Federal Energy R&D: Fusion Energy Sciences

BY COLIN CUNLIFF | APRIL 2019

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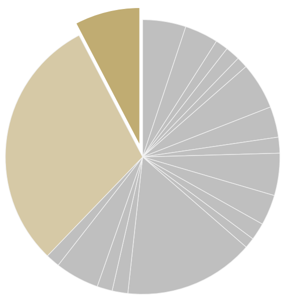
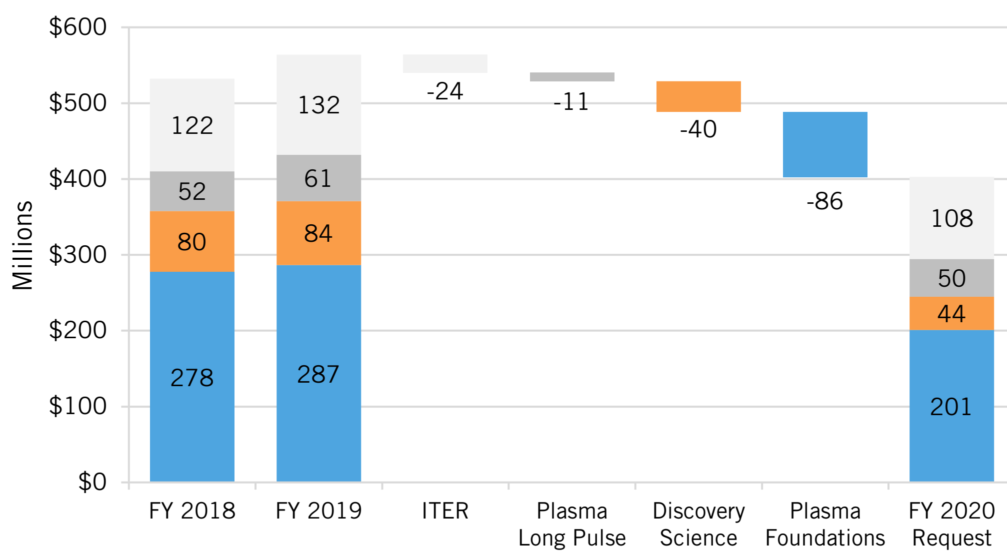


Fusion Energy (brown)
Basic Energy Science (brown)
Energy R&D (light gray)

The mission of the Fusion Energy Sciences (FES) program is to help build the scientific foundation needed to develop a fusion energy source by expanding the fundamental understanding of the physics behind plasmas (i.e., matter at very high temperatures and densities).[1] Comprising 99 percent of the visible universe, plasmas are at the heart of the fusion process that powers the stars. The promise of fusion—an energy system that could generate massive amounts of power, using fuel obtained from seawater and earth-abundant materials, with very little pollution—is enormous.

Figure 1: The FY 2020 budget request would cut fusion R&D by 29 percent.[2]



What's At Risk

Fusion RD&D has the potential to contribute to U.S. energy security by making available a robust clean energy technology that relies on widely available and virtually inexhaustible fuel sources. However, the technological advances needed to realize safe, low-cost fusion are still nascent, so basic research into plasma physics—including plasma confinement and plasma-materials interactions—remains essential to advancing toward the goal of fusion energy. Reductions in funding for this program could stall advances in fusion science, while threatening the United States' leadership in this important area.

Because its science is so wide-ranging, plasma research could spin off a number of applications for other technologies. Advances developed in the quest for fusion energy have already led to the creation of other technologies that provide considerable economic and societal impact, including applications in lighting, semiconductor manufacturing, medical and health science and technology, materials, and waste management.[3] Robust plasma-research funding is therefore necessary to prevent the United States from losing out on future benefits in these and other industries.

Fusion Energy Sciences R&D Activities

R&D in fusion energy is distributed across four subprograms:[4]

- **Burning Plasma Science: Foundations** advances the predictive understanding of plasma confinement, dynamics, and interactions with surrounding materials—and conducts research in advanced tokamak and spherical-tokamak science, as well as small-scale magnetic confinement experiments.
- **Burning Plasma Science: Long Pulse** explores new scientific regimes using long-duration superconducting international machines, and addresses the development of materials and technologies required to withstand and sustain burning plasma.
- **Discovery Plasma Science** explores the fundamental properties and complex behavior of matter in the plasma state to improve the understanding required to control and manipulate plasmas for a broad range of applications.
- **International Thermonuclear Experimental Reactor (ITER)** is an ambitious international collaboration among seven governments (China, the European Union, India, Japan, the Republic of Korea, the Russian Federation, and the United States) to demonstrate the scientific and technological feasibility of fusion power for electricity generation.

Key Elements of the FY 2020 Budget Proposal

- **A 30-percent reduction in Basic Plasma Science: Foundations**, including a $37 million cut to research and operations at DIII-D, the largest magnetic fusion user facility in the United States; and a $27.5 million cut to research and operations at the National Spherical Torus Experiment Upgrade (NSTX-U), the most powerful spherical tokamak user facility in the world.
- **An 18-percent reduction in Basic Plasma Science: Long Pulse**, including reductions in long-pulse tokamaks, as well as reductions in the fusion nuclear science and materials research that seeks to understand how plasmas interact with the materials that might be used in future fusion facilities.
- **A 48-percent reduction in Discovery Plasma Science,** including elimination of research in exploratory magnetized plasmas—which is necessary to advance innovative solutions and capabilities for the creation, control, and manipulation of magnetically confined plasmas for terrestrial and space applications; reductions in general plasma science, which explores low-temperature plasma science and

engineering; and reductions in high energy density plasma science, which explores the behavior of matter at extreme conditions of temperature, density, and pressure.

- **A 19-percent reduced contribution to the International Thermonuclear Experimental Reactor (ITER)**. As a member of ITER, the United States has committed to provide 9 of the construction costs in return for full access to all ITER technology and scientific data, which represents a significant opportunity for U.S. universities, laboratories, and industries to both design and construct parts, and propose and conduct experiments.[5]

ENDNOTES

1. DOE, "FY 2020 Congressional Budget Justification," Volume 4, DOE/CF-0154 (Washington, D.C.: DOE Chief Financial Officer, March 2019), 157-181, https://www.energy.gov/sites/prod/files/2019/03/f61/doe-fy2020-budget-volume-4.pdf.
2. Ibid.
3. Fusion Energy Sciences Advisory Committee, "Applications of Fusion Energy Sciences Research" (Washington, D.C.: DOE, September 2015), https://science.energy.gov/~/media/fes/fesac/pdf/2015/2101507/FINAL_FES_NonFusionAppReport_090215.pdf.
4. DOE, FY 2020 Congressional Budget Justification, Volume 4; see also Office of Fusion Energy Sciences, "A Ten-Year Perspective (2015-2025)," (DOE Office of Science, December 2015), https://fire.pppl.gov/FES_10Year_Perspective_2015.pdf; and National Academies of Sciences, Engineering, and Medicine, "Final Report of the Committee on a Strategic Plan for U.S. Burning Plasma Research," (National Academies Press, 2018), https://doi.org/10.17226/25331.
5. DOE, "U.S. Participation in the ITER Project," 1, (DOE, May 2016), https://science.energy.gov/~/media/fes/pdf/DOE_US_Participation_in_the_ITER_Project_May_2016_Final.pdf.

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