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A brief from the Legislative Research Office August 2022

Get Smart: Modernizing the Electric Grid

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The antiquated U.S. electric grid is being strained due to recent weather conditions and from the mass proliferation of electronic equipment. Both of these issues increase peak demand on a grid that is in desperate need of a widespread infrastructure upgrade. In 2021, for example, a heat wave in California necessitated rolling blackouts, and Hurricane Ida destroyed over 30,000 wooden utility poles across southwest Louisiana, which left millions of people without power for days. Also that year, a summer storm caused the Omaha Public Power District's largest power outage in history, affecting around 200,000 customers.

In their 2022 Summer Reliability Assessment released in May, the North American Electric Reliability Corporation noted that, "Drought conditions create heightened reliability risk for the summer." Shortly after, the electricity regulator in Texas cautioned that power use during peak times should be reduced to avoid rolling blackouts, fearing that a coming heat wave would raise demand. The regulator's warning came a year after the lone star state suffered a winter storm that collapsed the state grid resulting in the death of 246 Texans. Lastly, a request for a federal disaster declaration was approved by President Biden after severe storms in May 2022 blew 100 miles per hour wind gusts, which downed poles and power lines in 20 central and northeastern Nebraska counties.

"The challenges we face are both technological and institutional in nature; we need to advance and effectively integrate our technological solutions, as well as help decision makers with methods and tools so they can craft grid modernization strategies that deploy these solutions over time in practical ways to meet future demands."

- U.S. Department of Energy[1]

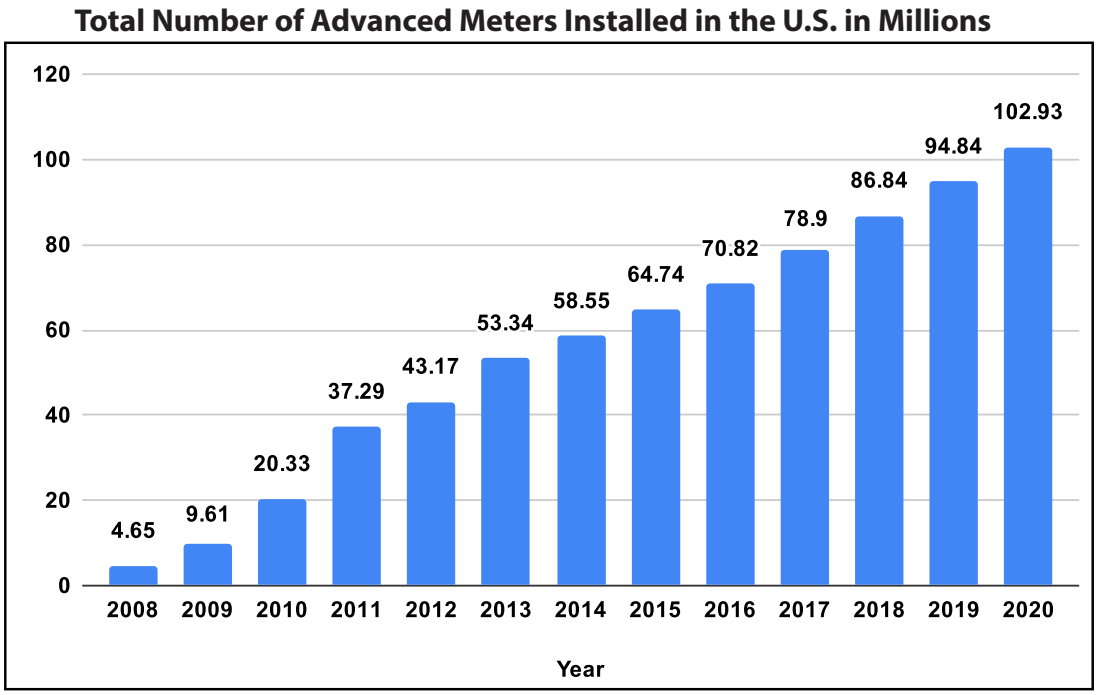
In order to reduce the impact of these disasters and to make electricity supply more reliable and efficient, governments and electric utility companies have been investing in grid modernization. A modern, or "smart," grid incorporates new technology to allow for a multi-directional flow of electricity, increased energy storage, instant monitoring and analysis of supply and demand data, and better consumer energy management.

