scale geographic "islands" of more resilient energy systems – present a technical solution to energy vulnerability. But energy planning is a socio-political process alongside a technical one, and while microgrids may create more resilient energy for some, they may further exacerbate cities' structural and spatial inequities. Discourses on energy democracy identify a democratic alternative to the existing socio-technical institutions that govern energy infrastructure. Inclusive, participatory planning processes present an opportunity to build resilient energy systems that work for the benefit of all.

On Thursday, January 4, 2018, the "bomb cyclone" storm system hit the East Coast of the United States, bringing high winds and heavy snowfall to a region already contending with a record-breaking cold spell. The storm wreaked havoc on the region's electricity grid. Almost 80,000 households and businesses lost power, and Massachusetts' only nuclear power plant was forced to shut down.[1] The power plants that stayed online ran dangerously low on fuel oil reserves. Without heat or light in the middle of a winter storm and record-low temperatures, Boston households faced crisis until authorities restored the state's power grid. Emergency shelters hosted families who would go without electricity for days after the storm.

Massachusetts residents' predicament in early January 2018 demonstrates the fragility of our electricity grid in the face of extreme weather events. It also highlights the critical role that a reliable and resilient supply of energy and electricity plays in our lives. Access to the services provided by electricity – refrigeration, lighting, and heating – define our contemporary lives, and even temporary outages or unstable supply can have far-reaching consequences.[2] As our working lives integrate more deeply with the digital world, our electricity infrastructure has transformed from what was once merely a medium for conveying energy services to an essential conduit to the outside world.[3] Our energy infrastructure provides an increasingly critical public good, but it faces growing exposure to disruption and interruption. At the outset of the 21st century, our grid is due for a transformation.

Transformation presents an opportunity to rearrange how our electric system distributes goods and services, but it also carries the risk of exacerbating the inequities of the current system. This essay identifies one potential way the grid is transforming – through microgrids – and illustrates how microgrids threaten to fracture a public good into a patchwork of grid technologies providing disparate levels of service and augmenting currently existing inequalities. First, I explore the critical nature of energy services and the challenges facing the grid of the 21st century. Second, I introduce microgrids as a potential technical solution. Third, I summarize the emerging discourse that identifies and problematizes status-quo development and point to new paradigms for understanding energy services.

RISKS TO ENERGY SECURITY: CLIMATE-DRIVEN EXPOSURE, MARKET-DRIVEN SENSITIVITY

As a warming world increases the incidence of extreme weather events, communities need to understand the exposure of their critical energy infrastructure to wind, waves, and rain. Recent history provides stark portraits of the sensitivity of our energy systems. Hurricane Sandy's 30-foot swells plunged lower Manhattan into darkness, doing $75 billion of damage[4] and leaving a permanent physical and psychological mark on the city.[5] The crippling, comprehensive, and ongoing outage in Puerto Rico post-Hurricane Maria has catalyzed a massive exodus from the island.[6] Damage to energy infrastructure has become shorthand for understanding the human impact of extreme weather (Figure 1). Like many climate risks, the threats and damages of power outages disproportionately affect marginalized communities least able to adapt to them.[7] Puerto Rico's long ongoing recovery after Hurricane Maria demonstrates that risks to energy infrastructure may be no different.

The risks posed by climate change and extreme weather events compound the structural and economic challenges

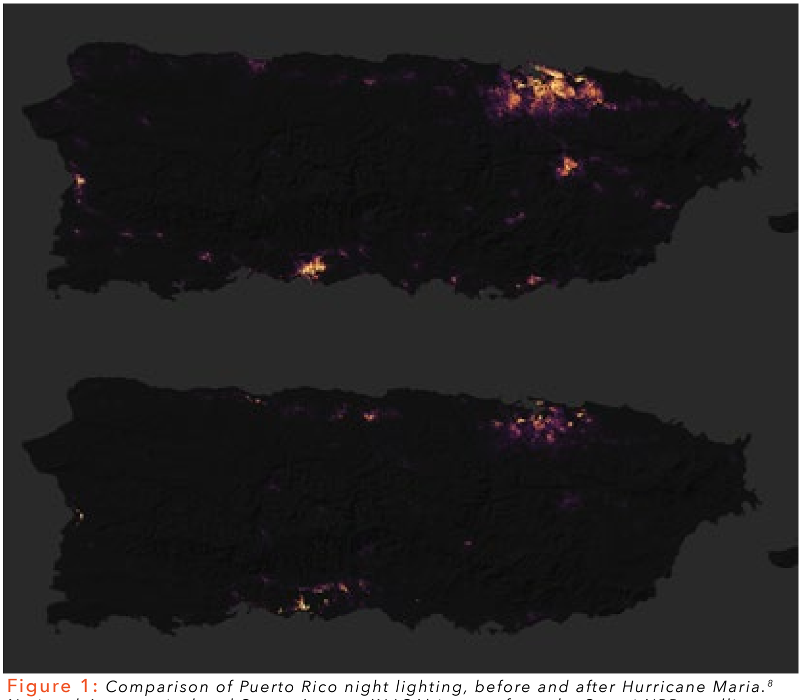

Figure 1: *Comparison of Puerto Rico night lighting, before and after Hurricane Maria.[8] National Aeronautical and Space Agency (NASA) images from the Suomi NPP satellite show the scale of blackouts post-Maria. The top image shows Puerto Rico's nighttime lighting before Hurricane Maria; the bottom image shows nighttime lighting after Hurricane Maria, on September 27-28, 2017.*

that have gripped the way electricity is generated, transmitted, and consumed in the United States. Even before climate impacts have taken full effect, the United States' aging infrastructure causes more blackouts than in any other country in the developed world.[9] As alternatives like solar power lead an increasing number of households to invest in their own power and opt out of the public grid, funds have become tighter for those urgent upgrades. The result has been dubbed the "utility death spiral."[10] Utilities must raise prices to cover their costs, thereby driving more customers away and fueling even higher prices.

