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Integration of a Smart Grid in the United States

Katie Buchholtz
Purdue University, kbuchho@purdue.edu

Cooper Fetters
Purdue University, cfetters@purdue.edu

Cooper LeComp
Purdue University, clecomp@purdue.edu

Integration of a Smart Grid in the United States

Katie Buchholtz, Cooper Fetters, & Cooper LeComp | Purdue University

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Instructors: Dr. Dwaine Jengelley (Honors College) & Dr. L. Allison Roberts (PPRI)

Executive Summary

In February 2021, the Texas power grid experienced widespread outages for days during a severe winter storm. The lack of fine control on grid technology and modernized infrastructure left hundreds of thousands of residents freezing in their homes instead of manageable short-term rolling blackouts. The electrical grid in the United States has not sufficiently modernized to keep up with the rise in technology developing throughout the United States. Without modernization and necessary improvements, limitations in the grid will expose themselves as widespread outages affecting residents, infrastructure, and companies across the United States.

Transitioning the United States to a smart grid is a complex long-term initiative requiring careful ethical considerations, proper funding, and diligent cyber-security maintenance. A proper implementation of the smart grid will provide the nation with a resilient electrical grid with bidirectional communication between the grid and electricity customers. The smart grid will lead to a better distribution in electricity usage throughout the day, reduced costs, and the capability for more distributed power generation and green energy. The cost of the transition is estimated to be in the hundreds of billions of dollars, but with a return on investment far exceeding the cost, beyond one trillion dollars, showing the positive return from the investment. The cost of not modernizing the electricity grid would be very detrimental to the United States and the stability of the electricity grids going into the future, so investments into the smart grid are crucial and necessary.

Scope of the Problem

The United States is using more electricity than ever before, further pushing the electric grid to its capacity [1, Fig.1], [2, Fig.2]. While the energy is readily available, there is a desperate need to modernize current facilities. The goal of a Smart Energy Grid is to be more resilient and connected during times of outages, with both electricity producers and consumers in mind. A reliable power supply includes bidirectional communication between technology, controls, equipment, and the users of the grid. When an equipment failure occurs, a smart grid allows for automatic rerouting of the energy providing a consistent flow of electricity to those users in need. Instead of major power "blackouts," customers receive a constant supply of electricity. This new use of information forces outdated and old technology to be replaced, preventing outages from occurring regularly. Smart Meters, connected electrical meters providing bidirectional communication between electricity consumers and the grid, will be installed in every household to let consumers monitor their energy usage in real time rather than solely getting monthly statements from the power company [3]. While it will take at least a decade for this new technology to be installed, the implementation phase will involve heavy testing and constant observation from the companies and agencies involved.

Benefits and Risks

A smart grid has many benefits for the stability and reliability of an electrical grid, but also brings numerous security implications. Currently, the Continental United States has three main grid interconnections. The first grid is the U.S. West Coast Interconnection; it includes the western United States, western Canada, and a portion of Baja California, Mexico. The second grid, U.S. East Coast Interconnection, encompasses the central and eastern United States, along with central and eastern Canada. Third, a large portion of Texas relies on a private grid interconnection, run by the Energy Reliability Council of Texas, ERCOT [4]. These grids work to ensure proper levels of electrical generation throughout the day, stabilizing each grid. Large electrical interconnections consequentially become massive hacking targets and security risks. Connecting the electrical grid to the internet opens up more avenues for cyber-attacks. Careful mitigation steps need to be followed and active funding needs to be continuously maintained to readily discover any security exploits and resolve the issues before hackers can find them [5]. These security risks are enormous if able to be exploited. Regions can potentially have their electricity shut down, causing manufacturing to cease, hospitals to lose power, and other critical infrastructure to cease functioning [6]. Before fully implementing a smart grid, it is necessary to address the many benefits and associated risks.

Policy Alternatives

Smart grid technology shows greater benefits than costs in the long run. Consumers under this new technology are able to control their energy usage, make decisions to reduce energy consumption and see the direct financial breakdown of such changes. Another benefit is the ability to purchase energy from cleaner, domestic resources since the correct infrastructure allows for consumer changes to energy sources [7]. These benefits rely heavily on consumer education and public knowledge on the ability to make decisions regarding their electricity, and open communications have not yet occurred. An alternative to forced implementation of smart grid technology would be to educate consumers and allow them to decide on further steps to be taken with these initiatives.

Current policy on the smart grid is unsatisfactory when it comes to widespread implementation of the technologies. An alternative to this ineffective implementation is to keep the current grid, and update at the current rate. Essentially, this would not improve the technologies and costs incurred over the long run would be due to blackouts, consumer consumption, and no relocation of energy sources. Even though implementation of the smart grid is inconsistent around the country, these small steps to widespread change are a step in the right direction.

Policy Recommendations

The United States currently has a smart grid Advisory Committee, a smart grid Task Force, and a program to further pursue smart grid technology research, development, and demonstration [8]. Additionally, some incentives have been implemented to promote smart grid technologies. For example, there is a "matching fund" providing reimbursement for twenty percent (20%) of the qualifying smart grid investments. The groundwork was completed, initial policy implemented, and a large amount of flexibility has been left up to the individual states. Despite this, the United States is still not close to widespread implementation of a smart grid. In order for this to occur, there is a simple but difficult solution: a large capital investment from the government.

