Incorporating Renewables into the Electrical Grid

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I. Introduction

The electrical grid is aging all over the U.S. just as the use of renewable energy sources is becoming increasingly common. The question of how to best equip the power grid to adjust to the fluctuations of renewable energy needs to be addressed. There are several different viable short-term options to deal with this question and at least one long term one that will be discussed. In North Carolina especially, as one of the leading adopters of solar energy, the state needs to come up with viable policy and legal solutions to improve the grid. This paper seeks to address a few possible solutions to this imminent problem.

II. Electrical Grid Overview

The electrical power grid is one of the most vital components of our modern lives that few people think much about. How does it work? And why does it sometimes not?

The electrical grid is a network of power plants and transformers that are "connected by more than 450,000 miles of high voltage transmission lines." [1] Large amounts of energy cannot be stored so electricity has to be used as it is made hence the numerous miles of both overhead and underground transmission lines. [2]

The electricity that comes to our homes starts at the power plant which is usually a spinning electrical generator.[3] A fuel source is required to generate the force to spin a power plant's generator. The force could come from a water wheel in a hydroelectric dam or from a big

[1] Erin Pierce, *Top 9 Things You Didn't Know About America's Power Grid*, Department of Energy (Nov. 20, 2014), https://energy.gov/articles/top-9-things-you-didnt-know-about-americas-power-grid.
[2] Dave Roos, *How Power Grids Work*, HOWSTUFFWORKS (2017), https://science.howstuffworks.com/environmental/energy/power4.htm.
[3] *Id.*

gas turbine.[4] However, it usually comes from a steam turbine created by coal, oil or natural gas. In some cases, it could come from a nuclear reactor.

Once the power is generated, it moves into a transmission substation at the plant. The substation uses transformers to convert the generated energy into high voltages so it can make the long-distance transmission.[5] Higher voltage results in less energy being wasted on the trip from the plant to customers. On the trip from plant to customer, the electricity will pass through different wires until it makes it to its final destination. The longest trip for electricity is usually about 300 miles.[6]

Electricity generation is the largest source of greenhouse gases in the United States, so modernizing this aspect of our energy use would have a huge impact on our country's environmental health.[7]

The U.S. Electrical Grid is comprised of three regionally separate grids: the first is the Eastern Interconnection[8], which serves all states east of the Rocky Mountains. The second is the Western Interconnection that covers everything from the Pacific Ocean to the Rocky Mountain states.[9] The last, and smallest grid, is the Texas Interconnected system.[10] These grids grew at first with very little governmental oversight, from the 1920s through the energy crisis of the 1970s, and the energy companies were largely left alone. [11] This in turn caused a natural monopoly

[4] *Id.*
[5] *Id.*
[6] *Id.*
[7] *Id.*
[8] *Learn More About Interconnections*, Office of Electricity Delivery & Energy Reliability, https://energy.gov/oe/services/electricity-policy-coordination-and-implementation/transmission-planning/recovery-act-0.
[9] Id.
[10] *Id.*
[11] James McBride, *Modernizing the U.S. Energy Grid*, Council on Foreign Relations (Jan. 26, 2016), https://www.cfr.org/backgrounder/modernizing-us-energy-grid.

where utility companies, up to that point, controlled every step of the process from the power plant to the homes of the consumers.[12]

After the energy crisis of the 1970s[13], Congress passed legislation to partially deregulate the utility sector so that non-utility power generators could enter the market.[14] A later act passed in 1992, the Energy Policy Act of 1992,[15] continued the process of deregulation mainly by separating the business of power generation from the business of transmission and distribution.[16] The policy goal of this act was to allow capitalistic forces to reign free on the open market system and to decrease the price of energy. Progress has been made on this front with a dozen states and Washington, D.C. allowing customers to shop for power much like cell service.[17] However, this issue is sticky and has not been solved throughout the U.S.[18] For example, in Texas people have the "power to choose" their power company and have the option to purchase renewable energy. [19] The goal for the power to choose movement was to make companies more honest and less likely to fix prices at high rates, however it has been noted that energy deregulation can lead to increased prices and increased confusion for consumers.[20]

