Memorandum

TO: Committee on Science, Space, and Technology

FROM: Majority Staff, Committee on Science, Space, and Technology

DATE: March 8, 2023

SUBJECT: Full Committee Hearing: "Innovation Through Collaboration: The Department of Energy's Role in the U.S. Research Ecosystem"

The Committee on Science, Space, and Technology will hold a hearing titled *Innovation Through Collaboration: The Department of Energy's Role in the U.S. Research Ecosystem* on March 8, 2023, at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose

The purpose of this hearing is to examine the role of the U.S. Department of Energy (DOE) in the federal research enterprise by exploring longstanding interagency research partnerships between DOE and the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture (USDA), and the National Science Foundation (NSF), among others. This hearing will serve as a legislative hearing for a series of bills that would strengthen these partnerships and codify them in law as appropriate.

Witness List

- **Dr. Harriet Kung**, Deputy Director for Science Programs in the Office of Science, the U.S. Department of Energy
- **Mr. James L. Reuter**, Associate Administrator for the Space Technology Mission Directorate, the National Aeronautics and Space Administration
- **Dr. Michael C. Morgan**, Assistant Secretary of Commerce for Environmental Observation and Prediction, the National Oceanic and Atmospheric Administration
- **Dr. Sean L. Jones**, Assistant Director for the Directorate of Mathematical and Physical Sciences, the National Science Foundation

Overarching Questions

- What specific role does or should DOE play in addressing national research challenges?

- What types of federal interagency research partnerships are the most useful in bolstering U.S. competitiveness in science and technology? How can Congress best facilitate these types of partnerships and protect them from Administration turnover?

- What research infrastructure investments are necessary to ensure the DOE and its interagency research partners can compete on a national stage? In a restricted budget environment, what research facilities or investments should be prioritized?

- Are there specific areas of DOE's research portfolio where additional coordination or consultation with relevant federal agencies is needed?

DOE's Research Capabilities and Role in the U.S. Research Ecosystem

DOE's mission is to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions. As a leader in energy technology innovation and as the largest federal sponsor of basic research in the physical sciences, DOE plays a central role in the U.S. research ecosystem. DOE employs over 14,000 federal employees and oversees 95,000 contractors.[1] It operates 17 world-leading national laboratories which steward cutting-edge research in high priority focus areas such as materials science, advanced scientific computing, high energy physics, fusion energy sciences, and diverse next generation clean energy technologies.[2]

Through its Office of Science, DOE maintains and operates 28 scientific user facilities, which serve as essential resources for the research and development community. These facilities include advanced supercomputers, large-scale analytical and experimental tools like particle accelerators, x-ray light sources, and neutron scattering sources, as well as dedicated facilities for nanoscience and genomics. Together, this network of user facilities supports tens of thousands of researchers each year and provides a foundation for U.S. competitiveness in science and technology.[3]

Since the 1950s, DOE has applied its unparalleled expertise and resources to national science and technology challenges - work that has led to major scientific discoveries and technology innovations. Just a few of DOE's accomplishments include jump-starting the shale gas revolution by pointing the way to key technologies and methodologies for cost efficient extraction; pioneering optical digital recording technology; partnering with other federal agencies to identify and map all of the genes of the human genome; building the radioisotope thermoelectric generators that fuel NASA missions; and developing some of the fastest supercomputers currently in operation, including two exascale computers.[4]

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[1] Department of Energy Overview. Performance.gov. (n.d.). Retrieved March 2, 2023, from https://trumpadministration.archives.performance.gov/energy

[2] "National Laboratories." *Energy.Gov*, www.energy.gov/national-laboratories. Accessed 2 Mar. 2023.

[3] "Office of Science User Facilities." *Energy.Gov*, www.energy.gov/science/office-science-user-facilities. Accessed 2 Mar. 2023.

[4] "75 Breakthroughs by America's National Laboratories." *Energy.Gov*, 14 Feb. 2018, www.energy.gov/articles/75-breakthroughs-americas-national-laboratories-0. Accessed 2 Mar. 2023.