Grid Modernization

First built 130 years ago, the U.S. electric grid has continuously been updated with the advent of new technology such as higher voltage power lines. Currently, the grid consists of thousands of power generating units that are connected to over 600,000 miles of transmission lines and 5.5 million miles of distribution lines.[1] Grid modernization encompasses updates to all aspects of the physical and digital electric power system; from generation to transmission and distribution and finally to end use. Technically, what makes a grid "smart" includes the installation of sensors that assess grid stability, meters that automatically report outages, and technology that enables the sharing of power and data between a supplier and the consumer.

The average number of power outages per year in the U.S. from 2015-2020 (9,656) was more than double the annual average number of outages during the six years prior to 2015 (4,609).[2] The two-way communication provided by a smart grid allows for the automatic rerouting of power during an outage or an equipment failure. During an outage, the issue can be quickly identified and confined, which minimizes the power disturbance before it becomes a large-scale blackout. Power supply can also be prioritized for emergency services, aiding in the rapid recovery of a community after a loss of electricity. A multi-directional network also provides customers and localities the ability to integrate their own power generation from small- or large-scale renewable sources.

1. United States Department of Energy. (2022, January). 2020 Smart Grid System Report. Department of Energy. https://www.energy.gov/sites/default/files/2022-05/2020%20Smart%20Grid%20System%20Report_0.pdf



Source: EIA

With this type of distributed generation, a town could power their own critical infrastructure and keep emergency services operating when power is unavailable from a utility. A related smart grid concept is called net metering, where customers generating their own electricity can sell the excess power they create back to the utility company for a credit on their bill.

The creation of a microgrid also helps communities maintain energy supply during a wider outage, and allows for increased integration of renewable energy. Considered a custom energy system, microgrids can be disconnected and operate separately from the wider grid. Another integral part of the smart grid is the capability for energy storage from renewable sources. The inconsistent nature of renewable energy necessitates the ability to store generated power for when it is most needed. With both a microgrid and energy storage, a community can be confident in energy reliability and resiliency.

The number of installed "smart meters" in the U.S. has grown every year since 2008. Covering nearly 75 percent of households in the U.S., almost 103 million total advanced meters were installed by the end of 2020. The estimated total number of necessary installations is just over 154 million advanced meters.

These devices, along with other smart grid components, provide greater customer control and allow the user to view real-time details about electricity consumption like the amount of power drawn, the time of use, and the cost. The information provided enables the end user to decrease energy expenses by cutting down on their electricity use when costs are high.

Finally, modernizing the physical infrastructure of the grid includes upgrading existing transmission lines, replacing the distribution lines that bring power to the public, and constructing new lines from renewable energy sources. Not only will new technology need to be installed, but a more resilient grid requires reliable hardware. Transmission poles downed in Louisiana during Hurricane Ida were insufficient to withstand 150 mile-an-hour winds, but previous infrastructure standards expected slower wind speeds.

Goals and Investment

Recent studies about the cost of national grid modernization found that estimated replacement and installation costs ranged from $1 trillion to $2.4 trillion by 2050.[2] Since the passage of the Infrastructure Investment and Jobs Act, the Department of Energy (DOE) has developed a $2.3 billion formula grant program dedicated to grid modernization.

2. Creaky U.S. power grid threatens progress on renewables, EVs. (2022, May 12). Reuters. https://www.reuters.com/investigates/special-report/usa-renewables-electric-grid/
3. National Conference of State Legislatures. (2021, September). Modernizing the Electric Grid: State Role and Policy Options. NCSL. https://www.ncsl.org/research/energy/modernizing-the-electric-grid-state-role-and-policy-options.aspx

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DOE has stated that investments in smart grid technology grew from $3.4 billion in 2014 to $6.4 billion in 2018 and are projected to increase to $16.4 billion annually by 2026.[1] Nationally, President Biden has set a goal of 100 percent carbon pollution-free electricity by 2035, and the recently signed Inflation Reduction Act includes tax credits for clean energy companies to deploy more solar, wind, and grid-scale battery plants. Nebraska is one of 16 states without a climate action plan of its own. LB266 (McCollister), introduced in 2021, would have required public power providers to reach net-zero carbon emissions by 2050.

Other than federal financing, the way energy rates are determined can spur investment in modernization. State legislatures are able to lay the groundwork wherein public utility commissions operate. Legislative policy can shape rate design to achieve objectives like lowering peak demand, increasing efficiency, and integrating distributed energy resources. In addition, policy can require that commissions study different rate designs and produce reports.[3]

In states across the country, electric utilities are investing in their own equipment to increase reliability. The major electric utility in Delaware, a state with one of the lowest rates of power outages, has prioritized grid modernization and has recently completed a $21.5 million project to refurbish power lines.[4] In Nebraska, the Omaha Public Power District stated in a recent news release that it is investing in grid modernization and smart grid technology, and it has a stated goal of becoming a net-zero carbon producer by 2050.[5]

Nebraska Public Power District (NPPD) notes two current grid modernization projects: a battery energy storage system (BESS) and a new transmission line, called the R-Line project. In Norfolk, the BESS demonstration project will connect to local solar energy generation and discharge the stored energy daily. The R-Line project is intended to increase transmission system reliability, relieve strain on the existing system, and aid in the development of renewable projects.