Despite the deregulation process being underway, the grid is still a massive, aging beast that needs a lot of updating in order to deal with both: (1) the impending electricity demand; and

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[12] *Id.*
[13] *Energy Crisis*, The National Museum of American History, http://americanhistory.si.edu/american-enterprise-exhibition/consumer-era/energy-crisis
[14] James McBride, *Modernizing the U.S. Energy Grid*, Council on Foreign Relations (Jan. 26, 2016), https://www.cfr.org/backgrounder/modernizing-us-energy-grid.
[15] ENERGY POLICY ACT OF 1992, PL 102–486, October 24, 1992, 106 Stat 2776
[16] James McBride, *Modernizing the U.S. Energy Grid*, Council on Foreign Relations (Jan. 26, 2016), https://www.cfr.org/backgrounder/modernizing-us-energy-grid.
[17] *Map of Deregulated Energy States and Markets (Updated 2017)*, Electric Choice, https://www.electricchoice.com/map-deregulated-energy-markets/.
[18] James McBride, *Modernizing the U.S. Energy Grid*, Council on Foreign Relations (Jan. 26, 2016), https://www.cfr.org/backgrounder/modernizing-us-energy-grid.
[19] Dave Lieber, *Your updated 2017 guide to shopping for electricity in Texas*, Dallas News (September 27, 2017), https://www.dallasnews.com/news/watchdog/2017/09/27/updated-2017-guide-shopping-electricity-texas.
[20] Jennifer Abel, *Deregulated energy providers: are they a good deal?*, Consumer Affairs (April 24, 2014), https://www.consumeraffairs.com/news/deregulated-energy-providers-are-they-a-good-deal-042414.html.

(2) the influx of renewable sources on the market.[21] Case in point, the American Society of Civil Engineers ("ASCE") gave the U.S. energy system the barely passing grade of a D+ this year on the Nation's 2017 Infrastructure Report Card.[22]

Most of the current electrical grid was installed in the 1950s and 1960s with only a fifty-year life expectancy.[23] Investment in an infrastructure update, by both the governmental and utility companies, is underway and most desperately needed. "Without greater attention to aging equipment, capacity bottlenecks, and increased demand, as well as increasing storm and climate impacts, Americans will likely experience longer and more frequent power interruptions."[24] The ASCE did give several helpful recommendations, relating in large part to adopting a federal energy policy that assesses needed changes to the power grid, including the introduction of alternative energy sources.[25]

III. Short-Term Improvements to the Power Grid Using Renewables

The question of how to integrate fluctuating renewables into the grid has weighed heavily on the minds of many over the past few decades. Solar panels provide energy when the sun is shining (sometimes too much energy); however, at night or on a cloudy day, there is considerably less energy. The same parallel can be drawn for wind power: when it's windy there is plenty of power, but on a calm day power will have to come from elsewhere. Renewable energy fluctuates because it is at the whim of nature, and in places like Texas and California, with lots of solar and wind energy, the price of electricity can sometimes dip into the negative-

[21] James McBride, *Modernizing the U.S. Energy Grid*, Council on Foreign Relations, https://www.cfr.org/backgrounder/modernizing-us-energy-grid (Last updated Jan. 26, 2016).
[22] American Society of Civil Engineers (Oct. 6, 2017, 5:10 PM), https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Energy-Final.pdf.
[23] *Id.*
[24] American Society of Civil Engineers (Oct. 6, 2017, 5:10 PM), https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Energy-Final.pdf.
[25] *Id.*

meaning power companies are paying the consumer to use power.[26] This may not sound like a bad deal to consumers but without incentives this may result in power companies investing less in renewable energy.

