Why the United States Needs a National Power Grid

Briefing Note

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Introduction

The Biden Administration has proposed investing in reliable, efficient electric power lines that deliver more renewable energy.[1] In the "American Jobs Plan,"[2] released on March 31, the Administration laid out a plan for investing in American jobs and renewable energy, as well as strengthening the resilience of the electrical grid. However, the United States needs a national power grid in order to increase its energy security and resilience to extreme weather events. By improving electricity transmission, a national power grid would also make the transition to clean energy easier and cheaper. The Administration should seek to better integrate the United States' three disparate electrical grids as part of its new infrastructure bill.

High voltage transmission lines in Duchesne County, Utah. Photocredit: Wikicommons / Staplegunther

The Texas Power Outages Reflected the Limitations of Isolated Power Grids

The extremely unusual cold snap Texas experienced in February 2021 paralyzed its electrical grid, triggering rolling blackouts and leaving over 4 million people without power.[3]

Electrical grids need to be constantly calibrated to ensure that supply and demand are perfectly matched.[4] The cold snap in Texas dramatically increased electricity demand[5] while damaging both renewable and conventional energy generators due to freezing conditions, thus decreasing supply. Over 80% of the power outages were caused by lack of electricity supply from fossil fuel generation systems.[6]

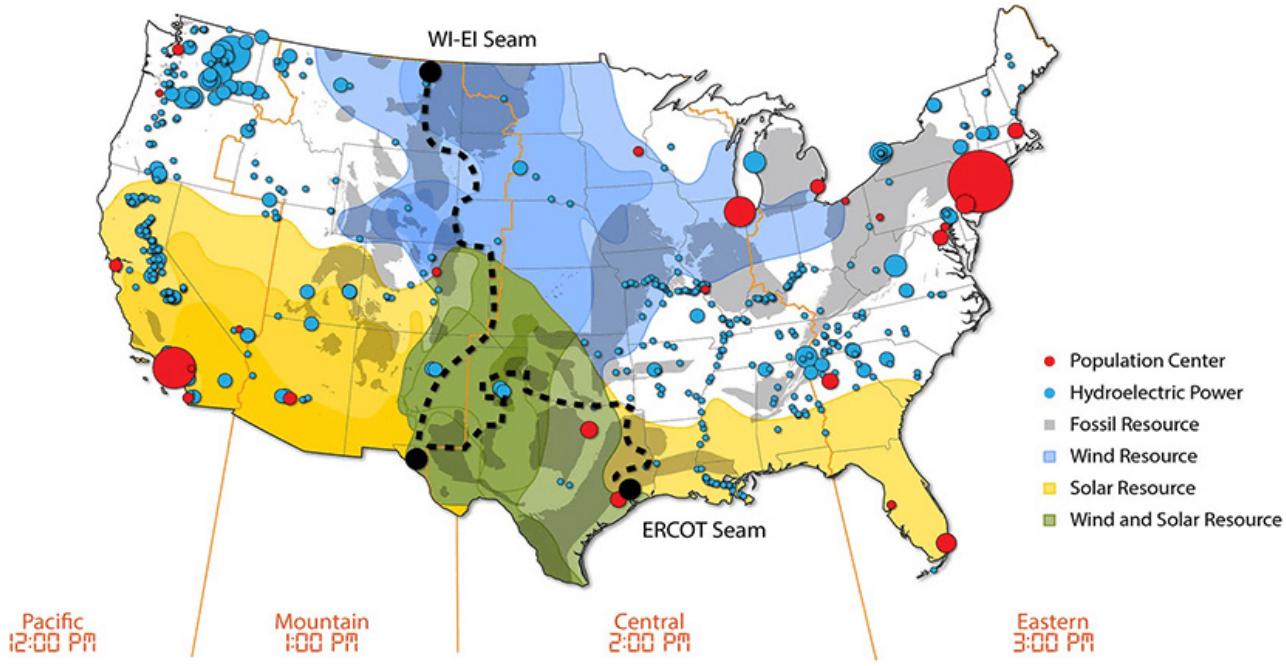
The Texas grid operator, or the Electric Reliability Council of Texas (ERCOT), planned to have about 67 gigawatts[7] of electricity available for extreme winter conditions – the majority of which would have been from natural gas.[8] However, actual peak demand during the storm soared to over 74 gigawatts.[9] As demand rose, energy supply, particularly from natural gas, fell dramatically. Approximately 40% of natural gas capacity was unavailable for an extended period during the crisis,[10] while renewable generation fluctuated and sometimes even exceeded expected generation levels.[11]

The electricity supply crisis was exacerbated by the fact that ERCOT is its own independent power grid that is not interconnected with the rest of the country. This means that Texas was unable to draw electricity from power generators elsewhere that were not experiencing freezing conditions.