In carrying out this work, DOE has developed longstanding partnerships with various federal research agencies. As international competition grows and new opportunities for government-wide coordination and collaboration emerge, there is a need to examine these partnerships and determine the appropriate steps for strengthening them.

DOE and NASA

Fueled by the Department's expertise in nuclear propulsion, DOE and NASA have held a formal research partnership since 1960. DOE's national laboratories were instrumental in developing the Radioisotope Thermoelectric Generator (RTG), which powered several successful missions such as the Apollo program and the Voyager and Cassini spacecraft.[5]

Over the last sixty years, this relationship has expanded to new areas; DOE's Office of Science has provided NASA with their expertise in variety of subjects such as astronomy, astrophysics, biology, materials science, plasma science, space weather, solar energy, microgrids, low dose radiation, and high energy science. In the early 2000s, both offices worked together to build the Large-Area Telescope, which is the primary instrument for the Fermi Gamma-ray Space Telescope. This device detects gamma rays emitted by phenomena and highly energized objects across the universe, which has greatly improved our understanding of black holes, supernovas, and the universe itself.[6] In addition, NASA has employed the DOE's Frontier system at Oak Ridge National Laboratory, an exascale supercomputer, for weather simulations as well as to model a potential Mars landing. The latter simulation required nearly 400 terabytes of data for the six different flight scenarios.[7]

The most recent Memorandum of Understanding between NASA and DOE was signed in 2020.[8] This agreement continued collaboration in these areas of research and established three working groups: infrastructure on the lunar surface, nuclear power and propulsion in space, and space safety and planetary defense. One main goal for this renewed partnership was to return humans to the Moon by 2024 and develop a sustainable crewed space exploration program.[9] In 2021, NASA and DOE's Idaho National Laboratory awarded funding to nuclear thermal propulsion system designs, which could aid crew and cargo missions to Mars as well as science missions to the outer solar systems.[10] In 2022, these two groups then granted funding to fission surface power system designs that could support long-duration missions on the Moon and Mars.[11]

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[5] "Radioisotope Thermoelectric Generators (RTGs)." *NASA.Gov*, 25 Sept. 2018, solarsystem.nasa.gov/missions/cassini/radioisotope-thermoelectric-generator/. Accessed 2 Mar. 2023.
[6] "Fermi Gamma-ray Space Telescope." *NASA.Gov*, 31 Jan. 2023, solarsystem.nasa.gov/missions/cassini/radioisotope-thermoelectric-generator/. Accessed 2 Mar. 2023.
[7] McDowell, Rachel. "NASA Team Releases Mars Landing Simulation Data to Encourage New Research into Spacecraft Descent Technologies." *Oak Ridge National Laboratory*, 23 Sept. 2020, www.olcf.ornl.gov/2020/09/23/nasa-team-releases-mars-landing-simulation-data-to-encourage-new-research-into-spacecraft-descent-technologies/. Accessed 2 Mar. 2023.
[8] "Department of Energy and NASA Sign Memorandum of Understanding." *Energy.Gov*, 20 Oct. 2020, www.energy.gov/articles/department-energy-and-nasa-sign-memorandum-understanding. Accessed 2 Mar. 2023.
[9] "Department of Energy and NASA Sign Memorandum of Understanding." *Energy.Gov*, 20 Oct. 2020, www.energy.gov/articles/department-energy-and-nasa-sign-memorandum-understanding. Accessed 2 Mar. 2023.
[10] Potter, Sean. "NASA Announces Nuclear Thermal Propulsion Reactor Concept Awards." NASA, July 13, 2021. https://www.nasa.gov/press-release/nasa-announces-nuclear-thermal-propulsion-reactor-concept-awards.
[11] Dodson, Gerelle. "NASA Announces Artemis Concept Awards for Nuclear Power on Moon." NASA, June 22, 2022. https://www.nasa.gov/press-release/nasa-announces-artemis-concept-awards-for-nuclear-power-on-moon.