There are several possible solutions to problems like this. The simple and short-term answer is increased grid flexibility. There are three relatively viable options to increase grid flexibility now.[27] The first option would be to dispatch electricity at sub hour intervals to match the availability of renewables. This means that if the city of Springfield uses more energy at 9:00 AM than at 9:30AM the grid can adjust faster to meet that need by changing the power output to less at that time. Alternatively, if the city needed less energy over the course of that time interval then the power company could save itself some energy that would've otherwise been wasted. The second way to increase grid flexibility for renewables is by installing more demand response technology by either adding more market driven adjustments based on time of use rates or technical responses contracted for in demand response ("DR") bids.[28] These options help ensure that power is not wasted when demand is low and ensure there is enough power when demand is high. A third way that the grid could feasibly be improved in the near future is by adding transmission lines between systems to increase integration and take advantage of geographical and technological diversity.[29] For example, if there was a transmission line between California and Utah, and it's sunny in California but Utah doesn't have much wind, Utah can take the excess solar energy. The more obvious but less feasible option for areas with excess power

[26] Richard Martin, *Texas and California Have Too Much Renewable Energy*, MIT Technology Review (April 7, 2016).
[27] Hal Harvey, *Five Ways to a More Flexible Grid*, Energy Collective (October 12, 2017, 4:30PM), http://www.theenergycollective.com/americaspowerplan/2377748/five-ways-to-a-more-flexible-grid.
[28] *Id.*
[29] *Id.*

would be to store it, but that technology is still being developed right now. However, battery storage could be a long-term solution to the woes of renewable energy.

IV. Long-Term Solutions to Integrating Renewable's into the Power Grid

Battery storage of excess power is an obvious solution to the "when it rains it pours" nature of alternative energy sources. If we could store power during peak energy production times and dispense it when it was needed, renewable generation would be far more efficient.

> In Hawaii (o)ne out of every eight homes . . . is equipped with solar panels, producing more electricity than the state needs on sunny days. But the grid can't use or store all that power. In some states, utilities pay wind farms to shut their turbines down on blustery days because the grid can't handle the power surge. [30]

The fact is that the U.S. cannot reach its renewable energy goals until it updates the grid to allow for renewable energy storage. California's target goal of having 50% of all electricity coming from renewables by 2050 will likely not be reached without some sort of storage innovation.[31] The latest and greatest innovation is the development of the lithium ion batteries that are projected to store three times as much power as any storage options we have today.[32] The development of these batteries (or any type of battery for that matter) helps resolve the issue of network priority on reliability.[33] "In 2013, California launched an aggressive effort to ramp up large-scale energy storage with an initial goal of building 1,325 megawatts of storage by 2020, the equivalent capacity of two average sized coal-fired power plants."[34] These batteries also have the capacity for businesses and homes to bypass the meter system and simply store their own

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[30] Gretchen Bakke, *Aging and Unstable, The Nations Electrical Grid is the 'Weakest Link'*, NPR (October 12, 2017, 5:12 PM), http://www.npr.org/2016/08/22/490932307/aging-and-unstable-the-nations-electrical-grid-is-the-weakest-link.

[31] Justin Worland, *How Batteries Could Revolutionize Renewable Energy*, TIME (October 15, 2017, 4:30PM), http://time.com/4756648/batteries-clean-energy-renewables/.

[32] *Id.*

[33] *Id.*

[34] Justin Worland, *How Batteries Could Revolutionize Renewable Energy*, TIME (October 15, 2017, 4:30PM), http://time.com/4756648/batteries-clean-energy-renewables/.

power.[35] Additionally, batteries installed in electric cars could also affect the electric grid as more and more electric cars come on the market. The use of batteries to store energy could help temper the strain they might put on the electrical grid. Therefore, it seems batteries are necessary for the expansion of alternative energy use. California is paving the way for battery storage of renewables and the rest of the states will likely look to them to see what works and what doesn't.

V. How to Improve the Grid in North Carolina

North Carolina is a diverse state with a large number of economic interests from agricultural to chemical industries. [36] Energy consumption is in the lowest third of all the states in the U.S., partially due to three fifths of the state being covered in 19 million acres of woodland.[37] The biggest energy consuming sector is transportation followed by residential, industrial, and finally, commercial.[38]

North Carolina is also one of the leading states for the use of alternative energy.[39] In 2017, North Carolina was the second largest producer of solar energy and even more interestingly, almost all of solar generation projects were installed by independently owned power producers.[40]

As mentioned above, a key way to move forward with our leadership in renewables would be to make the following small adjustments: sub hour dispensing of power, more demand response technology, and further integration. The long-term goal is to move forward with developing battery technology.

