Opportunities From the Aging US Power Grid

The US power grid is stressed and at increasing risk of serious disruption or failure. Power outages are becoming more frequent. Data from the US Department of Energy shows that there was a 64% increase in major outages – defined as affecting 50,000 customers or more – in the 2011-2021 period, as compared to 2000-2010.

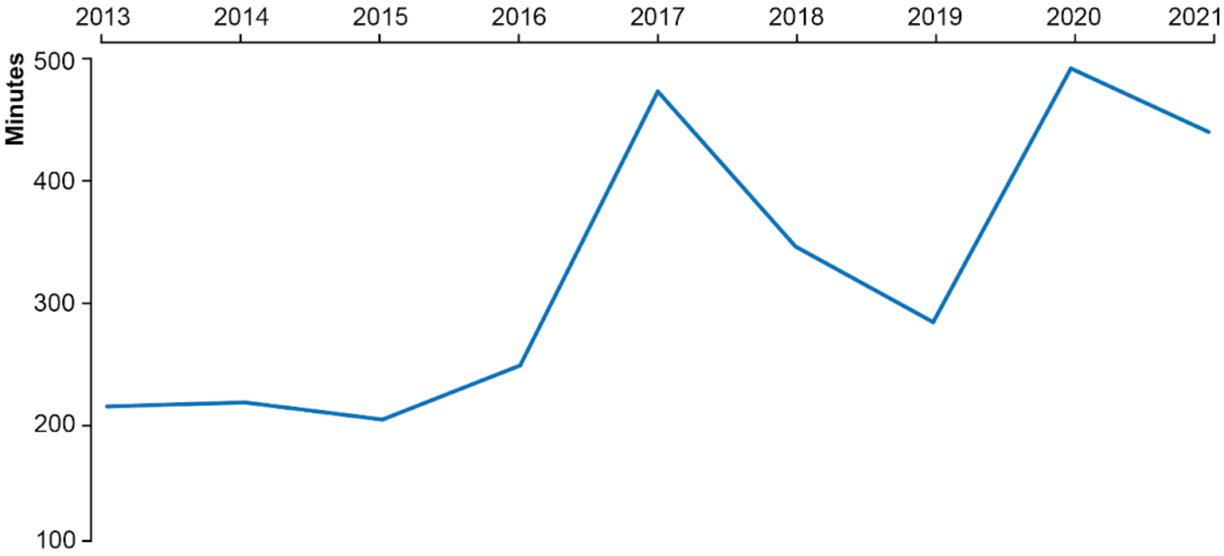
When they occur, power outages are lasting longer. DOE data shows that, from 2013 to 2021, the average duration of a power outage more than doubled, from about 3.5 hours to more than 7 hours.

Power Outages Are Getting Longer and More Frequent

The U.S. Energy Information Administration uses System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) as measures of electricity reliability.

