Power Outages in NOLA: The Problem, Implications, Solutions, and Moving Forward

By Emma King, Alliance for Affordable Energy
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Abstract

New Orleans is a city in which residents and businesses are plagued with frequent power outages. These outages are more than an inconvenience and affect people in a myriad of ways. This report provides a detailed understanding of how these outages hinder the New Orleans community by splitting the topic into four parts. The first discusses the problem of outages by calculating the cost to energy consumers and comparing outage data from Entergy New Orleans, the city's utility provider, to previously-conducted studies as well as the national average and averages from other Louisiana utilities. The second part examines the diverse implications of outages in New Orleans that may not be included in the calculated monetary cost because of the broad and encompassing effects of outages. The third section provides solutions to outages that can be undertaken by individuals, businesses, and cities as a whole. The fourth section places these solutions into the context of current efforts to reduce outages and improve energy efficiency in New Orleans and suggests how we move forward from here.

I: The Problem

A: Calculating NOLA Outage Costs

In order to estimate the cost of power outages on New Orleans consumers, we can use an estimation calculator created by the Lawrence Berkeley National Laboratory (LBNL) and Nexant which was most recently updated in 2015[1]. This meta-analysis estimates the value of service reliability for electricity customers in the U.S. by including 34 different datasets from surveys conducted by 10 different utility companies between 1989 and 2012; combining over 105,000 observations. These studies all used very similar methods for estimating interruption costs, which made the researchers at LBNL and Nexant able to fuse them into one single interruption cost estimator. The surveys asked respondents to estimate their willingness-to-pay/accept methods[2]. [To review the complete methodology of the calculator, see "Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States" in works cited.] Using 2017 data on Entergy New Orleans[3] [see Appendix A] and plugging it into an Interruption Cost Estimator[4], we gather this data:

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[1] Sullivan, Michael; Schellenberg, Josh; Blundell, Marshall. "Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States." (2015). Web.

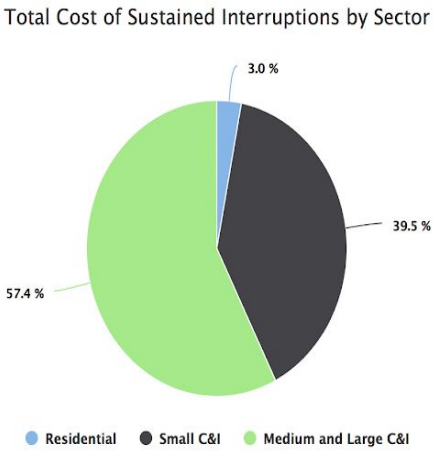
[2] Ibid.

[3] "Electric Power Sales, Revenue, and Energy Efficiency Form EIA-861 Detailed Data Files." *U.S. Energy Information Administration*, 12 Oct. 2018.

[4] "Interruption Cost." *ICE Calculator*.

Interruption Cost Estimates

Sector	# of Customers	Cost Per Event (2016$)	Cost Per Average kW (2016$)	Cost Per Unserved kWh (2016$)	Total Cost (2016$)
Residential	179,633	$9.17	$5.12	$1.90	$3,041,911.32
Small C&I	13,961	$1,537.42	$185.76	$68.97	$39,622,367.29
Medium and Large C&I	6,543	$4,768.33	$103.93	$38.59	$57,593,639.08
All Customers	**200,137**	**$271.37**	**$73.62**	**$27.34**	**$100,257,917.69**



Total cost ($100,257,917.69) divided by total customers (200,137) equals $500.95 per energy customer in 2017 in power interruption costs.

B. Comparison of NOLA Residential Cost per kWh to Previously Conducted Studies

The column "Cost Per Unserved kWh", or kilowatt hour, ($27.34) is useful to compare with other outage cost studies from different countries and using different methods. One study that compiled this data for residential customers differentiates between different methods used to help compare the cost per unserved kwH[5]. The macroeconomic method, which relies on indicators such as GDP, is generally seen as less-desirable than surveys due to its inability to take individual outage factors into account and calculate for specific direct damages. The more generally-desirable method of the survey allows consumers to analyze responses to questions based on hypothetical situations. This makes it possible for researchers to consider a plethora of consumer costs and conditions, however, the downfall is that it can be very subjective and time consuming. Our New Orleans estimate from the ICE Calculator is a hybrid of both approaches because it uses data from surveys in order to produce a formula that is based on macroeconomic factors and amount of customers. In order to compare our New Orleans estimate to the studies analyzed by Praktiknjo et al. we use our Residential Cost Estimate of $1.90 per Unserved kWh since this study only conducted the cost of outages for residential customers. To see a complete comparison of our estimate with the other studies, see Appendix B.

While both the average ($18.39/kWh) and median ($7.99/kWh) greatly exceed our New Orleans residential cost of $1.90, it should be noted that many of these studies are outdated or

[5] Praktiknjo, Hähnel, and Erdmann. "Assessing Energy Supply Security: Outage Costs in Private Households." *Energy Policy* 39.12 (2011): 7825-833. Web.

from countries that are very different than the United States. The discrepancies between measures is great. For example, a study conducted in 2002 in the United States by Balducci, Roop et al. found a residential cost of $.31 per kWh . Just one year later in 2003, a study in the United States by Lawton, Sullivan et al. found a residential cost of $13.90 per kWh[6]. Not only are there substantial discrepancies between studies, but these studies are too outdated to reliably compare ours with today. While calculating outage costs is one way to analyze resilience, reviewing reliability data is equally important.

