COMMITTEE ON
SCIENCE, SPACE AND TECHNOLOGY
CHAIRMAN FRANK LUCAS

SUBCOMMITEE ON ENERGY

HEARING CHARTER

"Unleashing American Power: The Development of Next Generation Energy Infrastructure"

Thursday, March 23, 2023
2:00 p.m.
2318 Rayburn House Office Building

Purpose

The purpose of the hearing is to explore future research challenges for key energy infrastructure technologies in the United States. This hearing will specifically examine the status of grid security, hydrogen, and pipelines research and development activities carried out or supported by the U.S. Department of Energy (DOE). This hearing will serve as a legislative hearing for a series of bills that would authorize DOE's work in these areas.

Witnesses

- **Mr. Spencer Nelson,** Managing Director - Research and New Initiatives, ClearPath
- **Dr. Richard Boardman,** Directorate Fellow, Idaho National Laboratory, Energy and Environmental Science & Technology
- **Mr. Cliff Johnson,** President, Pipeline Research Council International
- **Dr. Arvind Ravikumar,** Co-Director, Energy Emissions Modeling and Data Lab Research Associate Professor, Department of Petroleum and Geosystems Engineering, The University of Texas at Austin
- **Mr. Jason Fuller**, Chief Energy Resilience Engineer, Pacific Northwest National Laboratory

Overarching Questions

- How does fundamental and early-stage research translate to tangible results for the U.S. energy sector - in energy production, distribution, and transmission?
- What are the tools and technologies needed for industry to improve the strength, resilience, and security of the U.S. electric grid? How can DOE effectively partner with industry to identify and address these technology needs?
- In an all-of-the-above energy strategy, what role does hydrogen play in the future of U.S. energy infrastructure? What synergies can be created with other sources such as nuclear, oil & gas, etc.?

- What role should DOE and its research capabilities play in addressing our aging pipeline infrastructure?
- What is the appropriate function of federal research and development initiatives in ensuring a strong and secure domestic supply chain for these activities?

Background

Safeguarding and upgrading our nation's energy infrastructure is essential to our national security, economic prosperity, energy independence, and international competitiveness. In recent years, this aging energy infrastructure, a once world-renowned system of pipelines and energy distribution systems, has faced an abundance of new threats, as well as challenges in modernizing the system for evolving needs. . As the emerging technology and hazard landscape continues to evolve, the health of the U.S. energy sector relies on an infrastructure that is reliable, resilient, cost effective, and secure.

These challenges require effective solutions that focus on supporting early-stage research that will spur innovation across a large range of applications. As a global leader in energy technology development and scientific innovation, the U.S. Department of Energy (DOE) leads the way in advancing this next generation of key energy infrastructure technologies in grid security, pipeline innovation, and hydrogen R&D. In these areas and many others, DOE and its national laboratories work side by side with industry, academia, and utilities to modernize and secure the U.S. energy sector through both fundamental research initiatives and large-scale demonstration projects.

There is an urgent need for Congress to provide updated policy direction for these critical research and development activities. Despite recent key reauthorizations of DOE programs through the Energy Act of 2020 and the CHIPS and Science Act, and despite billions of dollars in additional appropriations for some of these activities in bills like the Infrastructure Investment and Jobs Act, Congress has not provided a comprehensive reauthorization of DOE's R&D activities in grid security, pipelines, and hydrogen in over 15 years.[1] Legislation to update these activities will help to unleash American energy and secure an energy independent future.

Legislation

This hearing will serve as a legislative hearing for three bills that would authorize research, development, and demonstration activities carried out or supported by the U.S. Department of Energy in the areas of grid security, hydrogen, and pipelines.

- Grid Security: this draft legislation would update and reauthorize DOE's grid security research, development, demonstration, and commercial application activities, including: an energy sector security program; a grid resilience and emergency response program; direction for the Secretary of Energy to coordinate on the development of best practices for energy sector cybersecurity research, vulnerability testing and technical assistance; interagency coordination; and a program on critical grid infrastructure tools and technologies, among other activities.
- Hydrogen: this draft legislation would update and reauthorize DOE's hydrogen and fuel cell technologies research, development, demonstration, and commercial application

[1] "H.R.6 - 110th Congress (2007-2008): Energy Independence and Security Act of 2007." *Congress.gov*, Library of Congress, 19 December 2007, https://www.congress.gov/bill/110th-congress/house-bill/6/text.

activities, including: R&D activities in clean hydrogen production, transportation, storage, and utilization; an Office of Science hydrogen innovation center; clean hydrogen demonstration projects; international hydrogen development; and a technology transfer initiative, among other activities.

