We Need Smart Grids Right Now: Advocating for Smart Grid Proliferation

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Abstract

The United States is expected to experience a 30% increase in load by 2030. To put that into perspective, the United States makes up nearly one-fifth of the entire world's power consumption.[1] Smart grids offer a variety of solutions to many of the problems our electricity grid might face through renewable utilization, resilient durability, and upgraded power flow capacities. While being cognizant of the negatives, we can safely and swiftly implement such a system. The best way to prevent future electricity crises is through the integration of these smart grids. The national grid that the United States depends on today was constructed over a century ago and employs obsolete techniques to manage electricity.[2] This paper argues why smart grids are the optimal option to serve electricity across the United States in the coming days. It also details a multilayered plan to help achieve this goal in a timely and realistic manner. Overall, the paper delivers a clear path forward as well as fuel future conversation about where the United States currently stands and what needs to be done, mainly in a policy-like tone.

Background

From February 10th to 27th of 2021, an unprecedented winter storm swept across Texas and caused mass power outages. By the end, over 4.5 million residents had

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[1] Frequently Asked Questions (FAQs) - U.S. Energy Information Administration (EIA), 15 Dec. 2020, www.eia.gov/tools/faqs/faq.php?id=87&t=1#:~:text=What%20is%20the%20United%20States%E2%80%99%20share%20of%20world,of%20world%20population%20was%20about%204%25%20in%202018.

[2] "U.S. Electricity Grid & Markets." EPA, Environmental Protection Agency, 26 June 2020, www.epa.gov/greenpower/us-electricity-grid-markets#:~:text=According%20to%20the%20U.S.%20Energy%20Information%20Administration%20Exit%2C,145%20million%20customers%20throughout%20the%20country%20%28EIA%2C%202016%29.

experienced power disruptions during this period. Affecting more than just electricity, the disaster cost Texans nearly 130 billion dollars, but the real cost came in the 111 people who lost their lives.[3] Similarly, in August of 2020, record-setting heatwaves pushed through California and resulted in higher electricity demands than what was available in the state. The existing system was unable to accommodate these situations, and operators were forced to make the decision to cut power to hundreds of thousands of residents during the evenings of August 14th and 15th or risk a much greater grid failure.[4] Both events can be traced to failures in the electricity grid – namely, insufficient power production and the inability to store electricity for emergency use.

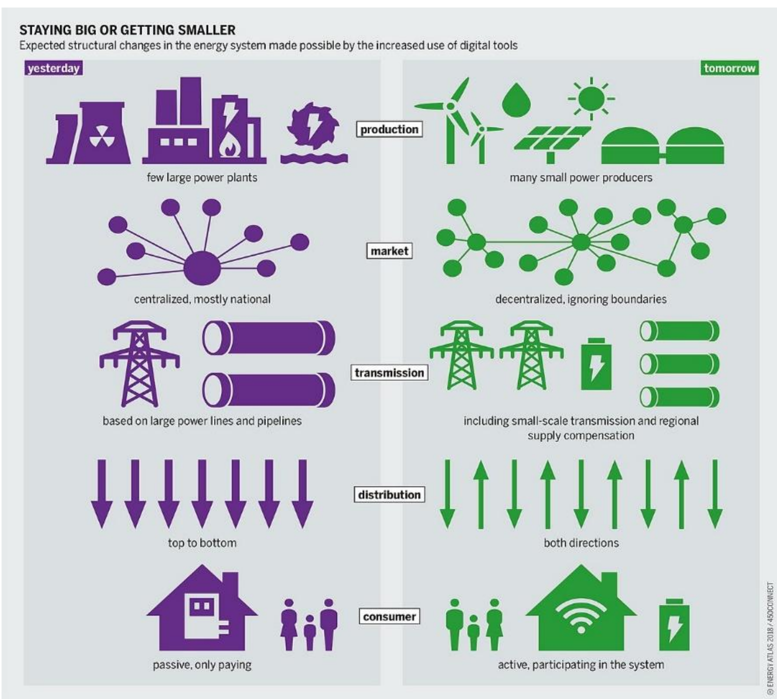

Figure 1 *Overview of smart grids compared to traditional grids*

Not merely an upgrade, smart grids provide a clear solution that traditional grids cannot offer. From SmartGrid.gov, "the digital technology that allows for two-way communication between the utility and its customers, and the sensing along the transmission lines is what makes the grid smart. Like

[3] Williams, Neil, et al. "The Great Texas Power Failure of February 2021." *BBN Times*, 6 May 2021, www.bbntimes.com/global-economy/the-great-texas-power-failure-of-february-2021.