C. Comparison of Entergy New Orleans outage data to other utilities

After considering cost, another useful indicator of reliability to compare New Orleans outages to national averages and other utilities in Louisiana are SAIDI and SAIFI. SAIDI is the System Average Interruption Duration Index. It measures, in minutes, sustained interruptions, which are most commonly defined as an interruption greater than or equal to 5 minutes. The higher the SAIDI score, the longer the duration of an outage. SAIFI, or System Average Interruption Frequency Index, measures the frequency of sustained interruptions. The higher the SAIFI score, the more often outages occur. Major Event Days, or MED, are sometimes excluded from these statistics in an effort to control for unavoidable events such as large storms[7]. In sum, high SAIDI and SAIFI scores, with or without MED, indicate long outages and frequent outages, respectively. To compare NOLA outages, outages elsewhere in Louisiana, and national outages, we use data from the US Energy Information Administration (EIA)[8]. In an attempt to control for unavoidable weather events, we will use SAIDI and SAIFI without MED. To see these comparisons, see Appendix C.

New Orleans' SAIDI and SAIFI (192.9 and 1.796, respectively) is higher than the national average (about 120 and 1.0) as well as the other reported SAIDI and SAIFI without MED for Louisiana utilities except for one, Dixie Electric Membership Corp. The SAIFI without MED from Beauregard Electric Coop, Inc. is greater than Entergy New Orleans by only .024, however ENO's SAIDI still exceeds theirs.

II. Implications of Outages in NOLA

Clearly, compared to the nation and Louisiana as a whole, New Orleans has excessively high durations and frequencies of interruptions. While these excessive outages are basically accepted as a way of life to New Orleans residents, they cause a plethora of problems that cannot be ignored.

A. Environmental Racism

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[6] Praktiknjo, Hähnel, and Erdmann. "Assessing Energy Supply Security: Outage Costs in Private Households".
[7] LaCommare, Kristina H., and Eto, Joseph H. "Tracking the Reliability of the U.S. Electric Power System: An Assessment of Publicly Available Information Reported to State Public Utility Commissions." (2008). Web.
[8] "Electric Power Sales, Revenue, and Energy Efficiency Form EIA-861 Detailed Data Files."

People in Council districts D and E (including the Gentilly, New Orleans East, and Lower Ninth Ward Neighborhoods" experience the greatest proportion of outages in the city. These residents are more susceptible than their neighbors Uptown or in the French Quarter and also typically tend to be lower-income[9]. These disproportionate outages, coupled with the fact that low-income households in NOLA are more likely to be located in areas at higher-risk to flooding and land subsidence[10], are a clear form of environmental racism. Additionally, New Orleans is the second-highest energy-burdened city in the United States, meaning that the percentage of household income spent on energy bills is the second-highest in the country in New Orleans. Further, families with high energy burdens are more likely to develop respiratory diseases, increased stress and economic hardship, and difficulty in moving out of poverty.[11] Low-income energy consumers in NOLA are clearly at a disadvantage when it comes to their energy needs being met at in an affordable and efficient manner.

Council District Map[12]

B. Income Inequality and Underpreparedness

The income inequality in New Orleans causes people to be unprepared for emergency situations and extended outages. NOLA's median income is $36,631, nearly 30% lower than the national average of $52,250. 12.5% of NOLA residents do not have a bank account, with 32.5%

[9] "New Orleans Has Been Kept in the Dark: Making Sense of Outages, Reliability, and Resilience." *Alliance for Affordable Energy*, Sept. 2017.
[10] "Resilient New Orleans Strategic Actions to Shape Our Future City." *Resilient New Orleans*, Aug. 2015.
[11] Ross, Lauren, and Ariel Drehobl. "Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities." *Energy Efficiency for All*, Apr. 2016.
[12] Swenson, Dan. "New Orleans City Council Districts." *Nola.com*, 23 Apr. 2015..

of African-American households in NOLA unbanked. More than half of renters in New Orleans are rent burdened, meaning that they spend more than 30% of their income on housing costs, which include utilities[13]. All these factors cause a vast amount of New Orleans residents to be unprepared in the face of an emergency, which is why we need a more resilient system to minimize the likelihood of such instances.

C. Businesses Suffer

Electrical outages affect every sector. When the power goes out, US businesses quickly lose customers and revenue. When customers cannot purchase merchandise from websites, unturned inventory increases, and inventory sales lag. In 2016, Amazon's website was down for between 13 and 15 minutes. This resulted in an estimated loss of $2,646,501 in revenue[14]. Restaurants are an enormous part of New Orleans' culture and tourism, and when the power goes out, food spoilage poses a serious threat. Food spoilage due to outages creates a health concern and the precautions restaurants take to ensure their food is safe to eat forces them to throw out food which is expensive. Perhaps most importantly, outages damage the business's reputation. People do not want to purchase goods or services from a website that seems unreliable, and this damage in reputation can be costly to try to restore[15]. Additionally, employees may not be able to complete tasks and IT employees may need to work overtime to resolve problems. Power outages are one of the primary causes of data loss, which can jeopardize an entire company in a millisecond. Outages also damage equipment, and frequent outages can damage computer hard drives, reduce their life spans, and be costly to repair[16]. According to the ICE Calculator, in New Orleans small commercial and industrial customers lose $1,537.42 per outage event, and medium and large commercial and industrial customers lose $4,768.33[17].