DOE and NOAA

DOE and NOAA collaborate on a range of weather and climate focused research activities. These agencies also work together through the National Climate-Computing Research Center (NCRC). Located at DOE's Oak Ridge National Laboratory, the NCRC provides NOAA with the ability to utilize high performance computing systems to develop, test, and apply complex Earth system models and computer simulations to all aspects of the climate and environment.[12]

Since the partnership agreement was established in 2009, the NCRC has contributed to the accelerated development and deployment of NOAA's four major modeling configurations: weather and subseasonal-to-seasonal forecasting (SHiELD), seasonal-to-multidecadal forecasting (SPEAR), high-resolution-ocean-based climate modeling (CM4), and Earth system modeling (ESM4). This work has been conducted on a computing system named Gaea that is operated by personnel from the National Center for Computational Sciences and capable of 5.29 petaflops.[13]

In January of 2021, DOE and NOAA formally agreed to renew their strategic partnership. This new agreement extends the partnership for another five years, funds a new series of technical and scientific projects, and installs a new HPC system that will increase Gaea's performance capability to around ten petaflops.[14]

DOE and the USDA

DOE and USDA have an established history of partnering to address multidisciplinary research challenges, and many of these collaborations have been formalized through various laws, agreements, and Memoranda of Understanding. A few focus areas include earth and environmental systems science, biomass and genomics-based research[15], sustainable aviation fuels[16], integrated water and natural resources[17], and methods for improving energy development in rural America.[18]

[12] "Climate Research Accelerated." *NCRC.Gov*, www.ncrc.gov/. Accessed 2 Mar. 2023.
[13] "GAEA." *NOAA.Gov*, 27 Feb. 2023, www.noaa.gov/organization/information-technology/gaea. Accessed 2 Mar. 2023.
[14] Turczyn, Coury. "DOE and NOAA Extend Strategic Partnership." *ORNL.Gov*, 12 Jan. 2021, olcf.ornl.gov/2021/01/12/doe-and-noaa-extend-strategic-partnership/. Accessed 2 Mar. 2023.
[15] 7 U.S.C. §8108.
[16] *Memorandum of Understanding Sustainable Aviation Fuel Grand Challenge*, 8 Sept. 2021. https://www.energy.gov/sites/default/files/2021-09/S1-Signed-SAF-MOU-9-08-21_0.pdf. Accessed 2 Mar. 2023.
[17] *Collaboration to Support Integrated Water Resources Science, Information, and Services*, 14 Jan. 2021. https://water.usgs.gov/osw/iwrss/ws00000587-final-iwrss-mou-signed.pdf. Accessed 2 Mar. 2023.
[18] *Relative to Cooperation and Coordination on Improving Energy Development in Rural America*, 25 Apr. 2017. Accessed 2 Mar. 2023.

For example, coordinating on fundamental genomics and early-stage biomass research helps the USDA and DOE overcome the challenges inherent in developing low-cost, high-efficiency biofuels. Through its Agricultural Research Service (ARS), and its National Institute of Food and Agriculture (NIFA), USDA has a history of coordinating with DOE and its Regional Feedstock Partnerships and Bioenergy Research Centers to develop science-based strategies to accelerate the production of regionalized biofuels feedstocks, renewable chemical feedstocks, and conversion systems that can support clean energy technologies and rural economic growth.[19,20]

Working together on future challenges, these agencies can improve crop science, maximize carbon storage, enhance precision agriculture technologies, and identify ways to combat invasive species, among many other areas.

DOE and the NSF

DOE and NSF have an active and extensive history of collaboration. These agencies collaborate on a wide range of research topics such as physics, quantum information sciences, biotechnology, artificial intelligence, advanced manufacturing, clean energy technologies, and advanced manufacturing.

Over the years, these agencies have developed several highly successful joint initiatives, such as the Basic Plasma Science and Engineering partnership. Since 1997, this program has expanded our understanding of plasma, its applications, and trained a new generation of scientists and engineers.[21] In addition, this partnership led to the development other initiatives such as the Algorithms for Modern Power Systems program which supports research projects to develop advanced mathematical and statistical algorithms that can improve the security, reliability, and efficiency of the power grid.[22]

DOE and NSF have also partnered to support the development of international scientific resources. The Vera C. Rubin Observatory, a world-leading tool for scientific discovery in astronomy, is a joint DOE-NSF project located in Chile. The Rubin Observatory is an 8.4-meter-wide field optical telescope designed to carry out a deep survey of our solar system and galaxy.[23] DOE and NSF have also provided funds for upgrades to the Large Hadron Collider at CERN (the European Organization for Nuclear Research), a project that has improved our global understanding of the fundamental nature of the universe.[24]

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[19] "Special Projects and Partnerships." *USDA.Gov*, www.wctsservices.usda.gov/Energy/SpecialProjects. Accessed 2 Mar. 2023.

