COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY
U.S. HOUSE OF REPRESENTATIVES
HEARING CHARTER

The Department of Energy's Office of Science: Exploring the Next Frontiers in Energy Research and Scientific Discovery
Wednesday, January 15, 2020
2:00PM EST
2318 Rayburn House Office Building, Washington, D.C. 20015

PURPOSE

The purpose of this hearing is to examine the current research and development activities and facilities supported by the U.S. Department of Energy's Office of Science, and to consider potential future directions for its various programs.

WITNESS

- **Dr. Chris Fall**, Director, Office of Science, U.S. Department of Energy

BACKGROUND

The U.S. Department of Energy's Office of Science is the lead federal agency supporting scientific research for energy applications and the nation's largest supporter of research in the physical sciences, supporting over 22,000 investigators at over 300 U.S. academic institutions and the DOE laboratories. The Office of Science portfolio has two principal thrusts: direct support of scientific research and support of the development, construction, and operation of unique, open-access scientific user facilities. These missions are primarily pursued by six research program offices: Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics, and Nuclear Physics. It also supports education initiatives through its Workforce Development for Teachers and Scientists program and general infrastructure projects for research facilities.

In carrying out these activities, the Office of Science stewards 10 of the 17 DOE laboratories. The laboratories execute long-term government missions and develop unique, often multidisciplinary, scientific instruments and resources beyond the scope of academic and industrial institutions. Key among the assets provided by the National Lab System are user facilities, which are used by over 32,000 researchers per year from universities, national laboratories, industry, and international partners.[1]

Office of Science Budget

FY 2019 Enacted: $6.58 billion
FY 2020 Enacted: $7.00 billion

Difference: +$420 million (+6.38%)

Advanced Scientific Computing Research (ASCR)

ASCR's mission is "to discover, develop, and deploy computational and networking capabilities to analyze, model, and simulate complex phenomena important to the Department of Energy."[2] ASCR supports research in both applied mathematics and computer science focused in areas relevant to high-end computing systems and stewards several of the largest computational facilities in the world. In addition, ASCR supports research in advanced networking capabilities to enable national and international research collaborations.

Notable ASCR facilities include the National Energy Research Scientific Computing Center (NERSC), which delivers high-end capacity computing services for the research community, currently supporting over 5,000 users; the Argonne Leadership Computing Facility (ALCF), which supports more than 800 active users and over 120 active projects; and the Oak Ridge Leadership Computing Facility, which supports Frontier, currently the fastest computer system in the world.[3]

Budget

FY 2019 Enacted: $935.5 million
FY 2020 Enacted: $980 million

Difference: +$44.5 million (+4.76%)

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[1] Department of Energy FY 2020 Congressional Budget Request. https://www.energy.gov/cfo/downloads/fy-2020-budget-justification
[2] Office of Science. Department of Energy. https://science.osti.gov/ascr/About
[3] Advanced Scientific Computing Research. DOE. https://www.energy.gov/science/ascr/advanced-scientific-computing-research

Basic Energy Sciences (BES)

BES supports research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels. The research disciplines that the BES program supports – condensed matter and materials physics, chemistry, geosciences, and biosciences – are those that lead to the creation of new materials and design new chemical processes. These disciplines touch virtually every aspect of energy resources, production, conversion, transmission, storage, efficiency, and waste mitigation.

Due to the breadth of its mission, BES is one of the nation's largest sponsors of research in the natural sciences and funds research at more than 170 research institutions in the U.S. In the process, BES supports many user facilities, including several massive light source and neutron source facilities, which enable materials characterization through x-ray and particle scattering, as well as five Nanoscale Science Research Centers. BES also stewards two Energy Innovation Hubs and 46 Energy Frontier Research Centers (EFRCs). Energy Innovation Hubs are integrated research centers (~$25 million annual budget per Hub) that combine research with engineering to accelerate scientific discovery in critical energy issue areas. BES specifically stewards the Fuels from Sunlight Hub, which focuses on advancing nonbiological processes to directly convert sunlight to liquid fuels, and a Batteries and Energy Storage Hub. EFRCs are integrated, multi-investigator centers (~$3-5 million annual budget per Center) that conduct research focused on one or more energy research "grand challenges" identified by the Basic Energy Sciences Advisory Committee.

Budget

FY 2019 Enacted:	$2.166 billion
FY 2020 Enacted:	$2.213 billion
Difference:	+$47 million (+2.17%)

Biological and Environmental Research (BER)

BER, by integrating molecular-level biological science with advanced computational and experimental approaches, seeks to gain a predictive understanding of living systems, from microbes and microbial communities to plants and other organisms. This knowledge serves as the basis for the redesign of microbes and plants for sustainable biofuel production, improved carbon storage, and contaminant remediation. As part of this work, BER supports four bioenergy research centers. BER also supports research that advances our understanding of the roles of Earth's biogeochemical systems (the atmosphere, land, oceans, sea ice, and subsurface), which includes developing advanced computational climate models. Additionally, in accordance with the Department of Energy Research and Innovation Act (P.L. 115-246) signed into law in September 2018, BER is required to re-establish a low-dose radiation research program to enhance the scientific knowledge of, and reduce uncertainties associated with, the effects of exposure to low-dose radiation to inform improved risk-management methods.[4]