D. Medical Facilities and Lives Compromised

Power is especially crucial to medical facilities, and outages can mean putting patients' lives at risk. People's' lives depend on medical equipment reliant on electricity to run, and backup generators require constant maintenance to ensure they will work. Even when fully functional, most hospital generators only have the capacity to backup the facility for 8 hours[18]. A few hospital services that require power are heating, cooling, gas and air handling, washing linens and dishes, cooking, maintaining the blood bank, radiology, medicine storage, communications, patient records, critical care devices, elevators, and ventilators[19]. Also, during

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[13] "Resilient New Orleans Strategic Actions to Shape Our Future City." *Resilient New Orleans*, Aug. 2015, resilientnola.org/wp-content/uploads/2015/08/Resilient_New_Orleans_Strategy.pdf.
[14] "The Effects of a Power Outage on a Business." *Foster Fuels Emergency Response Team*, Foster Fuels Emergency Response Team, 8 Feb. 2018.
[15] Ibid.
[16] Ibid.
[17] "Interruption Cost".
[18] Klinger, Chaamala; Landeg, Owen; Murray, Virginia. "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011-2012." *PLoS Currents* 6 (2014): . Web.
[19] Ibid.

an outage, critical patient data and files can be lost[20]. Without patient information and medical equipment, a hospital is rendered virtually useless.

E. City Infrastructure and Health

Outages also seriously threaten city infrastructure which in turn threatens citizen health. When the power goes out, we lose water monitoring and pumping mechanisms, which could lead to sewage treatment failure. An example of this is on November 17th 2018, a power outage in New Orleans lead to a boil water advisory for the entire city. Water treatment is reliant on power, and when we are without power, pumps cannot do their jobs and water ceases to flow. This means that we cannot wash our hands, clothes, or conduct personal hygiene (like showering and brushing our teeth), which creates health risks. When water pumping halts for longer than one day, sewer system backup occurs and sewage could come up through the drains. Of course, when the power is out we cannot boil water to sanitize it[21].

F. Transportation

When the power goes out, transportation in New Orleans is at risk. Outages can cause traffic lights to stop working and buses are more likely to miss their schedules. This is a problem for New Orleans residents who commute to work via the regional transportation system. If an outage occurs, causing them to be late, they are viewed poorly by their employers even if their tardiness is not their fault. Already, without a power outage, only 75% of New Orleans regional transportation is on time[22]. In 2016, 7.31% of workers in New Orleans commuted by public transit[23]. While this proportion does not seem high, it is important to realize that NOLA's regional transportation is inaccessible to people who need it the most. Since Katrina, NOLA's transit system has only regained 45% of its level of bus service and the operating budget of the Regional Transit Authority has been reduced by nearly 40%. These cuts primarily occurred in areas where people need public transportation the most, such as low-income neighborhoods, communities of color, and areas where people lack access to personal vehicles[24]. Additionally, as of 2018, a mere 12% of jobs held by NOLA residents are accessible via a 30-minute public transit commute[25].

G. Direct Residential Costs

Outages also pose significant risks to residential electric consumers. Food spoilage is one threat that residents face when the power goes out. Perishable foods, such as meat, eggs, and dairy, that are not kept under proper refrigeration can cause illness if consumed. While these

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[20] "The Effects of Power Outage on a Business".
[21] Klinger, et. al. "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011-2012".
[22] "From Plans to Action: The State of Transit 2018." Ride New Orleans.
[23] "New Orleans, LA." *Data USA*.
[24] "Resilient New Orleans Strategic Actions to Shape Our Future City."
[25] "From Plans to Action: The State of Transit 2018."

illnesses are not typically chronic, some may become severe or even life-threatening[26]. Additionally, if someone becomes ill due to food poisoning from an outage, they may need to miss work or important appointments in order to rest and recover.

Elderly populations are especially vulnerable to risks from power outages. In New York during Hurricane Sandy, power outages left elderly people in isolation in high rises as elevators were out of service. This led to confusion and agitation, especially among the elderly with dementia, when the lights went out[27].

Also, the loss of air conditioning can pose threats to consumers. While in New Orleans we are generally not at risk for hypothermia due to lack of heating, it would be reasonable to foresee heat stroke due to lack of air conditioning, which can cause death or permanent disability [28].

Perhaps most seriously, power outages can lead to carbon monoxide poisoning when generators are used incorrectly. Generator use is the most common cause of disaster-related carbon monoxide poisoning, accounting for 54% of non-fatal cases and 83% of fatal cases[29]. Given the extensive use of generators in New Orleans, from residential in-home uses to cookout generators used for grilling during parades, this is a serious safety concern.

H. Indirect Residential Costs

In addition to the direct costs to residential customers, indirect costs also weigh heavily. For example, when an outage occurs, it is likely that childcare centers such as daycares will be closed down. In response, parents are forced to stay home from work to take care of their child or find last-minute childcare, which can be expensive. Also, many people take a power outage as a reason to stay home from work because they know productivity will be compromised. If the power goes out, alarms will likely not go off, so even if someone wants to go to work they may not wake up in time. Without electricity, cellular phones stop charging and many people will hesitate to leave home if their major form of communication is compromised. Any appliance that relies on power, such as a hair dryer, water heating for a shower, or a microwave, can dissuade someone from leaving the comfort of their home when not functional and causes people to be late, wasting their time.

