Establishing Modern Grid Resilience in the Southeast United States

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Executive Summary: The electric grid plays a crucial role in the functioning of American households, schools, businesses, and health facilities, as well as national security. Action is needed to address the vulnerability of the grid to natural disasters, which are increasing in frequency and intensity due to climate change. States that are particularly under threat include those in the Southeast, such as Louisiana, Mississippi, and Florida, where hurricanes and severe storms can be especially destructive. States in this region also typically rely on natural gas as a primary source of energy, which upholds a centralized grid structure that is more susceptible to widespread power outages than a distributed structure. Power outages, which disproportionately impact low-income communities, can be detrimental to health and safety during a natural disaster by severing access to communication and necessary medical equipment. Using Louisiana as a case study, we recommend one policy through which the state can transition to a more distributed structure; the Louisiana Public Service Commission should revise the 2019 legislation that financially disincentivizes customers to install solar panels, and instead expand the benefits for these customers. This change will increase the proliferation of solar energy, which can serve as power sources in a distributed grid. Solar panels, coupled with battery storage, can reduce the likelihood of power outages during extreme weather events. Expanding the use of renewable energy in Louisiana could encourage other states in the region to also make this shift, serving as a model for stronger climate adaptation across the country.

I. Statement of Issue

The United States relies on the electric grid to deliver power to homes, businesses, schools, hospitals, and military bases, connecting approximately 145 million customers across the country (U.S. EIA 2016). However, the grid remains outdated, with 70% of transmission lines and power transformers over twenty-five years old (Gerrity and Lantero 2014), making them susceptible to damage caused by the increasing frequency and intensity of natural disasters due to climate change. The U.S. has endured more than double the number of billion-dollar disasters from 2010-2019 than in the previous ten-year period, after adjusting for inflation (Smith 2020). Disasters, which include flooding in the Midwest, wildfires in the West, and hurricanes in the East and Southeast, have resulted in losses of $25 to $70 billion annually (U.S. DOE 2013). The vulnerability of the grid to extreme weather events calls for action to modernize its infrastructure and build its resilience to climate change.

This manuscript focuses on Louisiana whose proximity to the Gulf of Mexico and high poverty rate relative to other states make it particularly at risk to the increasing frequency and intensity of tropical cyclones as a consequence of climate change (USDA 2019; Kossin et al. 2020). Severe storms such as

Hurricane Katrina (2005) and Hurricane Harvey (2017) have caused major disruptions in the electricity delivery of the state. In the aftermath of Hurricane Laura, the state's most recent major hurricane, 270,000 residents of Louisiana remained without power for a week after the storm; 1,100 miles of line, 9,760 poles, and 3,700 transformers were taken out (Pulver & Guidry 2020). As recently as February 2021, unprecedented winter storms led to an accumulation of ice on power lines, damaging the state's electric system and leaving 131,000 individuals without power (Entergy 2021). Power outages impair the functionality of households, businesses, hospitals, and military bases, resulting in safety hazards and economic loss (Anderson & Bell 2012). Low-income households and communities of color are disproportionately impacted by power outages for many reasons including: lesser means to evacuate before a disaster, lack of backup power generators, and a prevalence of health issues that require electricity-dependent durable medical equipment compared to higher income communities. (Chakalian, Kurtz, and Hondula 2019; Yabe and Ukkusuri 2020; Casey et al. 2021).

The electric system also has a key role in the nation's security, as the Department of Defense is dependent on the grid to sustain training and operations (Pellerin 2011). Severed access to electricity expends resources on power restoration and endangers mission preparedness. As Louisiana is home to four military bases, the increasing frequency of hurricanes poses a risk to federal defense operations (Dickstein 2020).

The current structure of Louisiana's electric grid depends heavily on large natural gas plants for energy production, and transmission wires to deliver power to consumers. This type of grid structure is known as centralized (NCSL 2021). Therefore, one downed line can lead to tens of thousands of residents losing power (Tong 2016). As of December 2020, Louisiana natural gas plants accounted for 73% of the state's electricity generation compared to 4% from renewable sources (U.S. EIA 2021). Renewable sources, such as solar, can produce small amounts of power compared to natural gas plants, but are typically placed at many more locations (i.e. residential and industrial roofs). This type of grid structure is known as distributed (U.S. DOE, n.d.), and is less reliant on transmission lines for immediate power delivery to a consumer. The use of a distributed grid that utilizes renewable energy sources can also reduce carbon dioxide (CO_2) emissions in the long term (U.S. EPA 2021). Louisiana's susceptibility to power outages presents a challenge and opportunity to modernize its grid. Grid modernization will increase the resilience of communities, particularly those that are non-white and/or socioeconomically disadvantaged, to extreme weather events, and allow the state to become a model for change across the Southeast U.S.