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[35] *Id.*
[36] *North Carolina State Profile and Energy Estimates*, U.S Energy Information Administration (August 1, 2017), https://www.eia.gov/state/analysis.php?sid=NC.
[37] *Id.*
[38] *Id.*
[39] *Id.*
[40] Sol*ar Spotlight North Carolina*, Solar Energy Industries Association, https://www.seia.org/sites/default/files/2017-12/Federal_2017Q3_North%20Carolina.pdf.

In 2017, Cypress Creek Renewables became the first North Carolina project to combine both solar generation and storage. [41] This project is only in its construction stage, but hopefully it will be just the beginning for North Carolina's transition to using more battery storage.

Additionally, at a state level, North Carolina needs to develop policies that encourage business owners and residential developers to use renewable energy in a way that works well with the power grid already in place. A case that is happening right now is doing the opposite of promoting policy incentives and precedent for businesses to do this. In *State ex rel. Utilities Commission v. North Carolina Waste Awareness and Reduction Network*, NC Waste Awareness and Reduction Network ("NC WARN") was ruled to have been acting as a "public utility" under the Public Utility Act[42] based on its installing solar panels onto a church and then charging the church for the amount of electricity created.[43] The Public Utility Act outlines the powers and duties of the Utilities Commission.[44] This case specifically highlights the commission's ability to dictate who can generate and dispense power. The court in this case also held that NC WARNS's actions provided an "electric service" to the church, which infringed on Duke Energy's monopoly. Duke Energy, as the largest utility company in the U.S., has fought and so far succeeded in keeping third party solar energy producers illegal in North Carolina.[45] However, many groups including both liberal and conservative politicians are seeking to change this. [46] Characterizing businesses that operate on an individual scale to provide solar panels (that likely

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[41] John Downey, *Cypress Creek's new N.C. projects combine solar and storage*, Charlotte Business Journal (October, 12 2017, 7:30PM), https://www.bizjournals.com/charlotte/news/2017/07/20/cypress-creeks-new-n-c-projects-combine-solar-and.html.
[42] N.C. Gen. Stat. Ann. § 62-30
[43] State ex rel. Utilities Comm'n v. N. Carolina Waste Awareness & Reduction Network, 805 S.E.2d 712 (N.C. Ct. App. 2017)
[44] *Id.*
[45] *Duke Energy vs. Solar Energy: Battle Over Solar Heats Up in North Carolina*, EcoWatch, https://www.ecowatch.com/duke-energy-vs-solar-energy-battle-over-solar-heats-up-in-north-caroli-1882188911.html.
[46] *Id.*

couldn't have afforded the up-front costs of getting the technology themselves) as a "public utility" and an "electric service" is a bad public policy move. In this specific set of circumstances, a company acting in a way that disturbs the power company's monopoly by offering a more accessible way for businesses and individuals to use green energy, should not be punished. The power grid and all of the technology already in place, is a public utility meant for the public good. Erecting barriers that prevent individuals from using clean energy is not reasonable and does not promote the public good.

In future cases, an exception should be made for companies, like NC AWARE, that attempt to make it easier for everyday people to use clean energy.[47] It seems highly unfair and unjust to be able to frame a relatively small company as a "public utility" in this way. Until a company like NC AWARE becomes such a force that the power company with the monopoly is taking significant losses, there seems to be no need for such harsh action.

VI. Conclusion

There is still a long way for alternative energy to go to be fully integrated into the grid, but there is definitely hope for a brighter and cleaner future for our power grid. The short-term options of sub hour dispensing, more demand response technology, and more transmission lines are all achievable. The long-term option of battery storage is also only awaiting further investment and adoption. Here in North Carolina, our legislature needs to take steps to further incentivize collaboration among groups like individual clean energy producers and Duke Power. It would also be beneficial to produce policy which incentivizes Duke energy to work on improving our aging power grid.

[47] State ex rel. Utilities Comm'n v. N. Carolina Waste Awareness & Reduction Network, 805 S.E.2d 712 (N.C. Ct. App. 2017)