I. Future Implications

Power outages cause a domino effect. We depend more than ever on an aging electrical grid that we simply cannot rely on. There are so many consequences of the power going out that it is impossible to quantify them all, however we do know that outages cost New Orleans

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[26] "Food and Water Safety During Power Outages and Floods." *US Food and Drug Administration*, Center for Drug Evaluation and Research, Nov. 2017.
[27] Klinger et. al. "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011-2012".
[28] "When the Power Goes Out: Natural Disasters and Severe Weather." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention.
[29] Klinger et. al. "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011-2012".

customers, on average, at least over $500 per customer per year[30]. In a city where the poverty rate is nearly 10% above the national average of 14%[31], $500 is an expense that could easily be the difference between paying rent or eviction. While New Orleans residents have become so accustomed to frequent outages they accept it as a way of life, we know the causes of the outages and we know they are fixable. Between June 2016 and May 2017, there were 2,599 outages in New Orleans alone. While Entergy New Orleans claims that many outages are unavoidable due to weather or "other" factors, such as animals or vegetation, in 2016 a total of 55% of outages were due to equipment failure[32]. ENO's proposed solution is to build a generator that would account for transmission issues they predict will occur in the future due to an overloaded system. However, with only 1% of outages in 2016 resulting from transmission issues[33], this is an expensive "solution" that will ultimately prove ineffective. Instead, we must improve infrastructure and grid resiliency.

III. Solutions

While the world today is certainly dependent on fossil fuels and electricity, there is a transition to more diverse forms of energy sourcing occuring. In the face of climate change, there is a push by cities and states to become more "green", which has resulted in cleaner and more efficient energy systems which in turn reduce power outages.

A. Energy Management for Electrical Systems

Another way to more efficiently use energy and reduce waste is Enterprise Energy Management, or EEM, which combines advanced metering hardware and software to monitor a facility's electricity usage, identify inefficiencies, and pinpoint potential threats to reliability[34]. A network of energy meters is linked to a centrally located server which logs information, responds to alarm conditions through notifications, and displays the status of the area. This is useful because managers can efficiently monitor power quality and energy usage, identify inefficiencies, review historical consumption data to predict energy usage, allocate costs, identify waste, and negotiate better power-supply contracts. An EEM can also verify the billing statements from utility providers to ensure the customer is not being overcharged. In terms of reliability, an EEM verifies power quality at all times and warns managers of an outage via email, pager, or cell phone. It can also provide forensic evidence after an outage event to identify the source of the event, which can help prevent future disturbances[35].

New Orleans is taking a step in the right direction in energy management with the deployment of Advanced Metering Infrastructure (AMI), which includes installing smart meters,

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[30] "Interruption Cost".
[31] "New Orleans, LA." *Data USA*, datausa.io/profile/geo/new-orleans-la/.
[32] "New Orleans has been Kept in the Dark".
[33] Ibid.
[34] "Energy Management For Electrical Systems." *Efficient Plant*, 2 Jan. 2006.
[35] Ibid.

in-home energy displays, and programmable communicating thermostats. A pilot study conducted in 2014 on AMI showed that the system helped low-income energy consumers feel empowered to manage their energy usage better and participants achieved a peak load reduction of 11-16%[36].

B. Solar Power

Solar energy provides a myriad of benefits, however people are reluctant to invest in solar panel systems because of their upfront expenses. Using the online calculator Wholesale Solar, we are able to estimate the cost of a residential solar power system in New Orleans using the zip code 70118. The calculator provides us the option to estimate either a grid-tie solar option, which is meant to save money on the customer's electric bill, along with a grid-tie solar plus energy storage option, which allows the user to store power in a battery to use in the event of an outage. We chose the grid-tie solar plus energy storage due to the inconsistency of the New Orleans grid and the high incidence of outages. The program computed a default monthly energy usage of 1291 kWh and default cost of electricity from Entergy New Orleans Inc. as $.0982/kWh. We chose the option in the program to offset 100% of the power bill cost with the solar power system and claim the Federal Tax Credit of 30% of solar system expenses applying to a credit. With all of this data plugged in, if a New Orleans resident purchased a solar power system directly from a wholesale supplier the system would cost between $28,127 and $35,158[37]. While this upfront cost may seem daunting, the estimated long-term savings are $46,650 and it would take between 15 and 19 years for the system to pay for itself. Also, a study by the Lawrence Berkeley National Laboratory showed that a solar power system increases the value of a home by an average of $15,000[38].

A solar power system is initially expensive, however it pays for itself, increases home value, and has many other benefits besides cost-effectiveness. It is a renewable and plentiful source of energy, as one hour of summer sun at 12pm is equal to the annual US electricity demand[39]. Especially in sunny New Orleans, solar supply is far from an issue. Additionally, solar power is a great way to help the environment. It reduces water consumption, gas emissions such as CO2, and other dangerous pollutants such as nitrogen oxides and sulfur oxides[40].

Even after all these benefits, it is unrealistic to expect New Orleans consumers to eagerly hand over tens of thousands of dollars to convert their homes to solar power. Luckily, there are less costly ways to utilize solar power. Solar generators utilize solar energy to power smaller residential devices such as a small medical device, a mini-fridge, or electronics. They are clean