Analysts have pointed to insufficient winterization of power plants and natural gas storage facilities as the driver behind the rolling blackouts.[12] However, the Texas crisis also laid bare the vulnerability of self-contained, decentralized power grids, particularly in the face of extreme weather events, which will likely become more frequent due to climate change.[13]

The U.S. Power Grid is Divided and Vulnerable to Climate Change

Right now, the U.S. power grid is split by two major 'seams'[14] — one that divides the eastern power grid and western power grid along the Rockies, and the other which encircles Texas' ERCOT grid. Currently, the Eastern and Western Interconnections and ERCOT operate independently from each other, and hardly any electricity is transferred between them.



This graphic shows how the major regions of the U.S. power system could be connected, enhancing the ability to harness abundant renewable resources and balance loads across the country. WI = Western Interconnection; EI = Eastern Interconnection; ERCOT = Electric Reliability Council of Texas. Image credit: NREL.

In addition, U.S. electricity infrastructure is notably unreliable compared to other developed countries. The American Civil Society of Engineering gave the U.S. power grid a C- on its report card on America's infrastructure.[15] The report finds that severe weather caused the majority of transmission outages between 2014 and 2018. The report also highlights the need to improve grid reliability and expand transmission infrastructure to increase power delivery from generation sources to areas with high energy demand.

However, the United States must prepare for increased damage to its electrical grids in the future as extreme weather events become more frequent due to climate change.[16] According to Climate Central, extreme weather-related events — including heat waves, heavy rains, and winter storms — caused a 67% increase in major power outages in 2019 compared to 2000,[17] the majority of which was due to damage to large transmission lines and substations.[18] In addition to the Texas cold snap, recent examples of power outages caused by extreme weather events include Hurricane Sandy in 2012, which cut power to over 8.5 million U.S. customers,[19] and planned blackouts to mitigate wildfire risks in California in 2019[20] and 2020.[21]

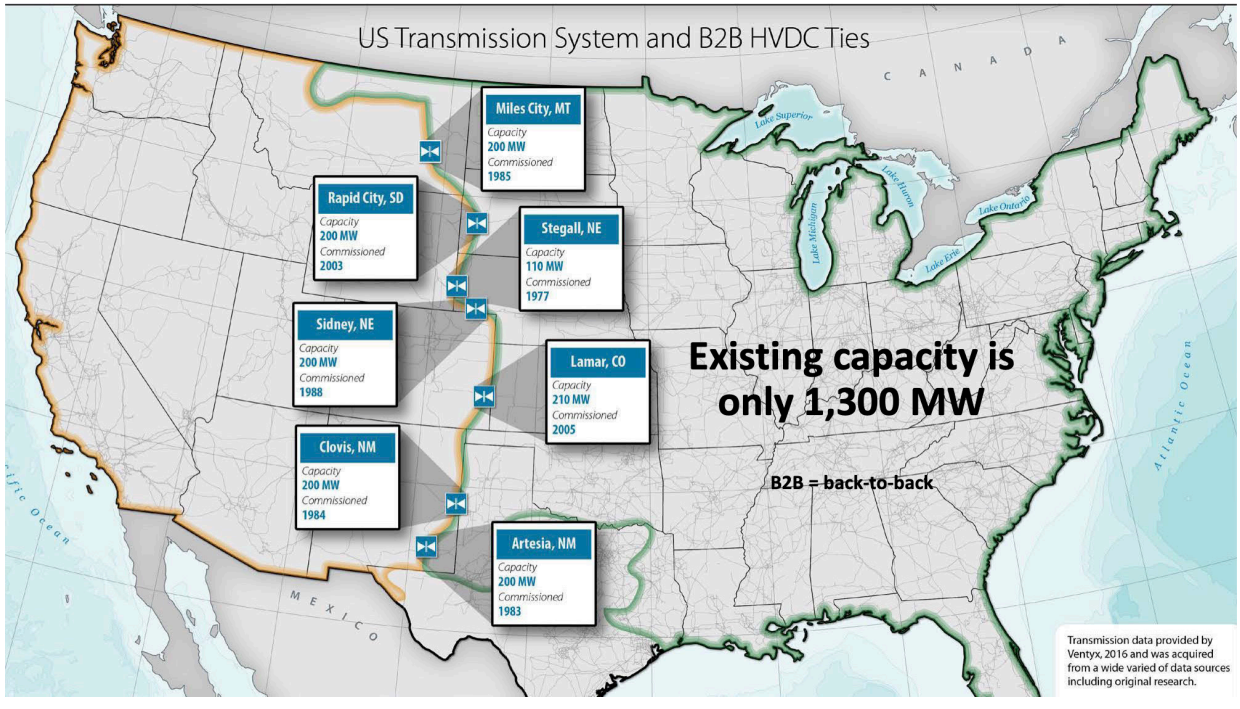
There is near scientific certainty that climate change is causing long-term global warming, but there is also evidence that climate change may cause extreme winter weather when the Arctic is unusually warm.[22] This is because warm temperatures may destabilize the polar vortex, or the circulation of low-pressure, extremely cold air swirling above the Arctic, sending pieces of it toward the United States, Europe, and Asia.[23] These weather patterns in turn cause unusually cold winter conditions, meaning that once-in-a-century[24] cold snaps like the one seen in normally-warm states like Texas may become more common. As a result, long-term planning is necessary to strengthen power grid resiliency in the face of such conditions.