The R-Line was planned to be constructed between Lincoln, Thomas, and Holt counties, but has been temporarily halted due to environmental concerns until more research is conducted.[6] NPPD board of directors approved a goal of net-zero carbon emissions from generation resources by 2050.

Overview of Select Smart Grid Technologies Across the Power System

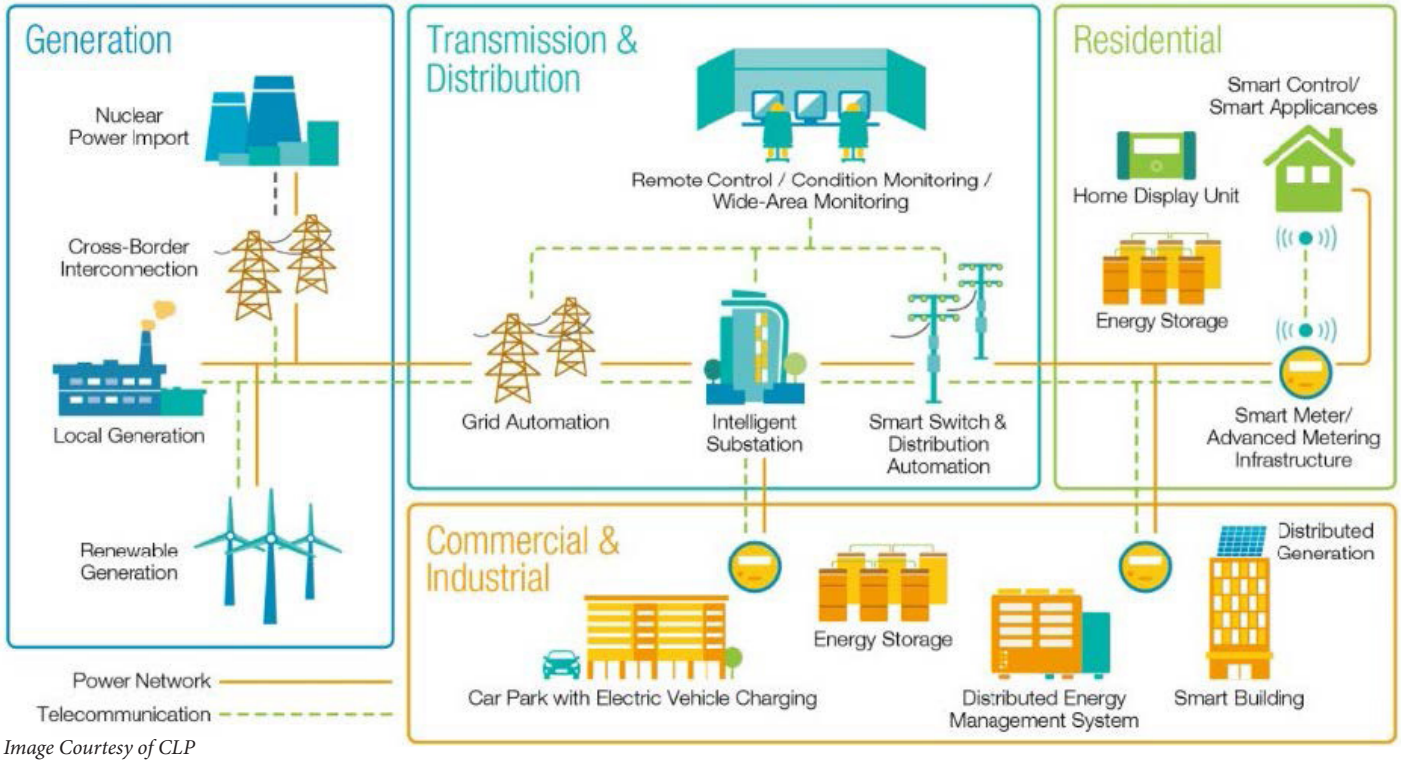

Image Courtesy of CLP

4. Cohn, S. (2021, July 14). These are America's 10 best states for infrastructure. CNBC. https://www.cnbc.com/2021/07/14/these-are-americas-best-states-for-infrastructure.html