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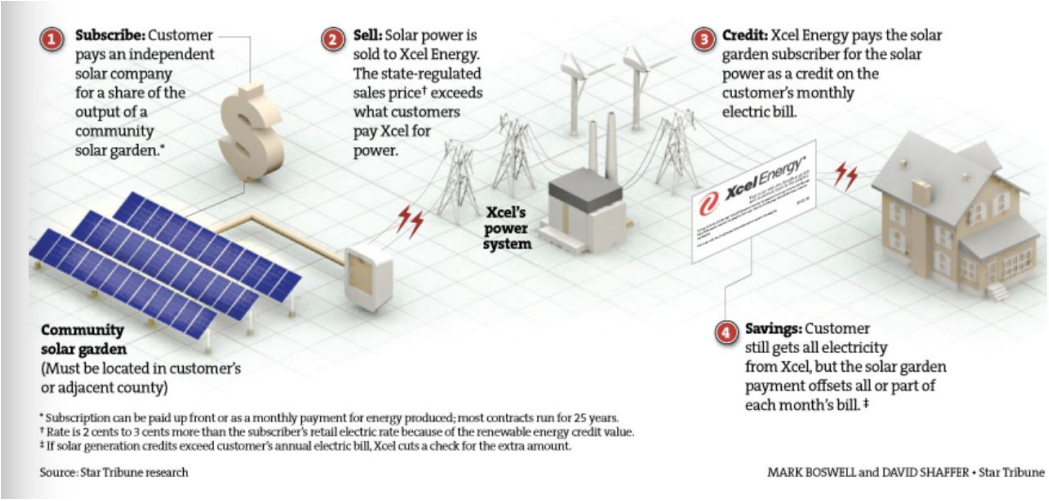
[36] "Entergy New Orleans, Inc. Advanced Metering Infrastructure Pilot." *SmartGrid.gov*, US Department of Energy, July 2014.
[37] "Solar Panel Cost Calculator." *Wholesale Solar*.
[38] "Benefits of Residential Solar Electricity." *Energy Saver*, US Department of Energy.
[39] "Benefits of Residential Solar Electricity".
[40] Ibid.

and can be used anywhere, unlike gas generators which must be used outside due to the risk of carbon monoxide poisoning[41].

Community Solar refers to shared renewable energy sources, or solar gardens, that multiple consumers are allowed to benefit from. Consumers can choose to buy or lease a portion of the solar garden and receive its benefits. This benefits people who cannot install their own rooftop solar system for reasons such as roof shading, poor roof conditions, or the large upfront cost. The solar projects themselves are owned by either third-party developers or utility companies and can be located anywhere that is suitable. In New Orleans, 91% of buildings qualify as suitable for rooftop solar systems. [42]The owners can receive tax credits to incentivize building projects in low-income areas and consumers may also be eligible for rebates or other incentives[43]. As of March 29th 2019, the Council of the City of New Orleans has moved forward with establishing rules and guidelines for New Orleans consumers to participate in community solar projects. Notably, the proposed rules set aside 30% of the total Community Solar Capacity Limit for Community Solar Generating ("CSG") Facilities to provide at least 10% of output to low-income consumers, however dissenting organizations such as the Alliance for Affordable Energy argue that this is too little. Additionally, the proposed rules would exempt low-income consumers from the minimum investment requirement, allowing them to be able to commit to a smaller portion than the other-wise required 1 kW. The proposed rules do not include any subsidies to incentivize low-income consumers to invest in community solar[44].



C. UPS Systems

[41] Connors, Jill. "Can You Afford Solar Power?" *HGTV*, HGTV, 15 Sept. 2018.
[42] Evans, Beau. "91 Percent of New Orleans Buildings Are Solar Power 'Viable,' Google Says." *Nola.com*, Nola.com, 27 Mar. 2017, www nola.com/science/2017/03/solar_map_google_app_new_orlea html.
[43] "Community Solar". National Renewable Energy Laboratory.
[44] City Council of New Orleans Rulemaking Proceeding to Establish Rules for Community Solar Projects, Resolution and Order Establishing Rule and Order Establishing Rules for Community Solar Projects, R-19-111. Docket No. UD-18-03 (March 28, 2019).

An Uninterruptible Power Supply (UPS), or battery backup, maintains a supply of electric power to connected equipment by supplying power from a battery source during a power outage[45]. These are typically used to protect computers and other technological equipment when an outage occurs and there are two main types: standby and interactive. A Standby UPS offers surge protection and passes utility power until an outage occurs, then switches over to battery power during an outage and back to utility power when the event is over. This is the most cost effective type of UPS and is designed for home use or for a single computer or terminal in a business[46]. A Line Interactive UPS, on the other hand, incorporates an automatic voltage regulator (AVR), which allows the device to adjust the incoming line voltage without switching to battery power. This is useful for long term over-outages or common under-voltages because it does not drain the UPS battery[47].

D. Resilient NOLA

In 2015, the City of New Orleans produced a plan to become more resilient by building upon ideas from 100 Resilient Cities, a program initiated by the Rockefeller Foundation. This plan "combines local expertise with global best practices to confront our most urgent threats and seek ways to redress our legacy of inequity and risk"[48]. It provides numerous ways to increase New Orleans' resiliency by becoming more energy-efficient and sustainable, which indirectly helps combat power outages by allowing the city to rely less on electric utilities. The following four sections are solutions posed by Resilient NOLA that will be useful in solving outages in this indirect way.

1. <u>Property-Assessed Clean Energy (PACE)</u>

PACE is a voluntary program in which property owners make energy efficiency improvements to their homes at little to no upfront cost. This is incentivized with low-interest capital and the potential to reduce insurance premiums, and loans are repaid through property tax bills for up to 20 years. Some improvements that qualify under PACE are floodproofing, storm shutters, and stormwater management features[49].

2. <u>Green Spaces</u>

In a city like New Orleans, where rainfall is prevalent and elevation is low, creating more natural spaces to absorb water runoff can increase resilience. In Rotterdam, the Netherlands, the city includes water plazas, green roofs, and a water storage facility in an underground parking garage in their infrastructure. This reduces flooding and connects water to opportunity,

[45] "UPS Types & Common Power Problems." *Smart Power Systems.*
[46] Ibid.
[47] Ibid.
[48] "Resilient New Orleans Strategic Actions to Shape Our Future City".
[49] Ibid.

recreation, and beautification[50]. In Chicago, rooftop gardens have gained popularity since the city's first green roof garden on City Hall in 2000. Supported by incentive programs, over the past 15 years hundreds of Chicago property owners have installed their own green roofs. These reduce stormwater runoff, conserve energy, decrease the urban heat island effect, and improve air quality[51].

