Forum: US Senate
Issue: Energy grid supply security and stability
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Introduction:

The power grid in the United States serves up to 145 million customers, with the electricity being generated at 7,300 power stations before passing through a complex network consisting of substations, nearly 160,000 miles of high-voltage power lines and distribution transformers to reach homes (U.S. Energy Information Administration, 2016). The sheer size of this infrastructure has made it an expensive and complicated procedure to begin upgrading the electrical grid, of which over 70% is more than 25 years old (The White House, 2022). However as the system gets older this leads to more vulnerabilities, to increasingly frequent and severe climate threats, cyber and physical security breaches as well as increasing integration of renewable energy sources into the national power supply.

Definition of Key Terms:

1. **Power station:** an installation where electrical power is generated for distribution (Oxford Languages, 2023).
2. **Substations**: Substations contain the specialist equipment that allows the voltage of electricity to be increased (step-up substation) or decreased (step-down substation) through the use of equipment called transformers (National Grid, 2023).
3. **Electrical transmission:** Electric power transmission is the stage where the bulk movement of electrical energy from a generating site, such as a power plant, to an electrical substation (Wikipedia, 2023). The power lines used during transmission will be high-voltage for long-distance transportation.
4. **Electrical distribution**: The final stage of delivery is carried from the transmission system to individual consumers; power lines used during distribution are low-voltage for short-distance transportation.
5. **Energy security**: the uninterrupted availability of energy sources at an affordable price (IEA, 2023)

6. **Energy resilience:** the ability of an energy system to withstand and recover from disruptions or shocks, such as natural disasters, cyberattacks, or supply interruptions, while maintaining a reliable energy supply

Background Information

History of Energy Security and Stability in the US

The US has a diverse energy mix to ensure energy security and stability. 60% of their energy is derived from fossil fuels such as petroleum, natural gas and coal, 18% from nuclear energy and 22% from renewable energy sources like wind, solar, and hydroelectric power. This diversity helps to ensure stability as if one source of energy becomes unavailable or too expensive, other sources can potentially fill the gap. The issue of energy security and stability has evolved drastically over the course of American history, beginning with the Industrial Revolution.

The Industrial Revolution

The Industrial Revolution marked a transformative period in the United States, bringing forth a profound shift in economic and societal dynamics. Central to this transformation was the unprecedented harnessing of energy sources, propelling the nation from agrarian roots to an industrial powerhouse. It thus had a significant impact on energy security and stability in the United States. It spurred a surge in energy demand as manufacturing industries emerged and developed, with the transition from traditional, manual labour to mechanised production methods being enabled by the abundant and reliable supply of coal and later oil. Coal became the primary fuel to power steam engines and factories. The development of transportation, particularly railroads, was accelerated by coal-powered steam locomotives pioneered by James Watt, facilitating the movement of goods and people.

1970s Energy Crisis

In 1973, the Organization of Arab Petroleum Exporting Countries (OAPEC) implemented an oil embargo against countries that supported Israel during the Yom Kippur War, causing a drastic increase in oil prices. As the US was heavily dependent on foreign oil to meet its energy needs, it experienced high inflation and

economic turmoil during this period. In response to the crisis, the US government established the Strategic Petroleum Reserve (SPR) in 1975, which is an emergency reserve of crude oil that aims to mitigate the impact of future supply disruptions. More importantly, the crisis sparked a shift in US energy policy where the development of domestic energy resources, including coal, natural gas, and renewable energy. It also led to the implementation of energy conservation measures and the promotion of energy efficiency.

Hydraulic Fracturing

More commonly known as fracking, hydraulic fracturing is a technique used to extract oil and natural gas from underground rock formations. This increased domestic energy production has reduced the US' reliance on imported oil and gas, turning it into a net energy importer to a net energy exporter while reducing its exposure to supply disruptions that could arise from international conflicts or geopolitical tension. While there are environmental concerns associated with fracking, the increased availability of natural gas has helped replace coal in power generation, providing a bridge for the US as it transitions to a more sustainable energy future.

Current Situation

Climate change and Renewable Energy

The growing recognition of the threat of climate change has led to a push for cleaner, renewable sources of energy like wind and solar power. While these technologies can enhance energy security by reducing reliance on fossil fuels, they also present challenges in terms of cost, intermittency, and the need for new infrastructure.

Bipartisan Infrastructure Law

The Bipartisan Infrastructure Law (BIL) is a $1.2 trillion investment in the nation's infrastructure, including transportation, broadband, water, and power. The BIL will invest $73 in improving the US' power infrastructure. The BIL will invest $23 billion to expand access to clean energy, such as solar and wind power. This includes investments in renewable energy projects, energy efficiency programs, and electric vehicle charging stations. The BIL will also invest $6 billion to prevent the premature retirement of nuclear plants. This includes investments in plant upgrades and safety improvements.

Inflation Reduction Act

The $500 billion Inflation Reduction Act (IRA) of 2022 is a piece of legislation that was signed into law by President Biden on August 16, 2022. The IRA incorporates several significant provisions related to energy security and stability, including investments in clean energy manufacturing such as solar and wind power, worth $60 billion. These investments aim to reduce the United States' dependence on fossil fuels and enhance energy independence. Additionally, the IRA offers tax credits to support clean energy investments, making it more accessible for businesses and individuals to transition to a clean energy economy. The act also allocates funds for energy efficiency programs like weatherization assistance and upgrades for homes and businesses, reducing energy demand and enhancing resilience to global energy market fluctuations. Moreover, the IRA fosters international cooperation on energy security to ensure stable global energy markets and mitigate supply disruptions for oil and gas.