- Pipelines: this draft legislation would authorize a DOE demonstration initiative to support projects that best advance research undertaken by DOE and PHMSA, establish a National Pipeline Modernization Center, and direct DOE, DOT, and NIST to enter into a new Memorandum of Understanding to conduct joint research activities.

Additional Information

Grid Security

The U.S. energy sector is currently facing many critical challenges from an aging electric grid, vulnerabilities to cyberattacks, higher demand, and the increasing integration of new sources of energy. According to the U.S. Energy Information Administration (EIA), the U.S. power grid is made up of just under 12,000 power plants and nearly 240,000 miles of high-voltage power lines which connect 158 million customers throughout the country[2, 3, 4]. This resulted in 4,301 gigawatt hours (GWh) of electricity being generated in the United States in 2021[5].

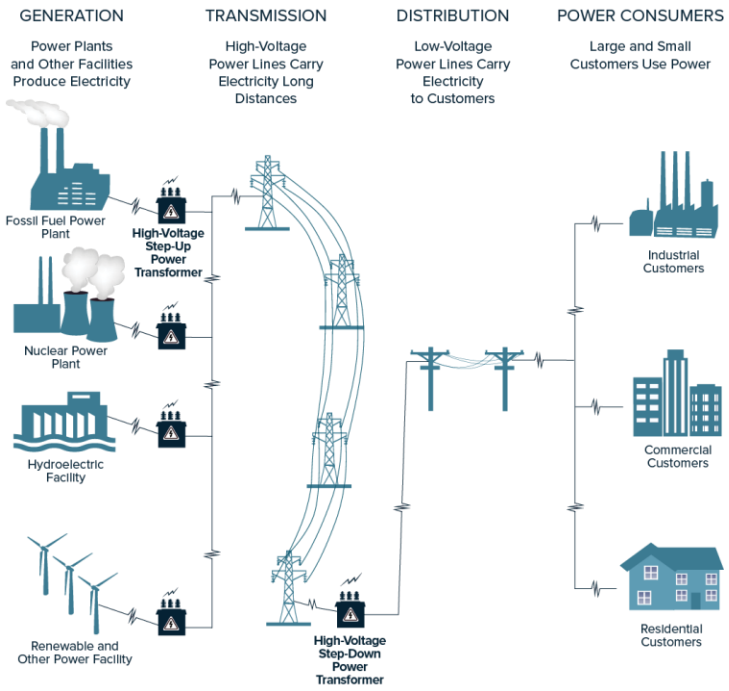


Figure 1. The Main Elements of the Electric Grid

[2] Marston, Theodore U. "The US Electric Power System Infrastructure and Its Vulnerabilities." *NAE Website*, 15 June 2018, https://www.nae.edu/183133/The-US-Electric-Power-System-Infrastructure-and-Its-Vulnerabilities.
[3] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *Electric Power Annual 2021 - U.S. Energy Information Administration*, 7 Nov. 2022, https://www.eia.gov/electricity/annual/.
[4] *2021 Total Electric Industry- Customers - Energy Information Administration.* https://www.eia.gov/electricity/sales_revenue_price/pdf/table1.pdf.
[5] "Frequently Asked Questions (Faqs) - U.S. Energy Information Administration (EIA)." *EIA*, 2 Mar. 2023, https://www.eia.gov/tools/faqs/faq.php?id=427&t=3.