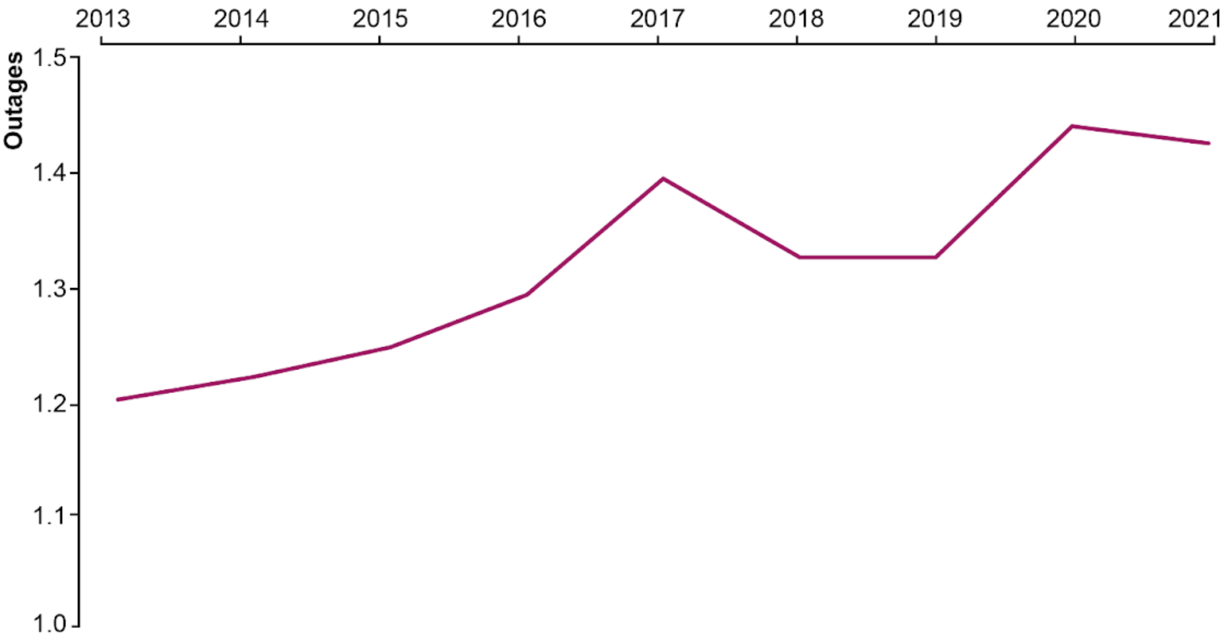
Duration of Power Interruptions

SAIDI refers to the number of minutes of nonmomentary electric interruptions a customer experiences in an average year.



Frequency of Power Interruptions

SAIFI is the number of interruptions a customer experiences in an average year. It measures the frequency of power outages.

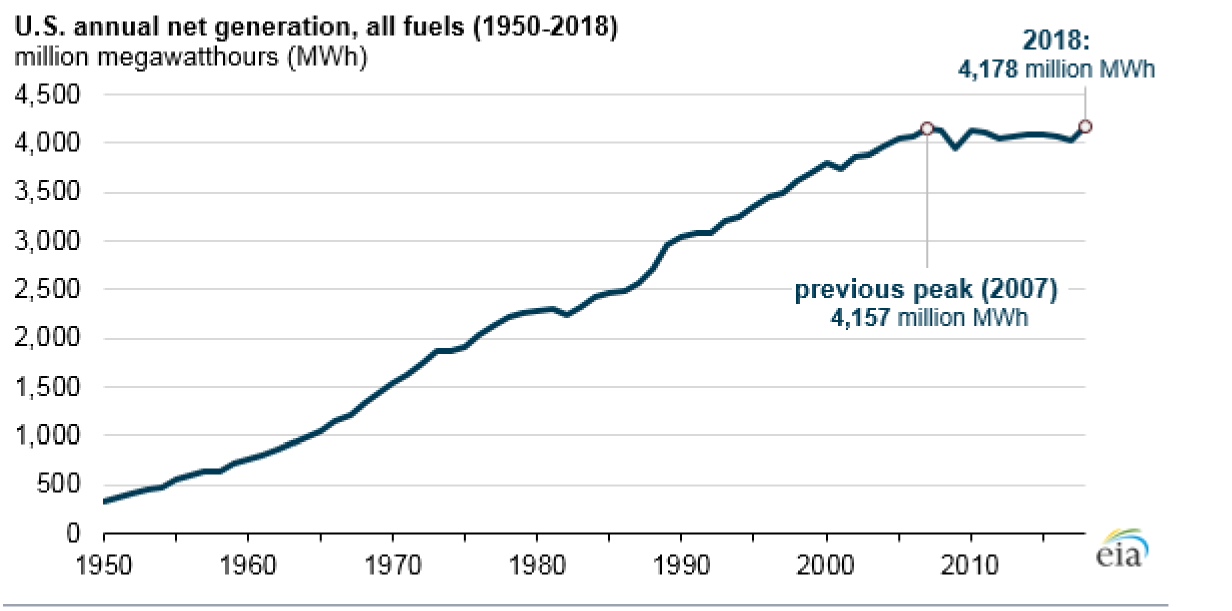


Source: Scientific American

Experts attribute this to three factors.

Aging infrastructure: Most parts of the U.S. power grid were designed and installed in the 1960s and 1970s, and with such equipment generally having a lifespan of about 50 years, much of our grid is past its expiration date. This leaves it less resilient,more prone to outages, and more difficult to bring back online after outages occur.

Increased demand: Demand for electricity has grown steadily over the past half century on an absolute level and on a per-capita basis. Increased industrialization, followed by increased computerization and digitization, have driven demand growth until now, and our accelerating transition from gas-powered cars and trucks to electric vehicles will only continue that growth.