The estimated upfront cost required to transition the United States' electrical grid to a smart grid is between $338 to $476 billion. This transition involves modernizing the necessary infrastructure to support distributed electrical generation and to ensure every electricity customer is connected. In return for this spending, the estimated 20-year benefits range from $1.29 to $2.08 trillion, signifying a predicated large return on investment [9]. This clear financial return on investment signifies the value of this spending. The benefits will outweigh the initial monetary cost. If the government is not able to find money in the budget to meet this cost, a variety of other steps can be explored such as increasing subsidies, increasing the matching fund, and putting more pressure on individual states to make the transition.

References

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Figures

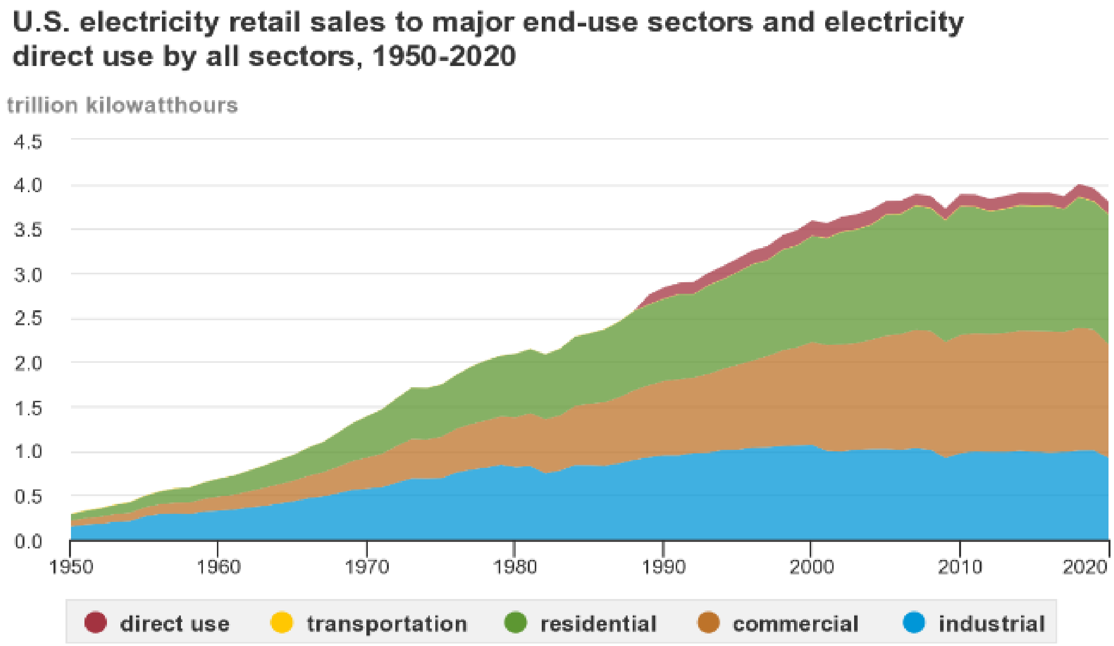

Fig. 1. U.S. Electricity Sales [1]

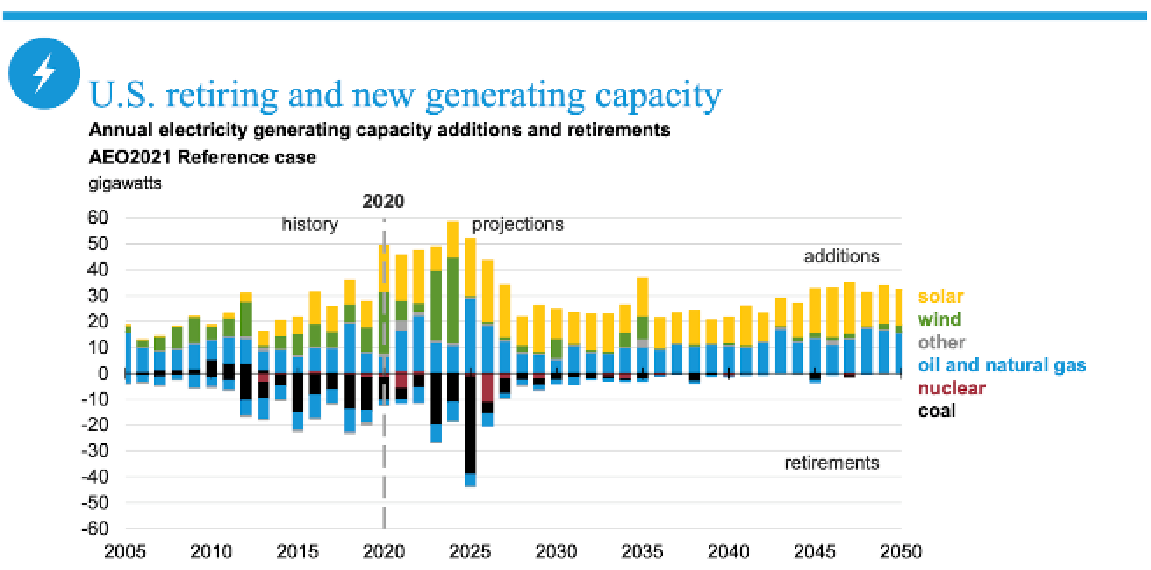

Fig. 2. U.S. Capacity Retirements and Additions [2]