Increased utility prices will hit urban, low-income, marginalized, and racial minority communities the hardest. Although these communities do not have substantially different energy practices than their more affluent neighbors,[11] they pay a higher portion of their income toward energy bills and are more likely to fall behind on payments.[12] Recent research on the lived experience of energy insecurity shows that households under a high energy burden suffer negative impacts to their social, physical, and psychological wellbeing.[13]

Climate hazards, aging infrastructure, and a diverse set of vulnerabilities characterize the city's energy landscape. At the same time, cities are uniquely situated to respond to growing energy instability. Urban energy provision retains the collective, networked nature of the grid, but the smaller, denser urban scale allows for the implementation of more precise policies and programs. Cities also wield unique political agency within regional energy policy regimes.[14] Resilient communities and cities must provide an electricity system that meets the needs of its citizens equitably, efficiently, and effectively, and mitigates these rising risks to energy security.

MICROGRIDS: A TECHNICAL SOLUTION TO A SOCIAL PROBLEM

Technology already exists to mitigate the risks to energy security. Microgrids – self-contained systems of power generation, transmission, and load – hold resiliency benefits because they are able to function even when the larger grid is down, or in some cases help to regulate the macro-grid.[15] In effect, they are "islandable," self-sustaining grids, which lends extra resilience to regional disruptions brought on by extreme weather events or breakdowns of the surrounding infrastructure. Microgrids can leverage that steadiness to provide stabilizing service to the surrounding grid, potentially reducing electricity prices, especially for those within the domain of a microgrid.[16]

Today, over 1,900 microgrids exist in the United States.[17] In New York and throughout the country, Hurricane Sandy's impact on New York has precipitated a new approach to resiliency and a commitment to resilient energy systems.[18] Groups in Puerto Rico are urging grid rebuilders to turn toward microgrids, which promise to serve electricity at half of the utility's retail rate and bring electricity to rural communities who previously could not afford access.[19] Industry analysts predict that the 3,000 megawatts of microgrids already on the ground in the United States will double in five years.
Ultimately, social and political institutions shape how new technologies emerge

in the world and how value is distributed across stakeholders. New energy infrastructure, no matter how innovative, is still shaped by those institutions. High-quality energy infrastructure tends to reflect the landscape of privilege in urban spaces, appearing most frequently in white and upper-income blocks, neighborhoods, and zip codes.[20] Who is included in "islands" of light and who is kept in the dark? Disparities in access to secure energy are invisible until energy is desperately needed. When Hurricane Sandy turned off the lights in New York, the city became two separate half cities – "one rich in power, the other suddenly, stunningly impoverished."[21]

A FRACTURED PUBLIC GOOD, AND WHAT'S NEXT

Selective deployment of microgrids creates "premium" networked spaces of privileged access to a public good. Delineations of light through urban microgrids represent and reinforce a "splintered urbanism" that stratifies the experience of the city by race, place, and class.[23] To the extent that microgrid technologies divert investment from the broader energy system toward privileged spaces, they threaten to fracture the public utility grid, providing reliable energy for those within the microgrid but second-rate services to those without. At a time when the grid is on the brink of transformation to cheap, available, and distributed renewable energy and high-quality electricity could be available to everyone, microgrid deployment might further exacerbate differences in energy security.

New problems, solutions, and tensions require new languages. A growing discourse is mobilizing "energy democracy" as an "integration of policies linking social justice and economic equity with renewable energy

Figure 2: *Power Outages after Hurricane Sandy, New York City, 2012.*[22]

transitions."[24] Energy democracy discourse allows for an imagination of an alternative form of energy provision characterized by self-determination and equity instead of technocratic, inaccessible decision making.[25]

Renewable-powered, grid-connected microgrids are still relatively immature technical interventions outside of hospitals and military applications, so current regulatory and planning regimes do not directly address enhancing microgrid deployment. Further, the regional scope and technical nature of energy infrastructure planning confines discussion of problems and solutions into "largely techno-economic" modes of thinking.[26] Energy democracy discourse, however, provides directions for new policies. Energy infrastructure could be integrated into other urban planning proceedings (e.g., housing, water, waste management). Microgrids and renewable energy projects could be included in plans for housing retrofits and updates. Cities could engage with their citizens through participatory, community-driven policymaking procedures.[27] In Chile, where the national government triggered a revision of its energy policy in 2014, participatory planning has taken center stage. The process is still in an early stage, but initial proposals reflect a commitment to communities' assets and concerns.[28] Communities face substantial challenges in achieving resilient energy systems, and planning for a highly uncertain future requires innovative approaches and paradigms. Energy provision will be an essential component of increasingly connected and electrified communities of the 21st century. While technologies for building resilient power systems are emerging, they may further reinforce existing inequities in our energy systems if they are not planned for and implemented appropriately. As historian Timothy Mitchell wrote, "The building of solutions to future energy needs is also the building of new forms of collective life."[29] Societies interested in building vibrant, equitable communities should design their energy systems to match. ■

ENDNOTES

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