Source: U.S. Energy Information Administration

Severe weather events: Storms, heat waves, and other extreme meteorological phenomena further add to the strain on the US power grid. Such disasters are occurring more and more frequently, and when they do, they are more and more intense. According to Climate Central, "Between 2011 and 2021, the average annual number of weather-related power outages increased by roughly 78%," compared to the preceding decade, and it's not difficult to see why.

This troubling state of affairs is made more fragile by the growing threat of cyberwarfare. The Department of Homeland Security regards cyberattacks as one of the biggest threats to the country's infrastructure. In March 2018, both the DHS and the Federal Bureau of Investigation warned of an ongoing, years-long effort by hackers linked to the Russian government to target the American electrical grid.

All of this points to an increasingly urgent need to significantly upgrade and update the US electrical grid as a whole. It stands to reason that companies that can play a role in such efforts are in a position to benefit – as are their shareholders. Small wonder, then, that President Biden has made modernizing and strengthening the power grid one of his major infrastructure initiatives, proposing more than $100 billion in funding to upgrade and improve the US power grid.

What is a power grid?

A power grid refers to all of the infrastructure used to generate electricity and deliver it to residential and commercial end-users. It includes:

- **Power plants** that generate electricity, typically by burning fossil fuels.
- **Transformers** that increase (or "step up") the voltage for longer-distance transmission and later reduce it (or "step it down") for local distribution to the end user. (High-voltage electricity can be more efficiently transmitted over longer distances, but is less safe for consumers.)
- **Transmission and distribution lines**, both overhead and underground, carrying electricity to users.

Since the beginning of US electrification in 1882, the US electric grid has grown to incorporate 11,000 power plants and 2 million miles of power lines, all owned and operated by some 3,000 utility companies. The current power grid has little storage capacity, and power-plant operators are forced to anticipate demand and match output accordingly. When power-plant operators overestimate demand, grid controllers help by coordinating distribution to where operators have underestimated demand.

This is important not just for meeting customer needs, but also because excess generated electricity can damage various parts of grid infrastructure and even cause blackouts. The August 2003 Northeast blackout, which affected 55 million people in the Northeastern US and parts of Canada, is an extreme example of what can happen when the system for distributing excess electricity to parts of the grid fails to work properly.

What might a modernized power grid look like?

Much of the US power grid was put in place at a time when large-scale power storage technology did not exist, when fossil fuels were generally the only way to generate electricity, and before the digital age. Advocates believe that a modernized power grid could exploit progress in those areas to create a systemthat is better able to prevent blackouts, to recover from them when they emerge, and to meet our increased demand for electricity – all while helping deliver energy independence, environmental benefits, and longer-term economic gains.

Much of that involves the increasing use of "green" energy sources to generate electricity – particularly solar and wind power. In 2016, the National Renewable Energy Laboratory (NREL) estimated that the potential US generative capacity from solar and wind power each far exceed current consumption levels of approximately 4,050 terawatt hours per year. It should be noted that the NREL based its calculations solely on technological and physical constraints. It does not consider potential economic or market-based constraints, and it does not consider the potential effect of any sociopolitical factors.

Nevertheless, the NREL estimates that the US has sufficient land space exposed to enough sunlight to generate many times that – 116,000 TWh per year. The potential from wind power is less impressive, yet still greater than current electricity demands – almost 50,000 TWh per year.

Table ES-1. Total Estimated U.S. Technical Potential Generation and Capacity by Technology

Technology	Generation Potential (TWh)[a]	Capacity Potential (GW)[a]
Urban utility-scale PV	2,200	1,200
Rural utility-scale PV	280,600	153,000
Rooftop PV	800	664
Concentrating solar power	116,100	38,000
Onshore wind power	32,700	11,000
Offshore wind power	17,000	4,200
Biopower[b]	500	62
Hydrothermal power systems	300	38
Enhanced geothermal systems	31,300	4,000
Hydropower	300	60

[a] Non-excluded land was assumed to be available to support development of more than one technology.
[b] All biomass feedstock resources considered were assumed to be available for biopower use; competing uses, such as biofuels production, were not considered.

Source: National Renewable Energy Laboratory, "US Renewable Energy TechnicalPotentials: A GIS-Based Analysis."

The challenges for modernizing the U.S. power grid involve control, storage, and distribution. These are also problems that confront those focused on making the power grid more resilient, more agile, and better at efficient storage and distribution.