II. Policy Options

i. Option 1: Maintain the status quo

Louisiana's grid is owned and operated by utility companies such as Entergy Louisiana (Entergy 2020). Currently, these investor-owned utilities perform equipment construction and maintenance. If maintenance is not carried out, degraded equipment can fail and lead to outages, especially during severe storms. Additionally, degraded equipment increases energy lost in transmission between power plants and consumers. In total, around 5% of generated electricity is lost in transmission in the U.S. (U.S. EIA 2021). Recent equipment upgrades in Louisiana have focused on the construction of substations and transmission lines with reinforced voltage wires, or the replacement of protective relays and circuit breakers (Kovaleski 2019). Utilities favor investments in these conventional upgrades because they can increase rates charged to consumers and utility companies therefore recoup the costs of updating infrastructure to earn additional profit (Giroaurd 2019; Masterson 2020). Entergy Louisiana, for example, spent $100 million on grid investment projects from 2018 to 2020, rebuilding and constructing lines, with plans to invest $4 billion more throughout 2021.

Advantages:

- Updates of infrastructure can mitigate outages, economic losses, and losses of critical loads (e.g. military bases, hospitals, dialysis clinics, and shelters) during extreme weather events (Gridwise Alliance 2013).

- Increases energy efficiency, which can decrease CO_2 emissions.
- No significant reduction in employment, as the natural gas and oil industries in Louisiana accounted for 249,800 jobs, or 11% of non-farm private jobs in 2019 (ICF 2020).

Disadvantages:

- Discourages investment in grid planning and targeted deployment of technology beyond substations and wires that can lower costs for consumers and meet location-specific needs (Umoff 2018).
- Updates are made at the discretion of the utility and may not result in long term grid resilience.
- Costs of large-scale infrastructure projects are spread to consumers, who may not benefit from them.

ii. Option 2: Institute Energy Efficiency Resource Standards (EERS) to update infrastructure

While infrastructure updates must be made by private utility companies, they can be incentivized with EERS, a set of state-designed policies to achieve energy savings (ACEEE 2021). EERS could be implemented by the Louisiana Public Service Commission (LPSC), a regulatory agency that adopts and enforces regulations for most utilities in the state (ACEEE 2020). In 2020, Louisiana ranked 45th of states in the U.S. for effectiveness of efficiency related policy, which can be improved with EERS (ACEEE 2020). EERS incentivize technologies and programs to make consumers more efficient electricity users. Examples of these demand side updates include appliance rebates and more efficient lighting. However, there is the additional possibility to meet EERS goals by updating equipment on the production side. Minnesota, for example, has instituted EERS that incentivize utilities to enhance their generation, transmission, and distribution infrastructure to save energy (ACEEE 2021). Instituting EERS in Louisiana that are implemented on the demand and production side could contribute to energy savings and modernize the grid.

Advantages:

- Demand side programs reduce energy usage, offsetting the need for more power generation (American Efficient 2019).
- On the production side, utilities are incentivized to update grid infrastructure that may not be carried out if EERS were not in place.
- Similar to the advantages of Option 1; production side equipment updates can decrease power outages and increase the resilience of critical loads during a disaster.