[4] John, Jeff St. "Final Analysis of California's August Blackouts Yields Few Surprises and a Tight Deadline for Solutions." *Greentech Media*, Greentech Media, 19 Jan. 2021, www.greentechmedia.com/articles/read/final-analysis-of-californias-august-blackouts-has-few-surprises-but-some-proposed-solutions.

the internet, the smart grid will consist of controls, computers, automation, and new technology and equipment working together […] to respond digitally to our quickly changing electric demand."[5] While it will possibly require a complete rework of the systems we rely on today, it will undoubtedly be best suited for the needs of tomorrow.

Introduction to Problem

The current conversation about smart grids is nonexistent in the United States. The latest policy was in 2014 when the Department of Energy published a report detailing that the adoption of smart grid technology is accelerating but at varying rates. The report found that this was mainly due to, "decision-making at the utility, state, and local levels." The most comprehensive legislation comes from the Energy Independence and Security Act of 2007. It appointed the National Institute of Standards and Technology (NIST) to coordinate the development of smart grid standards and research.[6] However, the NIST has not published a report or article of substance on the matter in years.[7] Given the proper investment, the following exploits of smart grids could be maximized.

The largest attraction of smart grids is their ability to curb the impact on climate change. There are four key methods that smart grids use to achieve this effect.

[5] "Smart Grid: The Smart Grid." *Smart Grid: The Smart Grid | SmartGrid.gov*, 16 Dec. 2019, www.smartgrid.gov/the_smart_grid/smart_grid.html.

[6] Campbell, Richard J. "The Smart Grid: Status and Outlook." *Federation of American Scientists*, 10 Apr. 2018, fas.org/sgp/crs/misc/R45156.pdf.

[7] Kristy.thompson@nist.gov. "Smart Grid Research, Reports and Presentations." *NIST*, 21 Nov. 2019, www.nist.gov/el/smart-grid/news-and-resources/reports-presentations.

1) Renewable energy sources and their fluctuating production can be easily managed without having to resort to nonrenewable energy sources to keep a steady stream of output.
2) More efficient transmission of electricity can help reduce the "up to 10 percent of the electricity" that is lost while traveling across the grid.[8]
3) Energy can be easily conserved as dynamic and responsive electricity flow allows consumers to never take more than absolutely needed.
4) Introduces the possibility and likelihood to increase fuel efficiency directly at suppliers.[9]

Another notable attraction of smart grids is their ability to sustain electricity flow through varying and uncertain conditions. With the increased usage of renewables, storing energy to be used during peak hours is becoming more of an issue. This will primarily come in the form of advanced batteries: sodium-sulfur batteries, vanadium redox batteries, zinc bromide batteries, or lithium-ion batteries.[10] Outside of optimizing storage integration, having a large and interconnected grid opens the possibility to draw from a variety of different locations. If one power plant were to go offline, another plant could have its power flow redirected. Likewise, redirecting flow is now easy to do because the grid is always under stable conditions.

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[8] Jung, Michael. "Smart Grid and Climate Change." *Energy Central*, 25 Sept. 2016, energycentral.com/c/iu/smart-grid-and-climate-change.

[9] Magill, Jim. "As It Undergoes Transformation, U.S. Power Grid Embraces AI." *Forbes*, Forbes Magazine, 29 Mar. 2021, www.forbes.com/sites/jimmagill/2021/03/29/as-it-undergoes-transformation-us-power-grid-embraces-ai/?sh=e5605ca7a52c.