A National Power Grid Would Increase Energy Security and Accelerate Decarbonization

Moving to a national power grid would increase grid reliability and incentivize development of clean energy. Not only would a national grid improve the country's grid and help meet decarbonization goals, but it also would likely save consumers a considerable amount of money in the long run.

Moving to a national power grid would strengthen energy security. If the United States had a nationwide electrical grid, operators could instantaneously divert power to areas that are experiencing extreme weather that might have limited or constrained local generation. For example, while most of Texas was experiencing wide-ranging blackouts, the impact in El Paso was minimal.[25] Even though this region endured the same winter storm, it is located within a small section of Texas that is actually connected to the Western Interconnection, as opposed to ERCOT. Instead of suffering forced blackouts, El Paso was able to import electricity from areas of the western grid that were not experiencing extreme weather.

A nationalized power grid would also be cost effective. A study by the National Renewable Energy Lab (NREL)[26] looked at the potential for increasing the cross-seam transmission capacity between the Eastern and Western Interconnections, and found that integrating the two Interconnections through high-voltage direct-current transmission would lead to net cost savings.[27] NREL's analysis showed that the benefits would outweigh the costs by almost a factor of three because of increased grid flexibility, transmission optimization, and sharing of generation resources.[28] According to another study by the National Oceanic and Atmospheric Administration (NOAA), a national power grid could save consumers $47.2 billion per year by making the system more efficient and unleashing the potential of renewable energy sources.[29]



This graphic shows the current capacity of the high-voltage, direct current (HVDC) electric power transmission system between the Eastern Interconnection and Western Interconnection and existing back-to-back transmission facilities. Image credit: NREL.

Finally, a national power grid would accelerate the clean energy transition and help fight climate change. The electricity sector is responsible for approximately 27% of total U.S. greenhouse gas emissions.[30] Decarbonizing this sector is key to mitigating climate change and reducing the likelihood of extreme weather events.

Long-distance high-voltage transmission lines would improve efficiency by allowing states with high renewable energy generation potential (for example, the Upper Midwest and Texas) to transmit energy to states with high energy demand (for example, the West and Northeast).[31] Coupled with energy storage, a national grid would reduce variability from renewable energy by allowing power grids to draw on energy resources from other regions.[32]

Investing in high-voltage transmission lines would also decrease grid congestion, a major problem in some regions that results in backlogs of unbuilt energy projects.[33] If there is not enough transmission capacity to deliver electricity from planned or newly built power resources, these projects must wait in an interconnection queue until network capacity can be expanded. According to Americans for a Clean Energy Grid, 734 gigawatts of proposed generation were waiting in interconnection queues nationwide in 2019, with almost 90% of that backlog in renewable projects.[34] Building transmission lines will incentivize development and allow for quicker and easier renewable energy deployment in resource-rich locations.