3. Redesign Regional Transportation Systems

Since Katrina, NOLA's transit system has only regained 45% of its level of bus service and the operating budget of the Regional Transit Authority has been reduced by nearly 40%. These reductions happen to have primarily occurred in low-income neighborhoods, communities of color, and areas where people lack access to personal vehicles. Where the need for public transportation is greatest, the city is failing to provide. If the regional transportation system in New Orleans were redesigned to be more reliable and more easily-accessible, people would rely less on private vehicles. This would make the city more economically competitive, reduce harm to the environment, and support growth[52]. RIDE NOLA, a nonprofit organization whose mission is to provide effective, equitable transportation for all New Orleans residents, has pushed the Regional Transit Authority (RTA) to develop a strategic plan for transportation improvements moving forward. In December 2017, the RTA passed the first long-term strategic transportation plan post-Katrina, the Strategic Mobility Plan (SMP), which includes 129 specific actions to implement in order to improve regional transportation. For example, it plans to increase the percentage of jobs reachable by public transit in 60 minutes from 42% to 60% by 2027[53]. While this plan is certainly a step in the right direction and could have exciting implications, it is essential that its lofty goals are implemented. Despite the SMPs publication in 2017, rider access to economic opportunities has not improved since the April 2016 service enhancements[54].

4. Microgrids

Microgrids are small backup electrical distribution and generation systems that can disconnect from the traditional grid to provide electrical power when an outage occurs. This enables more diverse sources of energy to be used in the face of an outage which helps reduce losses in transmission and distribution[55]. Microgrids that combine heat and power are especially helpful for increasing resiliency. Since New Orleans is so dependent on the greater electrical grid, a microgrid system would be very useful during an outage. For example, microgrid generations could be used to power hospitals when an outage occurs or keep the water pumping

[50] Ibid.
[51] "Resilient New Orleans Strategic Actions to Shape Our Future City.
[52] "From Plans to Action: The State of Transit 2018." Ride New Orleans.
[53] Ibid.
[54] Ibid.
[55] "Resilient New Orleans Strategic Actions to Shape Our Future City".

system operational. During Hurricane Sandy, microgrids helped critical facilities, such shelters, keep their power on[56].

The City of New Orleans worked with researchers at Sandia and Los Alamos national laboratories to brainstorm and analyze ways to increase energy resilience with microgrids. To do this, the team used Hurricane Katrina and an unnamed storm from 1947 to model hypothetical conditions that would threaten city infrastructure through flooding, sustained power outages, and lack of access to basic services[57]. Researchers simulated the storms using their actual trajectories and modelled what impact they would have on New Orleans today. By doing this, they were able to develop new algorithms to identify the best locations to potentially install a resilience node or grid modernization strategy[58].

An example of successful microgrid resilience efforts is the University of Genoa, Italy. In 2014, the university commissioned their "Energia 2020" project in an effort to reduce energy inefficiencies, expand its use of combined heat and power generation, reduce emissions, and increase system resiliency[59]. To do this, a series of diverse power sources, including a heat grid and solar power system (to read more, see Works Cited) were constructed to supply the university's power. A heat grid and an absorption chiller were built to supply heating and cooling. An electrochemical and two thermal storage systems were installed as well. All of these systems are connected to the control center, which utilizes a microgrid management system to manage resources[60]. While this may seem like a complicated and extensive system, the positive results have been great. Energy efficiency increased, the demand for purchased energy significantly decreased, operating costs have been reduced, and CO2 emissions are expected to reduce by 120 metric tons per year[61]. Siemens, the company that provided the case study on the University of Genoa, provides a diagram of what a microgrid system may look like.

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[56] Chittum, Anna. "What Is the Economic Value of Microgrid Resilience." *Microgrid Knowledge*, 9 Feb. 2017

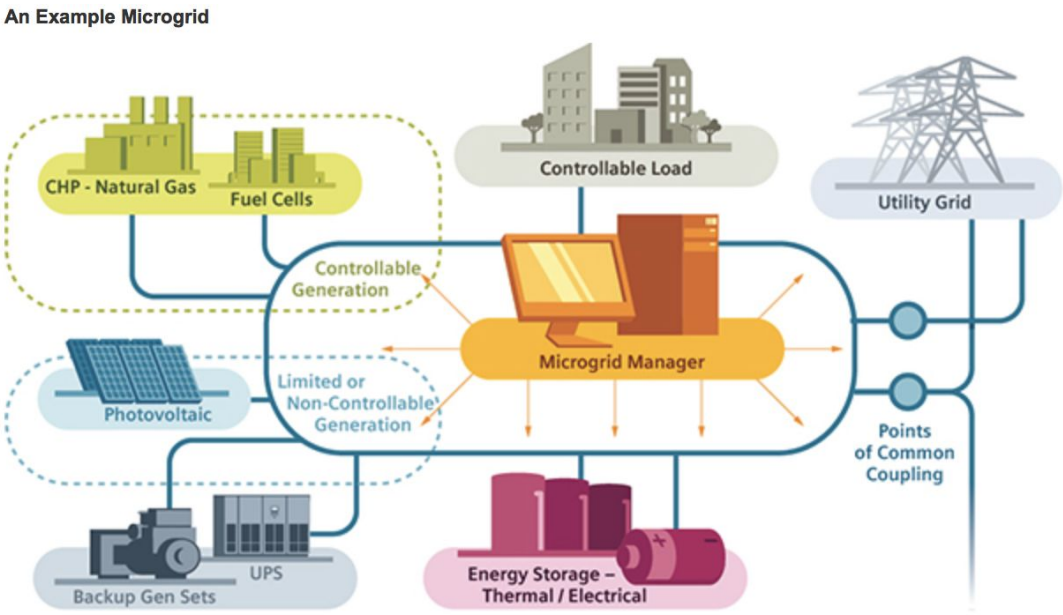
[57] "How Microgrids Could Boost Resilience in New Orleans." *Sandia National Laboratories*, 2019 National Technology and Engineering Solutions of Sandia, LLC, 14 June 2018.