[10] "Energy Storage - A Key Enabler of the Smart Grid." *National Energy Technology Laboratory*, Sept. 2009, www.netl.doe.gov/sites/default/files/Smartgrid/Energy-Storage_2009_10_02.pdf.

The final attraction of smart grids is the simple fact they are better suited to meet growing energy needs. From electric vehicles to households chock-full of smart devices, the internet of things is adding to electricity demands just as much as they are being used to solve them. The immediate cause will be electric vehicles, however, as they start to become mainstream, and charging them at varying times throughout the day will cause fluctuating levels of demand. The other cause is the internet of things; ordinary, everyday devices will soon be communicating through the internet with one another which tends to draw more power consumption, especially since they tend to be left on indefinitely. Driven by these causes, parts of the smart grid will be able to deliver data to new initiatives such as volt-var optimization and conservation voltage reduction to deliver more electricity than ever before.[11]

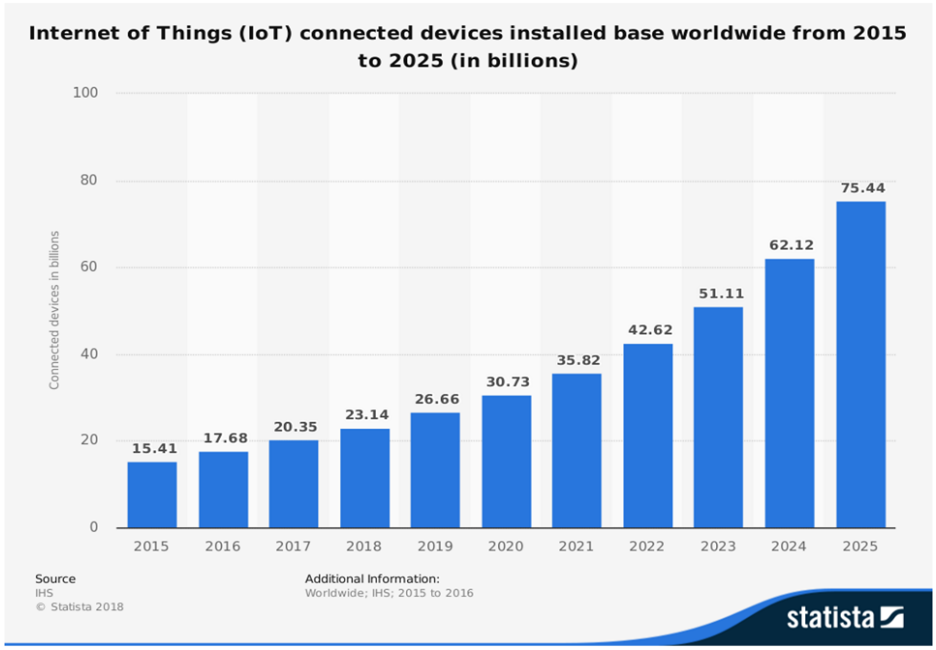

Figure 2 *The projected growth of the Internet of Things devices*

[11] Nakamura, Nick. "Preparing for Future Energy Demands with Smart Grid Technology." *Electric Energy Online*, 2018, electricenergyonline.com/energy/magazine/1163/article/Preparing-for-Future-Energy-Demands-with-Smart-Grid-Technology.htm.

Recommendations

The following plan will work best by starting with the basics. First, we need to address data privacy concerns that consumers might have and educate them on how the new service will operate. To do this, we need to develop distribution material such as brochures or short videos that detail how the new and futuristic system will function and benefit everybody involved. Then, we can spread the material via multimedia to achieve a wide reach.

The next steps are when we start to plan the deployment of our smart grids. First, we will want to survey existing infrastructure and invest in utilizing it as much as possible to mediate cost and time in the future. After identifying what we do have, we want to create nationwide rollout plans that work in steps – first local integration, then state integration, then nationwide. These plans should identify what new infrastructure needs to be built, give timelines for their completion, display the smart networks that will be set up, and discuss the user end of the network.