Interestingly enough, Texas has actually demonstrated this point at the state level through its Competitive Renewable Energy Zones (CREZ) initiative. In 2005, the Texas legislature passed a bill that directed its Public Utility Commission to identify regions to be beneficiaries of transmission upgrades in order to attract new wind projects. This CREZ program led to the development of long distance transmission lines connecting the sparsely-populated but windy western Texas region to the load centers in eastern Texas.[35] It has subsequently resulted in Texas becoming the nation's leader in wind power, with about three times as much generation capacity as the state with the next highest amount, while also more recently enabling a boom in utility-scale solar.[36] If similar programs can be implemented at the national level, it will likely create comparable results on a larger scale.

Concluding Thoughts

While this paper argues that the United States needs a national power grid in order to boost reliability and accelerate decarbonization, some think that moving to a more distributed grid, or microgrids, would be a better solution to improving grid resiliency.[37] Microgrids are localized distributed generation systems that can generate and store electricity for use independent of the national grid and can be disconnected from the grid as an "electrical island" in the case of a local blackout.[38] Microgrids do offer a number of benefits, including localized grid resiliency, avoidance of transmission and distribution losses, and reduced vulnerability to cyber attacks, among others.[39]

Although the focus here is on expanding to a national grid, this is not an either-or issue, and microgrids can be connected to a more efficient, integrated national grid. Climate change is a multi-faceted problem that will require many different solutions within every relevant sector. For the electricity sector, microgrids and distributed resources should be developed where their impact can be maximized. At the same time, the United States should work toward expanding transmission infrastructure and interconnecting larger regions of the grid.

Expanding to a national power grid would certainly be rife with challenges, including resistance at the state level, pushback from the fossil fuel industry, and technical complexity of grid integration. Nevertheless, a nationalized power grid is a vital long-term strategy to ensure the United States has a modern, resilient, and efficient energy system. The Biden Administration and Congress should meet the moment and pass legislation to connect the United States' disparate power grids as part of the American Jobs Plan.