DOE Initiatives

The DOE has released grant applications and initiated the distribution of $3.2 billion in funds for residential energy retrofitting and weatherization. This increased funding will enable states to retrofit numerous low-income homes, making them healthier and more energy-efficient while reducing utility bills. Additionally, the DOE launched the $10.5 billion Grid Resilience Innovation Programs (GRIP) to strengthen the power grid's resilience and reliability. Moreover, the historic regional clean hydrogen hubs program (H2Hubs) was introduced, aiming to catalyse America's clean hydrogen economy, with $7 billion in funding applications open.

Infrastructure and Cybersecurity

Having been in operation for several decades, the ageing energy infrastructure in the US, including power plants, transmission lines, and pipelines, poses risks to energy stability. Besides growing inefficiencies and higher maintenance costs, such infrastructure is also becoming increasingly vulnerable to natural disasters, including hurricanes, tornadoes, earthquakes, and floods. Additionally, the increasing digitization of the energy sector has raised concerns about cybersecurity and the potential for cyber attacks on critical infrastructure. Specifically, cyberattacks on energy infrastructure, such as power plants, grid control systems, and oil and gas facilities, can have severe consequences, including

disrupting energy supply, compromising critical services, and potentially causing safety hazards.

Bipartisan Infrastructure Law

$50 billion will be spent on modernising the electric grid, making it more resilient to cyberattacks and extreme weather events. This includes investments in new transmission lines, substations, and distribution systems, reducing the risk of blackouts.

Inflation Reduction Act

Approximately $11.7 billion will be allocated for the Loan Programs Office (LPO) to issue new loans and expand existing loan programs by about $100 billion. The IRA introduces the Energy Infrastructure Reinvestment (EIR) Program with $5 billion in funding to retool, repower, or replace energy infrastructure and reduce emissions.

Major Parties Involved and Their Views

Department of Energy (DOE)

The Department of Energy (DOE) is the principal organisation in formulating policies, coordinating energy research and development, and ensuring the security of the national energy infrastructure. Most recently, in January of 2023 it announced that it would be “investing over $20 billion in federal funding” with the intention of modernising and expanding the electrical grid, through public and private partnerships, research and development (Forbes, 2023).

Cybersecurity, Energy Security, and Emergency Response (CESER)

As one of the several offices under the DOE, the CESER also announced in 2022 that it would fund 15 research projects focused on 6 different topic areas suggested by the DOE, largely focused on cybersecurity and resilience.

Department of Homeland Security (DHS)

The DHS is heavily involved in the cybersecurity response of the energy network, which has been made particularly vulnerable as the operational technology of the transmission distribution network allows for remote access and connection to business networks, which could give external users access to disturb the operations of such

businesses. DHS also operates information-sharing programs e.g Enhanced Cybersecurity Services, to make energy companies aware of threat information in a timely fashion.

General Electric

General Electric is a multinational conglomerate with a dedicated focus on grid modernization in the US. It is one of the biggest private sector companies in developing technologies to help in the transition of principal sources of energy from fossil fuels to renewable, as well as create ‘smart grids’ - an electric system enhanced with technologies like smart substations, smart switches, and smart metres to detect problems on the electric grid and increase responsiveness between power producers and consumers.

NextEra Energy

NextEra Energy is a private company which is the biggest provider of wind and sun energy and the largest electrical company by market capitalization in the country. NextEra Energy Resources, a subsidiary of NextEra Energy, is the largest renewable energy generator in North America. It operates some of the largest renewable energy projects in the United States including wind farms and solar arrays, which makes a substantial contribution to American renewable energy capacity. Further, its focus on renewable energy has resulted in a reduction of carbon emissions from the energy sector and NextEra themselves aims to reach zero carbon emissions by 2050.

US Involvement and Past Resolutions

The American Recovery and Reinvestment Act (ARRA), was a bill drafted in response to the financial crisis. It included over USD 80 billion to support clean energy research, development, and deployment (IEA, 2021). It had a positive impact on the U.S. energy sector by accelerating the adoption of renewable energy, improving energy efficiency, and supporting job creation however its long term effects are still yet to be assessed, based on how well the investments are integrated into broader plans for energy.

Superstorm Sandy was one of the most significant storms in the history of the U.S. power sector due to the combination of its size, scope and timing. It highlighted the vulnerability of the energy infrastructure on the East Coast, so in response, the U.S. Department of Energy initiated efforts to strengthen the resilience of critical energy infrastructure, particularly in areas prone to extreme weather events.

Possible Solutions

1. Investing into developing ‘smart grids’ and modernising the electricity supply grids including implementing advanced sensors, automation technologies, and grid analytics for real-time monitoring and control to prepare for next-generation electrical demands.
2. Use funding allocated for upgrading and expanding transmission lines to connect regions, especially where it’s extremely windy, with households and communities given that the location of current power stations away from windy regions due to the lack of civilian population makes wind-sourced power relatively inaccessible. This can also be achieved by collaborating with private-sector companies in the renewable energy market e.g NextEra Energy
3. Encourage use of demand response programs, which request customers to reduce their energy use during times of high demand on the system in return for monetary incentives; this helps to make grids more resilient and increases reliability of energy supply
4. Promoting collaboration between federal agencies and public utilities with private companies will help enhance grid security, specifically digitally as threat intelligence can be shared and response efforts coordinated to improve efficiency in detecting and responding to security incidents. Improving physical security through greater surveillance and perimeter security measures is also essential.

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Useful Links

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