[20] Office of Science (2019) *Plant Feedstock Genomics for Bioenergy Joint Awards 2006-2018.* Available at: https://genomicscience.energy.gov/wp-content/uploads/2021/09/usda-doe-Awards_flyer_2018.pdf (Accessed: March 2, 2023).

[21] Zweibel, E., Brown, M., Mauel, M., Milchberg, H., Rocca, J., & Thomas, E. J. (2017, March 31). The NSF/DOE partnership in Basic Plasma Science & Engineering at 20: Report on the Anniversary Workshop. AUrora Home. Retrieved March 2, 2023, from https://aurora.auburn.edu/handle/11200/49635.

[22] *Algorithms for Modern Power Systems (AMPS)* NSF. Available at: https://www.nsf.gov/pubs/2022/nsf22569/nsf22569.htm (Accessed: March 2, 2023).

[23] *National Science Foundation - Where Discoveries Begin* NSF. Available at: https://www.nsf.gov/about/budget/fy2022/ (Accessed: March 2, 2023).

[24] "NSF Awards $153 Million for High Luminosity Upgrades to Particle Detectors at Large Hadron Collider." *NSF.Gov*, 31 Mar. 2020, www.nsf.gov/news/special_reports/announcements/033120.jsp. Accessed 2 Mar. 2023.

DOE and other Federal Research Agencies

DOE also partners with additional federal agencies like the National Institute for Standards and Technology (NIST) and the Department of Homeland Security (DHS). NIST and DOE have worked closely over the past few years to improve critical infrastructure cybersecurity through NIST's updated cybersecurity framework.[25] Both agencies also are active participants in the National Quantum Initiative along with NSF. DOE and DHS signed an MOU in 2020 to partner on a new Energy Sector Pathfinder initiative.[26] The goals of this initiative are to advance information sharing, improve training and education to understand systemic risks, and develop joint operational preparedness and response activities to cybersecurity threats. The two agencies also collaborate at DHS's National Urban Security Technology Laboratory (NUSTL) in New York to help first responders prepare, protect, and respond to homeland security threats.[27]

Relevant Legislation

This hearing will serve as a legislative hearing for three Science Committee Majority bills that would codify in law the existing research partnerships between DOE and NASA, DOE and NOAA, and DOE and the USDA. This hearing will also be used to inform the development of future legislation in this area.

Last Congress, in August 2022, the DOE Office of Science was authorized in P.L. 117-167, the bipartisan CHIPS and Science Act. This legislation includes detailed program direction and targeted funding for DOE fundamental research programs and for critical research infrastructure, including upgrades and construction for scientific user facilities, at the DOE National Laboratories. It advances cutting-edge science with a responsible, scalable funding increase and provides a long-term strategic roadmap for DOE's R&D activities. CHIPS and Science also includes investments in NSF, NIST, and NASA, as well as provisions to protect these investments from theft and interference by adversaries. Oversight of CHIPS and Science implementation is a key priority for the Science Committee this Congress.

[25] Department of Energy Order 205.1C, May 15, 2019. https://www.directives.doe.gov/directives-documents/200-series/0205.1-BOrder-c-chg1-ltdchg/@@images/file

[26] "U.S. Department of Energy, U.S. Department of Homeland Security, and U.S. Department of Defense Announce Pathfinder Initiative to Protect U.S. Energy Critical Infrastructure." *Energy.Gov*, 3 Feb. 2020, www.energy.gov/articles/us-department-energy-us-department-homeland-security-and-us-department-defense-announce. Accessed 2 Mar. 2023.

[27] "National Urban Security Technology Laboratory." *Dhs.Gov*, 14 Feb. 2023, www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory. Accessed 2 Mar. 2023.