Endnotes

1. Friedman, Lisa and Tankersley, Jim. "Biden's Recovery Plan Bets Big on Clean Energy." The New York Times. March 23, 2021. https://www.nytimes.com/2021/03/23/climate/biden-infrastructure-stimulus-climate-change.html. Accessed March 31, 2021.
2. The White House. "FACT SHEET: The American Jobs Plan." March 31, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/. Accessed March 31, 2021.
3. Caspani, Maria. "Cold snap leaves one dead, over 4 million without power in Texas." Reuters. February 15, 2021. https://www.reuters.com/article/us-usa-weather-texas/cold-snap-leaves-one-dead-over-4-million-without-power-in-texas-idUSKBN2AF0OK. Accessed April 1, 2021.
4. The Ezra Klein Show. "Transcript: Ezra Klein Interviews Leah Stokes and David Wallace-Wells." The New York Times. February 26, 2021. https://www.nytimes.com/2021/02/26/podcasts/ezra-klein-podcast-leah-stokes-david-wallace-wells-tra.html. Accessed April 1, 2021.
5. Roberts, David. "Lessons from the Texas mess." Volts. February 24, 2021. https://www.volts.wtf/p/lessons-from-the-texas-mess. Accessed April 1, 2021.
6. Greenberg, Jon. "Natural gas, not wind turbines, main driver of Texas power shortage." PolitiFact. February 16, 2021. https://www.politifact.com/article/2021/feb/16/natural-gas-not-wind-turbines-main-driver-texas-po/. Accessed April 1, 2021.
7. Milligan, Patrick. "Winter storms wreak havoc on ERCOT grid." ICF. February 23, 2021. https://www.icf.com/insights/energy/winter-storms-ercot-grid. Accessed April 1, 2021.
8. Gilbert, Alex; Bazilian, Morgan. "The Texas electricity crisis and the energy transition." Utility Dive. February 19, 2021. https://www.utilitydive.com/news/the-texas-electricity-crisis-and-the-energy-transition/595315/. Accessed April 1, 2021.
9. Milligan, Patrick. "Winter storms wreak havoc on ERCOT grid." ICF. February 23, 2021. https://www.icf.com/insights/energy/winter-storms-ercot-grid. Accessed April 1, 2021.
10. Gilbert, Alex; Bazilian, Morgan. "The Texas electricity crisis and the energy transition." Utility Dive. February 19, 2021. https://www.utilitydive.com/news/the-texas-electricity-crisis-and-the-energy-transition/595315/. Accessed April 1, 2021.
11. Morehouse, Catherine. "Power experts cite gas constraints as main cause of ERCOT outages, but system planning questions remain." Utility Dive. February 18, 2021. https://www.utilitydive.com/news/power-experts-cite-gas-constraints-as-main-cause-of-ercot-outages-but-syst/595255/. Accessed April 1, 2021.
12. Blanchard, Charles. "The Great Texas Blackout Was Caused by a Failure to Ensure Supplies of Natural Gas." Texas Monthly. March 3, 2021. https://www-texasmonthly-com.cdn.ampproject.org/c/s/www.texasmonthly.com/politics/texas-blackouts-natural-gas/amp/. Accessed April 1, 2021.
13. United States Environmental Protection Agency. "Climate Change Indicators: Weather and Climate." https://www.epa.gov/climate-indicators/weather-climate#:~:text=Scientific%20studies%20indicate%20that%20extreme,storms%2C%20floods%2C%20and%20droughts. Accessed April 1, 2021.
14. Fairley, Peter. "How a Plan to Save the Power System Disappeared." The Atlantic. August 20, 2020. https://www.theatlantic.com/politics/archive/2020/08/how-trump-appointees-short-circuited-grid-modernization/615433/. Accessed April 1, 2021.
15. "2021 Report Card for America's Infrastructure." American Society of Civil Engineers. https://infrastructurereportcard.org/cat-item/energy/. Accessed April 1, 2021.
16. United States Environmental Protection Agency. "Climate Change Indicators: Weather and Climate." https://www.epa.gov/climate-indicators/weather-climate#:~:text=Scientific%20studies%20indicate%20that%20extreme,storms%2C%20floods%2C%20and%20droughts. Accessed April 1, 2021.
17. Climate Central. "Power OFF: Extreme Weather and Power Outages." September 30, 2020. https://medialibrary.climatecentral.org/resources/power-outages. Accessed April 1, 2021.
18. Kenward, Alyson; Raja, Urooj. "Blackout: Extreme Weather, Climate Change, and Power Outages." 2014. pp. 4. https://assets.climatecentral.org/pdfs/PowerOutages.pdf. Accessed April 1, 2021.
19. Alemazkoor, Negin; Rachunok, Benjamin; Chavas, Daniel; Staid, Andrea; Louhghalam, Arghavan; Nateghi, Roshanak; Tootkaboni, Mazdak. "Hurricane-induced power outage risk under climate change is primarily driven by the uncertainty in projections of future hurricane frequency." Scientific Reports 10, 15270. September 17, 2020. pp. 1. https://www.nature.com/articles/s41598-020-72207-z#:~:text=Hurricanes%20are%20the%20leading%20cause,last%2040%20years30%2C36. Accessed April 1, 2021.
20. Newburger, Emma. "More than 2 million people expected to lose power in PG&E blackout as California wildfires rage." CNBC. October 26, 2019. https://www.cnbc.com/2019/10/26/pge-will-shut-off-power-to-940000-customers-in-northern-california-to-reduce-wildfire-risk.html. Accessed April 1, 2021.