DOE's grid security R&D activities are primarily carried out through its Office of Cybersecurity, Energy Security, and Emergency Response (CESER), which is tasked with enhancing the security and resilience of U.S. critical energy infrastructure, mitigating the impacts of disruptive events, and responding to and facilitating recovery from various energy disruptions.[6] DOE's national laboratories play a central role in these efforts. For example, CESER's Cyber Testing for Resilient Industrial Control System (CyTRICS) program leverages the expertise of DOE National Laboratories like Oak Ridge National Laboratory and Pacific Northwest National Laboratory to test manufacturers systems and flag any issues that could be vulnerabilities to the sector[7]. This capability is critical as new technologies and tools are deployed by industry to counter increasingly complex threats to the electric grid. Similarly, Idaho National Laboratory hosts the Critical Infrastructure Test Range Complex (CITRC), an 890 square mile site capable of large-scale electric grid testing. This type of testing capacity is helpful to DOE, and relevant stakeholders, as they plan for and respond to incidents impacting the energy grid.

As the lead agency for grid security of the energy sector, it is critical that DOE coordinate with other federal agencies in developing a strategic plan that can identify crosscutting research needs through collaboration with relevant stakeholders and maintain a training and workforce development system. This will ensure that the government and industry are prepared to face the challenges of the future by working together, along with academia, to prioritize relevant science and technology areas that will maintain our strategic advantage.

Hydrogen

Hydrogen is one of the most abundant elements on our planet and is a versatile clean energy carrier and fuel source.[8] When hydrogen is burned with oxygen, it produces only heat and water, which can result in net emissions reduction when compared to conventional fuel sources. Rarely found in usable form, hydrogen fuel must be produced through various methods. Today, 95% of hydrogen is produced from fossil fuels through steam methane reforming (SMR).[9] Hydrogen can also be produced from renewables, nuclear, and coal.

Traditionally, hydrogen has been used in industrial applications and to produce chemicals such as ammonia, but it can be stored as energy in fuel cells, power vehicles and trains, and convert to transport hydrogen due to its scalability and high capacity. In the U.S., there are over 1,607 miles of active hydrogen pipelines, almost all of which are in Texas, Louisiana, and Alabama.[10]

Congress first directed DOE to conduct hydrogen research, development, and demonstration activities in 1990 and later reauthorized these activities in the Energy Policy Act of 2005. DOE's hydrogen R&D activities are led mainly by its Hydrogen and Fuel Cell Technologies Office, which

[6] "CESER Mission." Energy.Gov, https://www.energy.gov/ceser/ceser-mission. Accessed 16 Mar. 2023
[7] Cybersecurity Testing for Resilient Industrial Control Systems." Energy.Gov, https://www.energy.gov/ceser/cybersecurity-testing-resilient-industrial-control-systems. Accessed 20 Mar. 2023
[8] Campbell, Richard J. *Hydrogen in Electricity's Future*, Congressional Research Service, 30 June 2020. https://crsreports.congress.gov/product/pdf/R/R46436. Accessed 20 Mar. 2023.
[9] "Hydrogen Fuel Basics." Energy.Gov, https://www.energy.gov/eere/fuelcells/hydrogen-fuel-basics. Accessed 16 Mar. 2023
[10] Parfomak, Paul W. *Pipeline Transportation of Hydrogen: Regulation, Research, and Policy*, 2 Mar. 2021. https://crsreports.congress.gov/product/pdf/R/R46700. Accessed 15 Mar. 2023.