Figure 3 *Circular smart meter. Can also come in a box shape*

After writing up comprehensive plans, we then need to execute them within a timely frame. Before we can get to the main components of the system, we need to install the smart meters on all participating installations. Next, try to perform any upgrades required to work with the existing transmission lines or where not possible construct new ones. Following the completion of transmission lines, we will want to integrate all smart tech components; this includes smart substations, distributed generation devices, and storage systems. Remember to test the grid after each development so that any errors are manageable.

To complete the adoption of smart grids, there are a few final steps that need to be done. Once the nationwide grid is up, decommission the previous grid system and recycle whichever material is accessible and cost responsible. Collect success rate in controlled time intervals to test the sustainability of the network and ensure proper installation. The success rate can be measured via analytics on the producer and management side of the system as well as through surveys sent to consumers to gather satisfaction and opinions on the smart grid. To ensure the continued success of the smart grid, establish an overhead committee to smoothly run the smart grid and conduct future projects.

The above recommendations are informed mainly by two examples. The first example is Brazil. Brazil boasts some clean developments that have been incorporated, but the real inspection should be on Brazil’s shortcomings. There are two immediate challenges they are facing. The first is there has been little concrete policy to advance the rollout of smart grids. This is most apparent when it comes to the adoption of smart meters; they are currently being left to electricity regulators to install, but this leads to issues where consumers do not know how to properly use these new systems or feel an invasion of privacy since they are never informed about how they function.[12] The second is not a lot of research has been conducted into storage technology.[13] This is especially important for Brazil since the main need for storage technology comes from heavy utilization of renewable energy and is one of the main pieces to a fully operating smart grid.

The other example is Europe. Like Brazil, Europe has both pros and cons and the following focuses on the latter. The most concerning issue is the public’s lack of participation in the initiatives. While it is true the European public has been gradually learning more about smart grids, there is simply little consumer demand. This can be easily contributed to three things: the inability to recognize the community-wide benefits, fears for data privacy, and poor experiences with the already installed smart meters. Another pitfall has been the “lack of a clear regulatory framework and incentives.”[14] Since each member state has been left to control the implementation of smart grids past

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[12] Dranka, Géremi Gilson, and Paula Ferreira. “Towards a Smart Grid Power System in Brazil: Challenges and Opportunities.” *Energy Policy*, Elsevier, 22 Oct. 2019, www.sciencedirect.com/science/article/pii/S0301421519306202?casa_token=gCNj0YmGeq8AAAAA%3A-26ZL8xF6s7fkPWqB-RLg3w5JF2b_eKOJLvakgfMXDMTPFU-mMxHhNnmV0TD8I0VghJWiFZZulc.

[13] Dantas, Guilherme de A., et al. “Public Policies for Smart Grids in Brazil.” *Renewable and Sustainable Energy Reviews*, Pergamon, 9 May 2018, www.sciencedirect.com/science/article/pii/S1364032118303071.

[14] Giglioli, Enrico, et al. “How Europe Is Approaching the Smart Grid.” *McKinsey*, 2010, www.mckinsey.com/~/media/mckinsey/dotcom/client_service/EPNG/PDFs/McK%20on%20smart%20grids/MoSG_Europe_VF.aspx.

the smart meter individually, it has been difficult to create a network that can adequately utilize the cross-border smart meters.[15] There is also no clearly outlined method to encourage utilities to shift to smart grids.

Conclusion

After years of eventual construction, the wait for smart grids will present a basket of rewards for everyone. Residents of Texas and California will no longer have to live in fear of the next power outage. Instead, they will be rejoicing in the newfound control they have over their own electrical needs as well as their impact on creating a more sustainable and equitable electricity grid for all. Population centers and quaint hamlets alike will be able to consume less power and fearlessly plug in their electric vehicle. Ultimately, people will finally have peace of mind when it comes to any of their electricity woes. But first, we need a plan to get there.

[15] Le Ray, G, and Pierre Pinson. "The Ethical Smart Grid: Enabling a Fruitful and Long-Lasting Relationship between Utilities and Customers." *Pierre Pinson*, 2 Jan. 2019, pierrepinson.com/docs/LeRayetal2019ethics.pdf.

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