21. Romero, Dennis. "Power outages planned for nearly 500,000 as California braces for more fires." NBC News. October 24, 2020. https://www.nbcnews.com/news/us-news/power-outages-planned-nearly-500-000-california-braces-more-fires-n1244619. Accessed April 1, 2021.
22. Cohen, Judah; Pfeiffer, Karl; Francis, Jennifer. "Warm Arctic episodes linked with increased frequency of extreme winter weather in the United States." Nature Communications 9, 869. March 13, 2018. pp. 1. https://www.nature.com/articles/s41467-018-02992-9. Accessed April 1, 2021.
23. Freedman, Andrew. "The polar vortex is splitting in two, which may lead to weeks of wild winter weather." The Washington Post. January 5, 2021. https://www.washingtonpost.com/weather/2021/01/05/polar-vortex-split-cold-snow/. Accessed April 1, 2021.
24. "US cold snap: Why is Texas seeing Arctic temperatures?" BBC News. February 15, 2021. https://www.bbc.com/news/world-us-canada-56058372. Accessed April 1, 2021.
25. Juarez, Sierra. "El Paso Heeded the Warnings and Avoided a Winter Catastrophe." Texas Monthly. February 19, 2021. https://www.texasmonthly.com/news-politics/el-paso-electric-winter-storm-2021/. Accessed April 1, 2021.
26. National Renewable Energy Laboratory (NREL). Interconnections Seam Study. https://www.nrel.gov/analysis/seams.html. Accessed April 1, 20201.
27. Brinkman, Gregory; Novacheck, Joshua; Bloom, Aaron; McCalley, James. Interconnections Seam Study: Overview. National Renewable Energy Laboratory (NREL). October 2020. pp. 33. https://www.nrel.gov/docs/fy21osti/78161.pdf. Accessed April 1, 2021.
28. Bloom, Aaron; Novacheck, Josh; Brinkman, Greg; McCalley, James; Figueroa-Acevedo, Armando; Jahanbani-Ardakani, Ali; Nosair, Hussam; Venkatraman, Abhinav; Caspary, Jay; Osborn, Dale; Lau, Jessica. "The Value of Increased HVDC Capacity Between Eastern and Western U.S. Grids: The Interconnections Seam Study." National Renewable Energy Laboratory (NREL) (Submitted to IEEE Transactions on Power Systems). October 2020. pp. 1. https://www.nrel.gov/docs/fy21osti/76850.pdf. Accessed April 1, 2021.
29. MacDonald, Alexander; Clack, Christopher; Alexander, Anneliese; Dunbar, Adam; Wilczak, James; Xie, Yuanfu. "Future cost-competitive electricity systems and their impact on US CO2 emissions." Nature Climate Change. January 25, 2016. pp. 3. https://www.vibrantcleanenergy.com/wp-content/uploads/2016/09/Future_cost-competitive_electricity_syst.pdf. Accessed April 1, 2021.
30. United States Environmental Protection Agency. "Sources of Greenhouse Gas Emissions." https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions. Accessed April 1, 2021.
31. Roberts, David. "A national US power grid would make electricity cheaper and cleaner." VOX. June 20, 2020. https://www.vox.com/energy-and-environment/2020/6/20/21293952/renewable-energy-power-national-grid-transmission-microgrids. Accessed April 1, 2021.
32. Roberts, David. "Why wind and solar power are such a challenge for energy grids." VOX. June 19, 2015. https://www.vox.com/2015/6/19/8808545/wind-solar-grid-integration. Accessed April 1, 2021.
33. Caspary, Jay; Goggin, Michael; Gramlich, Rob; Schneider, Jesse. "Disconnected: the need for a new generator interconnection policy." Americans for a Clean Energy Grid. January 2021. pp. 4. https://cleanenergygrid.org/wp-content/uploads/2021/01/Disconnected-The-Need-for-a-New-Generator-Interconnection-Policy-1.14.21.pdf. Accessed April 1, 2021.
34. Ibid.
35. Americans for a Clean Energy Grid. "Texas as a National Model for Bringing Clean Energy to the Grid." October 13, 2017. https://cleanenergygrid.org/texas-national-model-bringing-clean-energy-grid/. Accessed April 1, 2021.
36. WINDExchange: U.S. Department of Energy. "U.S. Installed and Potential Wind Power Capacity and Generation." https://windexchange.energy.gov/maps-data/321. Accessed April 1, 2021.
37. Kotch, Micah. "Three energy-innovation takeaways from Texas' deep freeze." Tech Crunch. March 16, 2021. https://techcrunch-com.cdn.ampproject.org/c/s/techcrunch.com/2021/03/16/three-energy-innovation-takeaways-from-texas-deep-freeze/amp/. Accessed April 1, 2021.
38. The American Security Project. "El Niño and the Case for Microgrids." October 8, 2015. https://www.americansecurityproject.org/el-nino-and-the-case-for-microgrids/. Accessed April 1, 2021.
39. Roberts, David; Chang, Alvin. Meet the microgrid, the technology poised to transform electricity. VOX. May 24, 2018. https://www.vox.com/energy-and-environment/2017/12/15/16714146/greener-more-reliable-more-resilient-grid-microgrids. Accessed April 1, 2021.