Budget

FY 2019 Enacted:	$705 million
FY 2020 Enacted:	$750 million
Difference:	+$45 million (+6.38%)

Fusion Energy Sciences (FES)

FES is the lead federal program that supports research in the science and engineering required to confine plasmas for the purposes of generating net fusion energy. The program is responsible for building, operating, and improving several major fusion research facilities, including U.S. contributions to the ITER project (described below). It is also the lead program that stewards research in plasma science, which has applications in a broad range of areas from microchip processing to astrophysics. Additionally, in accordance with the Department of Energy Research and Innovation Act (P.L. 115-246) signed into law in September 2018, FES is required to re-establish an alternative and enabling concepts program; establish an inertial fusion R&D program which will, among other activities, leverage expertise and research facilities supported by DOE's weapons stockpile stewardship program for potential energy applications[5]; advance the development of fusion-relevant materials; improve coordination with the Department's Advanced Research Projects Agency – Energy (ARPA-E); and develop a 10-year strategic plan to establish R&D priorities under "not fewer than 3 realistic budget scenarios."[6]

ITER[7] (pronounced "eater") is a major international research project with the goal of demonstrating the scientific and technological feasibility of energy from nuclear fusion. The project is being designed and built by the members of the ITER Organization (IO): the European Union (EU), India, Japan, China, Korea, Russia, and the U.S. The device is under construction at Cadarache in southeastern France with the EU serving as the host party, and it is currently scheduled to begin preliminary operations by 2025. ITER is expected to generate fusion power that is at least 10 times greater than the external power delivered to heat its plasma by 2035. The

[4] https://www.congress.gov/bill/115th-congress/house-bill/589
[5] See National Research Council. 2013. *An Assessment of the Prospects for Inertial Fusion Energy*. Washington, DC: The National Academies Press. https://doi.org/10.17226/18289
[6] https://www.congress.gov/bill/115th-congress/house-bill/589
[7] ITER was originally an acronym for "International Thermonuclear Experimental Reactor," but that full title is no longer officially in use, and the project's leaders now note that *iter* also means "the way" in Latin.

project is designed to explore and test expectations of plasma behavior when the nuclear fusion process itself provides the primary heat source to sustain its high temperatures.

Budget

FY 2019 Enacted: $564 million
FY 2020 Enacted: $671 million

Difference: +$107 million (+18.97%)

High Energy Physics (HEP)

HEP supports research to advance our understanding of the fundamental building blocks of matter and energy as well as the nature of space and time and the interactions between them. HEP explores fundamental scientific frontiers ranging from the origins and behavior of the universe to the importance of the discovery of the Higgs Boson, which had been predicted to largely explain the origin of mass in matter.

It does this through support for proton and electron accelerator-based physics (using accelerators to create and analyze particles); non-accelerator based physics (examining phenomena such as dark matter, dark energy, neutrinos, and primordial matter, often in partnership with NASA and/or NSF); theoretical physics (providing the mathematical framework for understanding and extending knowledge about high energy physics); and R&D to develop the next generation of accelerator and detector technologies.

In 2017, HEP initiated construction of the Long-Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE) at Fermilab in Illinois and the Sanford Underground Research Facility (SURF) in South Dakota, which is designed to be the premiere facility in the world that will examine the properties of neutrinos. Neutrinos are fundamental to understanding physics beyond the long-established "Standard Model" of particle physics and can help scientists determine how the universe continues to evolve.

Budget

FY 2019 Enacted: $980 million
FY 2020 Enacted: $1.045 billion

Difference: +$65 million (+6.63%)

Nuclear Physics (NP)

The mission of NP is to discover, explore, and understand all forms of nuclear matter. Nuclear matter consists of any number of clustered protons and neutrons which makes up the nuclei of atoms, but exactly how they fit together and interact to create different types of matter in the universe is still largely not understood. To try to answer the many remaining questions in this field, NP supports experimental and theoretical research – along with the development and operation of specially designed particle accelerators and other advanced technologies – to create, detect, and describe the different forms of nuclear matter that can exist in the universe, including those that are no longer found naturally.

Specifically, NP supports research into the interaction of quarks and gluons that make up the nucleus; why the universe is made up of matter rather than antimatter (which is also relevant to HEP as described above); new and predicted matter including matter and phenomena that existed during the universe's infancy; how protons and neutrons are bound into stable nuclei versus rare and unstable nuclei; the evolution of the cosmos, and the theoretical underpinning needed to support the interpretation of data obtained from all other NP research in order to advance hypotheses and stimulate experimental investigations.

On January 9th, 2020, DOE announced that Brookhaven National Laboratory in New York, in partnership with the Thomas Jefferson National Accelerator Facility in Virginia, will be the site for construction of a major new NP facility called the Electron Ion Collider (EIC). The EIC is designed to be the premiere facility in the world that "will smash electrons into protons and heavier atomic nuclei in an effort to penetrate the mysteries of the 'strong force' that binds the atomic nucleus together."[8]

In addition, NP supports the production and development of techniques to make isotopes that are in short supply for medical, national security, environmental, and other research applications.

Budget

FY 2019 Enacted:	$690 million
FY 2020 Enacted:	$713 million
Difference:	+$23 million (+3.33%)

[8] https://www.energy.gov/articles/us-department-energy-selects-brookhaven-national-laboratory-host-major-new-nuclear-physics