[58] Ibid.

[59] "Smart Energy Supply for the University Campus of Savona." *Siemens*, Siemens AG, 2014.

[60] Ibid.

[61] Ibid.



(source: https://w3.usa.siemens.com/smartgrid/us/en/microgrid/pages/microgrids.aspx)

IV. Conclusion and Moving Forward

Clearly, there are many different strategies to reduce power outages through efforts by the city as a whole and by individual citizens. In order to decide what additional resilience efforts can be utilized moving forward, it is important to analyze current efforts. Entergy New Orleans (ENO) has released its 2019 Reliability Plan. While there are some improvements to funds allocated to reliability, it is questionable whether or not these funds are sufficient. In total, the plan allocates $15.4 million in reliability efforts for 2019. Remarkably, the vast majority of these funds ($11.04 million) are being allocated to transmission infrastructure when in 2018, only 14 outages were due to the ENO transmission system in 2018[62]and between 2011 and 2016, 1.9% of outages were due to transmission issues[63]. In contrast, we know that the vast majority (98.1% between 2011 and 2016) of outages in New Orleans are due to distribution issues[64], yet only $2.5 million of the 2019 Reliability Plan is set aside for the Distribution Automation ("DA") Program, which installs devices to diversify power supply so that when an outage occurs, these devices switch on and reduce the number of customers affected[65].

This DA Program is also a part of the Advanced Metering Infrastructure ("AMI") effort, which deploys smart meters and will enable in-home displays and programmable communicating thermostats for New Orleans energy consumers in order to provide them with the tools necessary to regulate their energy usage, eliminate excess usages, and become more efficient[66]. It helps

[62] "ENO Reliability Plan 2019".
[63] "New Orleans has been Kept in the Dark".
[64] Ibid.
[65] "ENO Reliability Plan 2019".
[66] "Entergy New Orleans, Inc. Advanced Metering Infrastructure Pilot." *SmartGrid.gov*, US Department of Energy, July 2014.

reduce outages because the smart meter notifies Entergy in the event of an outage and provides a detailed and accurate analysis of the outage instead of sending trucks into the field[67]. This way, ENO can respond more quickly and efficiently. In a pilot study, AMI helped low-income energy consumers feel empowered to better manage their energy usage and participants achieved a peak load reduction of 11-16%. According to a post-study survey, 91% of participants said they would be interested in permanent program participation[68]. As a result of the pilot study success, Entergy New Orleans applied to deploy AMI and requested cost recovery from the Council of the City of New Orleans. This was approved in February of 2018 and according to the timeline, implementation should have begun in 2018[69]. In reality, according to the Utility Committee Meeting on March 21st, 2019, AMI installation only began in February 2019 and its completion is expected in December 2020.

While the Distribution and Automation Program and Advanced Metering Infrastructure plans are steps in the right direction to reduce outages, they are not a high enough priority. $2.5 million over one year is simply not enough. To put this into perspective, Entergy's proposed gas plant will cost over $210 million and will not reduce the occurrence of outages experienced in New Orleans[70]. The plant focuses on power supply, which is not the reason New Orleans is plagued by outages. Between 2011 and 2016, 98.1% of outages were due to distribution, 1.9% were transmission issues, and 0.0% were due to generation[71].The $210 million dollar plant will sit idle over 85-90% of the year, will only create at most 13 permanent jobs, and will actually harm New Orleans by releasing known carcinogenic pollution[72]. It is no secret that support for the gas plant has been controversial at best. Entergy literally paid actors to attend public hearings to provide support for the gas plant on two separate occasions. Individuals were paid to show up to the hearings and give speeches, and Entergy was billed $55,000 for these paid supporters, which was only part of the $1.3 million campaign including "local reputation management, scripting letters of support for the plant, tracking media coverage and monitoring groups that opposed the plant"[73]. If ENO can pay $1.3 million just to exaggerate public support for the gas plant, one would think they could devote more funds to solutions that actually work.

Even though some of Entergy's reliability efforts are arguably misguided, there are other opportunities for New Orleans consumers to bolster their energy efficiency. Energy Smart NOLA is a program developed by New Orleans City Council and administered by ENO to incentivize energy efficiency by providing rebates for improvements to businesses' and residents' energy efficiency[74]. Businesses can receive up to 100% of the project cost back, including $50,000 for lighting upgrades per site per year and $100,000 for non-lighting upgrades

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[67] "Hi, NOLA.Meet Ami, Your New Energy Assistant." *Energy Future New Orleans*, Entergy.
[68] "Entergy New Orleans, Inc. Advanced Metering Infrastructure Pilot."
[69] "Stipulated Settlement Term Sheet: UD-16-04". Council of the City of New Orleans, 30 January 2018
[70] "ENO New Orleans Power Station Cost Recovery Docket UD-16-02."
[71] "New Orleans has been Kept in the Dark".
[72] "ENO New Orleans Power Station Cost Recovery Docket UD-16-02."
[73] Stein, Michael Isaac. "Investigation into Entergy Paid Actor Scandal Delayed by New Cache of Evidence." *The Lens*, 5 Sept. 2018.
[74] "About Energy Smart." *Energy Smart NOLA*

per site per year. Residents can request a house assessment from Energy Smart to analyze their home needs and will be provided with an estimate for recommended upgrades and possible rebates[75].