Power Storage Capabilities

In layman's terms, there are two major challenges to wide adoption of renewable energy. The first is that the sun doesn't always shine, and the wind doesn't always blow. Therefore, to maintain a dependable, uninterrupted supply of renewably generated electricity, renewable-power plants need the ability to generate maximum levels of energy whenever possible while storing the excess for later use.

As with electric vehicles, battery technology will be key to this objective. Companies involved in developing battery technology and producing power-storage solutions can expect to benefit. They include:

Tesla ($TSLA). Though best known for its electric vehicles, Tesla also makes a variety of power-storage systems, including its commercial/utility-grade Powerpack and Megapack battery systems.

Fluence Energy ($FLNC). This joint venture between Siemens ($SIEGY) and AES ($AES) focuses on grid-scale battery solutions, along with an accompanying software and digital intelligence package for managing power storage.

Eos Energy Enterprises ($EOSE). Unlike the other companies in this section, EOS makes zinc-based, grid-scale battery solutions. Zinc has lower power density capabilities (i.e., bigger batteries are needed per watt of storage), but they are generally less expensive and safer than other battery technologies.

More Efficient Long-Distance Transmission

A second problem with renewable energy is that the sunniest and windiest parts of the United States are typically not near the parts of the country that use the most electricity.

Most fossil-fuel and nuclear power plants are located within several hundred miles of their primary end users. A shift to greater use of renewable energy, however, could mean that electricity generated from an offshore wind farm would need to be transmitted to a customer in the Midwest, or from a solar-panel farm in Texas to customers in Pennsylvania.

This would likely require the installation of millions of miles of HVDC (High Voltage Direct Current) lines across the country. HVDC is generally regarded as superior to the more common HVAC cables used in the US power grids, because they transmit with less power leakage, take up less space, and can thus be installed underground (which makes it easier to get regulatory approval) or even underwater (useful for offshore wind farms.) HDVC systems also offer more precise control of voltage and flow, thus resulting in better grid stability.

Some companies that manufacture HVDC cables and systems include:

ABB ($ABBNY). ABB is one of the largest automation solutions providers in the world. Its Power Grids division offers ways to automate and optimize generation, transmission, and storage of electricity, both for power utility and microgrids. This includes communications, cables, infrastructure, and analytics software.

General Electric ($GE). GE's Grid Solutions division provides products, services, and expertise related to long-distance transmission, automated monitoring and diagnostics, advanced grid analytics, and grid-management software.

Siemens ($SIEGY). Siemens provides products and services for grid automation, grid management, and power grid digitalization. This includes HVDC cabling and systems, storage solutions, switches, transformers, and more.

Smart controls

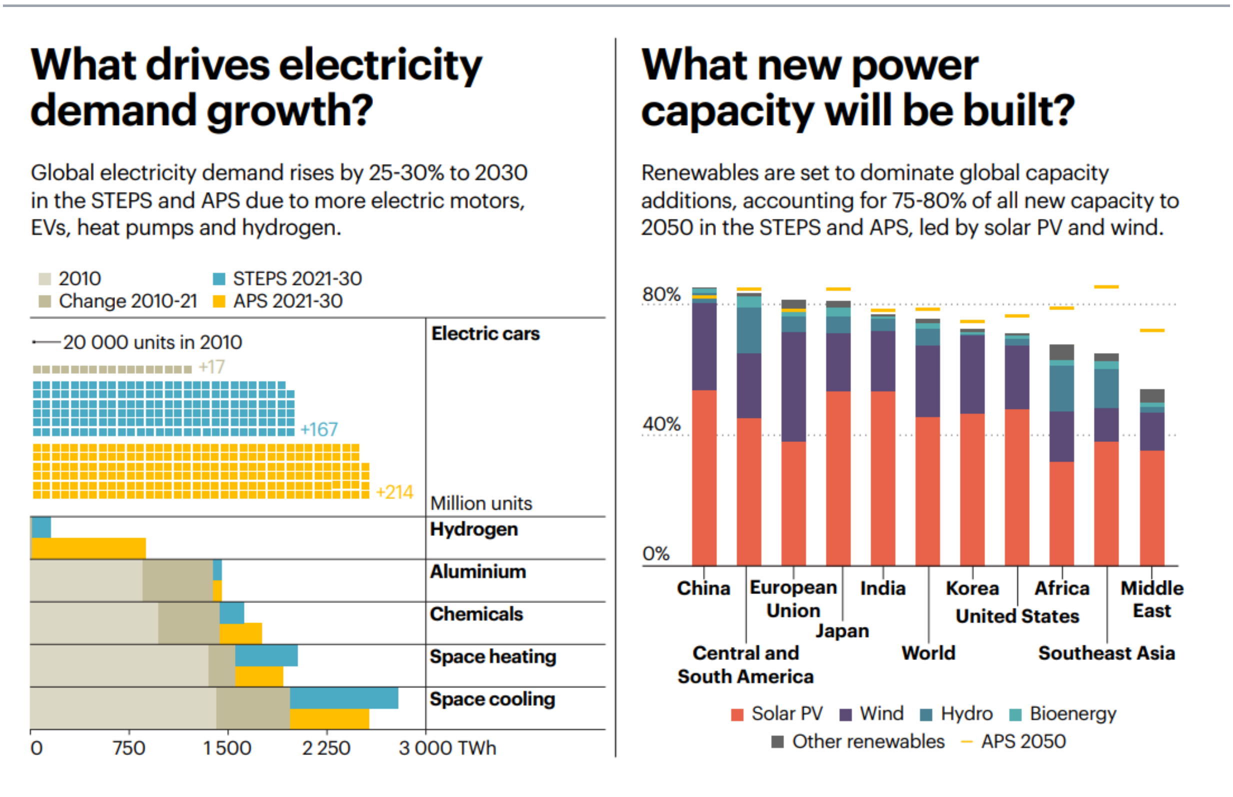
Modernizing the US power grid fundamentally means improving scale and capacity. This requires infrastructure capabilities including:

- Real-time metering and connection monitoring
- Automated distribution controls to monitor grid performance, identifying potential fluctuations in supply and demand and quickly redirecting power flow in response. This includes the ability to detect outages and reroute power while bringing back affected parts of the grid back online.
- Communications that allow grid participants to monitor usage to detect waste and reduce costs.

A modernized power grid will also require leading-edge cybersecurity, and cybersecurity companies can expect to benefit from the modernization of the US power grid. We will reserve a discussion of cybersecurity companies for a separate edition of *Signal From Noise*.

The rest of the world

Finally, it is worth noting that such companies are also in a position to benefit from increased global demand for electricity, in our view. The International Energy Agency projects that global demand for electricity will grow 25-40% by 2030, and 77%-150% by 2050. Demand is projected to grow particularly quickly in emerging economies like India and various countries in Southeast Asia, Africa, and Central and South America, driven by population growth and increasing electrification.



Source: IEA, *World Energy Outlook 2022*

Challenges

Although the need and the opportunities described above are considerable, so too are the challenges. Large infrastructure projects, such as building or modernizing electrical power systems, municipal water systems, and railroads, typically require the involvement of a dizzying array of federal, state, and local regulatory bodies, and the ability to navigate the various and at times conflicting laws under which they operate. Inertia and tight budgetary constraints often work to impede progress, particularly since such projects tend to be expensive and only yield benefits years in the far-off future.

Companies hoping to participate in the modernization of the US power grid must also deal with the country's approximately 3,000 independent electricity providers, a mix of publicly traded for-profit companies, non-profit cooperatives, and entities owned and/or operated by public sector entities at the federal, state, and local levels.

And then there is the risk from new technologies. Among those in the early stages of development include efforts by California Institute of Technology scientists to harvest solar power from satellites and beam it via focused microwaves to receptor stations on the ground. EMROD, a New Zealand-based startup, is currently testing a system to beam electricity through focused electromagnetic waves, by way of antennas and relay stations up to 25 miles apart. EMROD is also developing a satellite-based electricity-distribution system that could work in a similar fashion to the Caltech team's.

Nevertheless, the current practice of patching up antiquated systems will likely someday come up against drawbacks too significant to ignore, and when that happens, this will provide investors with some potential opportunities. As always, *Signal From Noise* should serve as a starting point for further research before making an investment, rather than as a source of stock recommendations. Although the names mentioned above each have the potential to benefit from the need for a modernized US power grid, this alone should not be the basis of a decision to invest.

We encourage you to explore our full *Signal From Noise* library, which includes deep dives on the path to automation, the transition to electric vehicles, and the increasing importance of Big Data solutions. The library also features an examination of the youngest generation of adults, Generation Z.

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