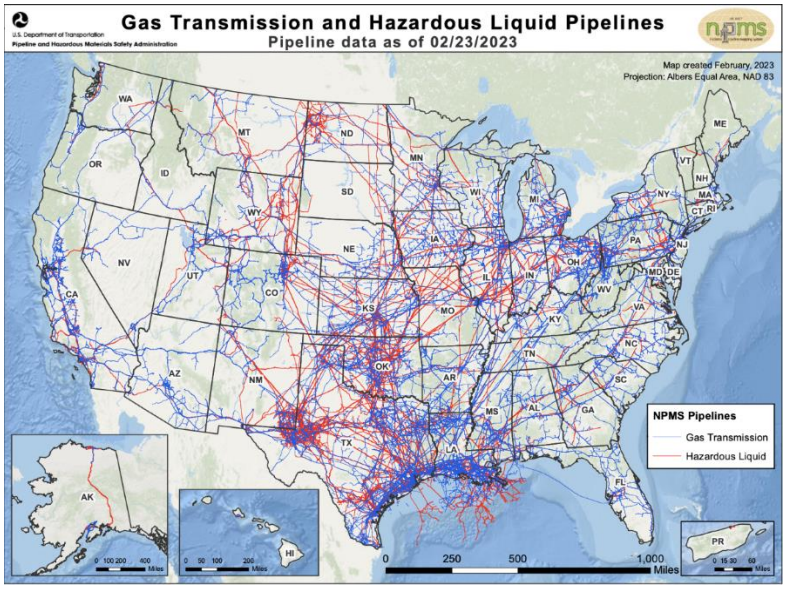
is housed under its Office of Energy Efficiency and Renewable Energy. Today, DOE has over 400 hydrogen research and development projects in the form of grants, contracts, and cooperative agreements with national laboratories, universities, and industry.[11] As one example, at Pacific Northwest National Laboratory, researchers are conducting chemical and material science experiments using 2-D materials, composed of carbon, boron, and nitrogen, which may improve hydrogen storage. Additionally, scientists at Sandia National Laboratory are studying materials that would improve the electrolysis process for hydrogen production through solar.[12]

Recently, the Infrastructure Investment & Jobs Act (IIJA) directed DOE to carry out additional hydrogen R&D activities, like Regional Clean Hydrogen Hubs, a National Clean Hydrogen Strategy Roadmap, the Hydrogen Manufacturing and Recycling Program, and the Clean Hydrogen Electrolysis Program, and appropriated billions of dollars in additional spending for these activities. The administration is in the process of accepting final applications for the Hydrogen Hubs where it will award 6 to 10 proposals a total of $7 billion. Congressional language directs the DOE to award applicants on variety of feedstocks and end uses as well as geographic locations. In light of these efforts to stimulate a hydrogen economy, it is now more important than ever for Congress to provide a comprehensive reauthorization of DOE's hydrogen R&D programs.

Pipelines

Due to the growth of global energy markets and recent innovations in oil and gas, the United States has built the largest pipeline network in the world. According to U.S. Department of Transportation (DOT), in 2019, there were over three million miles of pipeline including 219,746 miles of hazardous liquids (crude oil, refined products), 302,249 miles of natural gas transmission, 246,000 miles of natural gas gathering, and 2,301,090 miles of natural gas distribution mains and service lines.[13] Pipelines are an efficient and cost-effective fuel transportation method connecting producers to consumers from Texas to New York.

[11] Offutt, Martin C. *Department of Energy Funding for Hydrogen and Fuel Cell Technology Programs*, Congressional Research Service, 19 Oct. 2022. https://crsreports.congress.gov/product/pdf/IF/IF12163. Accessed 16 Mar. 2023.
[12] Mundy, Beth. *Storing Hydrogen on Materials*, Pacific Northwest National Laboratory, 27 Sept. 2022. https://www.pnnl.gov/publications/storing-hydrogen-materials. Accessed 17 Mar. 2023.
[13] Annual report mileage summary statistics. *PHMSA*, 1 Sep. 2020, https://www.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-summary-statistics ; Gathering Pipelines FAQs. *PHMSA*. 20 Aug. 2018, from https://www.phmsa.dot.gov/faqs/gathering-pipelines-faqs



Source: National Pipeline Mapping System, "Gas Transmission and Hazardous Liquid Pipelines."
Figure 2. U.S. Natural Gas Transmission and Hazardous Liquid Pipelines

However, despite this success, 50% of the U.S. pipeline system is more than sixty years old. With this aging network operating at capacity, it is inevitable that leaks and anomalies occur without new inspection and leak detection technologies.

Currently, both DOE and the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) conduct research on different elements of pipeline safety and innovation. DOE has focused its research and development activities on materials, real-time sensing and repair, transmission and distribution technologies, and natural gas conversion while PHMSA has developed an expertise in pipe manufacturing and installation quality control. While DOE's Office of Fossil Energy and Carbon Management leads the Department's initiatives in pipeline research and development, its Hydrogen and Fuel Cell Technologies Office plays a role due to their interest in using existing pipelines to transmit hydrogen. Despite these research activities, Congress has yet to provide a comprehensive authorization of these activities, so Congressional action is necessary to ensure the continuation of this important work.