5. Omaha Public Power District. (2022, January 20). OPPD Board of Directors Meeting. OPPD. https://www.oppd.com/news-resources/news-releases/2022/january/oppd-continues-strong-focus-on-reliability-resiliency-for-future-generation/?label=2022+News+Releases

Transmission System in Relation to Power Generation and Distribution

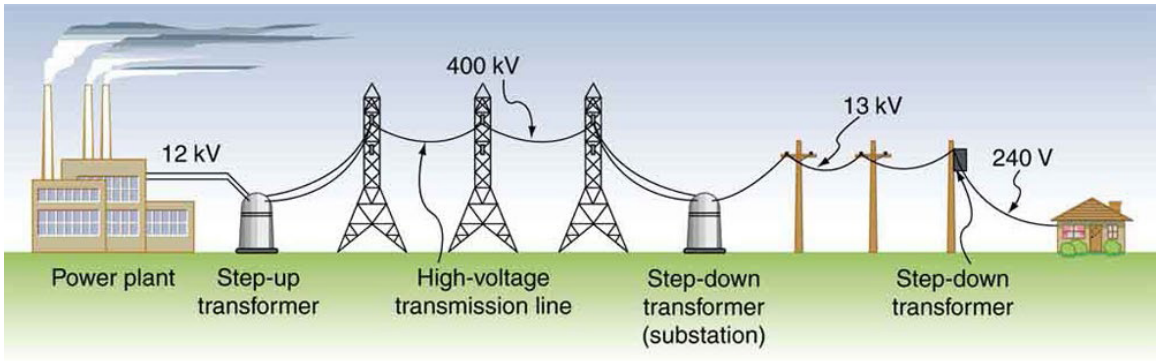

Image Courtesy of Electrical Academia

With the goal of increased energy reliability, the Lincoln Electric System (LES) placed a microgrid into service in October 2020. The Lincoln microgrid employs the existing power distribution network and a generator powered either by diesel or natural gas. During an emergency or outage, the microgrid can power downtown Lincoln including the arena, residential buildings, businesses offering fuel and food, local government facilities, and the state capitol building. Because LES already possessed the necessary components, the microgrid was installed at virtually no cost.[7] Compared to other public utilities in the state, LES has set a more ambitious goal of 100 percent net decarbonization by 2040.

State Policy Actions

A matrix of local, state, and regional regulators have the authority to initialize grid modernization - not the federal government. Within the country's three interconnections, which generally operate independently of each other, there are a number of balancing authorities, known as independent system operators (ISOs) and regional transmission organizations (RTOs). Generally, state policy actions for modernizing the grid include creating commissions to study the issue, comprehensive legislation, and appropriating funds or establishing grants for research and development of smart grid technology.

States like Minnesota and Missouri, among a few others, have passed expansive bills that bolster ongoing grid modernization. Nearly 30 states, other than Nebraska, have approved renewable portfolio standards, which instruct utilities that a percentage or amount of their energy sales shall originate from renewable sources.

A handful of states, including Maine and New Mexico, recently passed bills setting dates for when all energy must be generated from carbon-free sources. Most states provide net metering or another version of compensation for generation, including the state of Nebraska where LB436 (Haar) was signed into law in 2009.[3]

In their latest Grid Modernization Index report, GridWise ranks all states and Washington D.C. on their progress towards a modern electric system. The Index takes into account over 75 metrics across three categories: state support, customer engagement, and grid operations. Nebraska ranks near the bottom of states (48th) in the most recent Index from GridWise.

A modern and efficient energy system is an integral part of the largest industries in Nebraska, where grid reliability and outage repair ranks high among other states. However, current heat and drought conditions are increasing the risk of grid overload and disruptions to farming operations. Just across the southern border, weather patterns may elicit a worse drought than 1956, the driest year ever recorded in Kansas. In the cornhusker state, the University of Nebraska recently stated that 50% of Nebraska is experiencing severe or worse drought conditions. Furthermore, the manufacturing industry in Nebraska, including ethanol plants, requires quality inputs and cheap and dependable energy in order to conduct business uninterrupted.

As with any new technology, consumer education and the development of standards and regulations will be critical for successful implementation. Successful modernization depends on energy regulatory commissions that have the authority to govern smart grid implementation.

6. Nebraska Public Power District. (2022). Current Projects. NPPD. https://www.nppd.com/powering-nebraska/projects?locale=en
7. Lincoln Electric System. (2021). 2021 LES Sustainability Initiatives. LES. https://www.les.com/sites/default/files/board-071522-decarb.pdf