Disadvantages:

- Similar to the disadvantages of Option 1; if Louisiana focuses on conventional infrastructure updates to meet EERS, the state could experience further lock-in to the existing centralized grid structure, and utilities spreading costs of projects to consumers.

iii. Option 3: Restore net metering benefits

Distributed grids are often used to reduce grid failures and downtime associated with its repair. Solar energy is an example of a renewable source that can be incorporated into a distributed grid through rooftop solar panels. In Louisiana, a shift to a distributed grid by incorporating solar energy would require regulatory changes such as expanding net metering, a mechanism by which solar energy system owners are credited for excess energy generation. In 2019, the LPSC reduced consumer benefits for net metering, significantly decreasing the financial incentive for consumers to install rooftop solar panels (LPSC 2019). Under this policy, customers are credited at a minimum rate for excess energy they produce. However, they also pay the utility the full retail rate for energy consumed. These changes allowed Entergy Louisiana to pay only $1.66 million in net metering benefits to consumers between 2008 and 2014, a small share of the company's $849 million in revenue in 2018 alone (Lane 2020). Prior to 2019, LPSC's net metering policy, which could be reinstated, required customers to only pay the retail rate of the net energy produced.

Advantages:

- Distributed grids, in which the distance from energy source to consumer is shortened, decrease the risk of power outages, especially for critical loads during extreme weather events (U.S. DOE 2019).
- Solar panels can withstand hurricane-level damage (Zientara 2021).
- Allows large-scale generation systems to avoid ramping up during peak hours (Mishra and Palanisamy 2018).
- Reduction of CO_2 emissions (Pratt 2010).
- With fewer projected grid-related failures in distributed systems, utilities can purchase insurance with less service interruption coverage and reduce the costs passed onto customers (Grosberg 2018, International Risk Management Institute, n.d.).
- Can lead to greater public awareness of energy savings (Schwaegerl 2013).
- A distributed grid lends itself to the targeted deployment of advanced technologies such as sensors, that can meet location-specific needs. This contrasts with a centralized grid, where utilities have limited knowledge of customer needs in a given location due to the abundance of transmission lines (Horowitz 2019).

Disadvantages:

- Solar power must be stored in a battery to supply energy to a household or business during a disaster because solar panels shut off during outages to prevent electric shocks to maintenance workers (Kuznia 2021).
- Could result in lost revenue for utilities as consumers are able to generate electricity locally.
- Increase in lobbying pushback from utilities would be expected (Kowalski 2020).
- Cost shifting may occur, where solar customers do not pay the full cost of grid operation and shift the cost to non-solar customers (Lane 2020).

III. Policy Recommendation

We recommend the Louisiana Public Service Commission adopt *Option 3: Restore net metering benefits* by revising the 2019 changes to net metering. These changes were said by the LPSC to resolve cost shifting and lost revenue, both of which have not materialized in Louisiana since the amount of solar is almost negligible. Studies have shown that even as solar increases, cost shifting and lost revenue are unlikely to become significant problems for non-solar customers and utilities (Barbose 2017). Increasing solar energy would lead to a more distributed grid, which decreases the risk of power outages and reduces CO_2 emissions. Additionally, the reduction of CO_2 emissions is in line with Louisiana Gov. John Bel Edwards's May 2021 announcement to invest in renewable energy and make the state carbon-neutral by 2050 (John Bel Edwards, Office of the Governor 2021).

In order to achieve the goals of *Option 3*, namely increase the use of solar energy, customers could be encouraged by the LPSC to leverage federal and state level assistance programs (U.S. DOE 2017; Entergy 2019). One such program is the Weatherization Assistance Program, which helps low-income households achieve energy savings through technologies including solar (U.S. DOE 2017). Furthermore, customers could take advantage of federal tax credits such as the Investment Tax Credit to reduce the cost of solar energy systems, which includes battery storage (U.S. DOE 2021). Expanding the use of battery storage can also help the state avoid a drop in the price of solar on the market due to eventual oversupply (Katz 2020). Incentives for solar energy can alleviate the financial burden of such a system on users, especially low-income households, and make solar panels coupled with battery storage a feasible energy source during a disaster.

The implementation of EERS by the LPSC (*Option 2: Institute Energy Efficiency Resource Standards to update infrastructure*) would benefit the state in the short term and could make the grid more efficient. However, we do not recommend expending the state's resources solely to revitalize the current grid because its centralized structure is vulnerable to large-scale power outages and dependent on natural gas as an energy source, which contributes to CO_2 emissions. Many states in the Southeastern U.S. are at risk of climate-related natural disasters and have similar energy portfolios to Louisiana, i.e., a

centralized grid structure that relies on natural gas plants. Louisiana's legislative decisions on grid modernization, such as shifting to a more distributed system, could influence other states in the Southeast region to follow suit and help the U.S. ensure broader climate resilience.

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