Independent from the Energy Smart program, the City's office of Resilience and Sustainability is running the NOLA Energy Challenge, a free, voluntary challenge available to all buildings in NOLA that are not single or double-family homes. Participants agree to track their building's energy and water use, input the data into an online calculator, allow contest administrators to analyze the data, and develop a 5-year plan to reduce energy use. The contest improves efficiency by raising awareness of excessive energy and water usage and provides free training on how to benchmark and improve usage. For example, free training is available on topics such as ENO's Energy Smart program, EPA Energy Star Portfolio Manager, and energy efficiency financing. "Winners" of the competition are recognized in areas such as best ENERGY STAR score, most improved ENERGY STAR score, and greatest percentage reduction in total energy use, and awarded prizes[76].

In sum, New Orleans' power outages will not be solved until more funds are devoted to distribution issues. Outages cause serious problems for every man, woman, and child and are more than a mere inconvenience. Neglecting to recognize the true cause of the problem- distribution errors- while devoting hundreds of millions of dollars to a gas plant that will do nothing to solve the issue is an injustice to New Orleans residents. Until this fundamental problem is resolved, efforts to increase energy efficiency are largely up to the individual consumer. While Entergy's 2019 Reliability Plan has the facade of improving efficiency, the majority of funds are being allocated toward solving transmission issues. Rather, more funds should be devoted to distribution and diversifying the electric grid. Individuals and businesses are more likely to reduce their energy costs by participating in programs such as the NOLA Energy Challenge and Energy Smart NOLA to learn about their unique energy expenditures, reduce waste, and in turn reduce costs. While there are efforts underway to improve energy efficiency, power outages plague New Orleans by wasting money, time, and negatively impacting the livelihood of us all in a myriad of ways, only the basics of which are mentioned in this report. To the people who have given it so much, the city must provide energy consumers with the reliability and efficiency they deserve and as a whole, a more resilient New Orleans will result.

[75] Ibid.
[76] "NOLA Energy Challenge." *City of New Orleans*, Resilience and Sustainability: City of New Orleans.

V. Appendix

A. Data Used as Input for the Interruption Cost Estimator

- State: Louisiana
- SAIDI with MED: 298.4
- SAIFI with MED: 1.846
- Number of customers: 200,137
- Residential customers: 179,633
- Non-Residential Customers: 20,504

B. Comparison of NOLA Outage Cost to Other Studies in $/kWh

In order to convert the study's use of Euros in 2007 to USD 2007, http://www.likeforex.com/misc/historical-exchange-rates/EUR/USD/2007 was used..

In order to adjust for inflation from USD 2007 to USD 2017, https://www.usinflationcalculator.com was used. The inflation rate was 21.1%.

Reference	**Country**	**Method**	**Outage cost ($ in 2017/kWh)**
ICE Calculator for New Orleans (2019)	USA	Hybrid of survey and Macroeconomic	1.90
Anderson and Taylor (1985)	Sweden	Survey	6.36
Baarsma and Hop (2009)	Netherlands	Survey	6.53
Balducci, Roop et al. (2002)	USA	Survey	.31
Bertazzi, Fumagalli et al. (2005)	Italy	Survey	19.40
Billinton and Wangdee (2000)	Norway	Survey	.98
Bliem (2005)	Austria	Macroeconomic	29.65
Bliem (2008)	Austria	Survey	9.45
Burns and Gross (1990)	USA	Survey	10.20
De Nooij, Koopmansb et al. (2007)	Netherlands	Macroeconomic	29.20
Jenkins, Lim et al. (1999)	Mexico	Macroeconomic	1.33
Kjolle, Samdal et al. (2008)	Norway	Survey	1.93
Krohm (1978)	USA	Survey	4.38

Lawton, Sullivan et al. (2003)	USA	Survey	13.90
Tol (2007)	Ireland	Macroeconomic	121.22
Sanghvi (1982)	USA	Survey	.86
Wilks and Bloemhof (2005)	Netherlands	Survey	38.54

This table compares studies quantifying power outage costs for residential customers. It identifies the location of the study, the type of study, and quantifies cost using the unit dollars per kilowatts per hour. The average is $18.39/kWh and median is $7.99/kWh.

C. Comparison of ENO SAIDI and SAIFI without MED to National Average and other Louisiana Utilities

Utility	**SAIDI without MED**	**SAIFI without MED**
National Average	About 120	1.0
Entergy New Orleans LLC	192.9	1.796
Beauregard Electric Coop, Inc.	179.4	1.820
Cleco Power LLC	132.000	1.600
Dixie Electric Membership Corp	244.930	2.973
City of Lafayette	31.570	.540
Entergy Louisiana LLC	172.800	1.480
Northeast Louisiana Power Coop Inc.	3.140	1.430
Panola-Harrison Elec Coop Inc.	Not reported	Not reported
Pointe Coupee Elec Member Corp	Not reported	Not reported

City of Ruston	Not reported	Not reported

This table compares the SAIDI and SAIFI, without MED, of Entergy New Orleans, other Louisiana utility providers, and the overall national average. The average SAIDI without MED is 134.593 and the average SAIFI without MED is 1.580. The three utilities that did not report SAIDI and SAIFI without MED did report the statistics with MED, but we exclude them because they are different units of measurement.

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