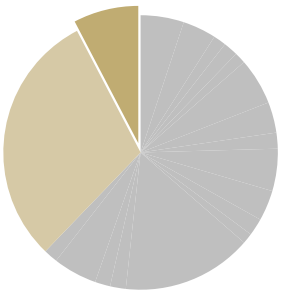
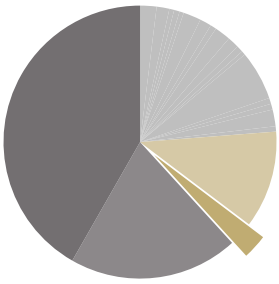
Federal Energy R&D: Fusion Energy Sciences

BY DAVID M. HART AND COLIN CUNLIFF | APRIL 2018

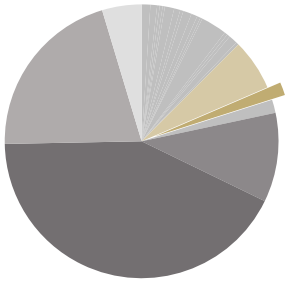
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



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



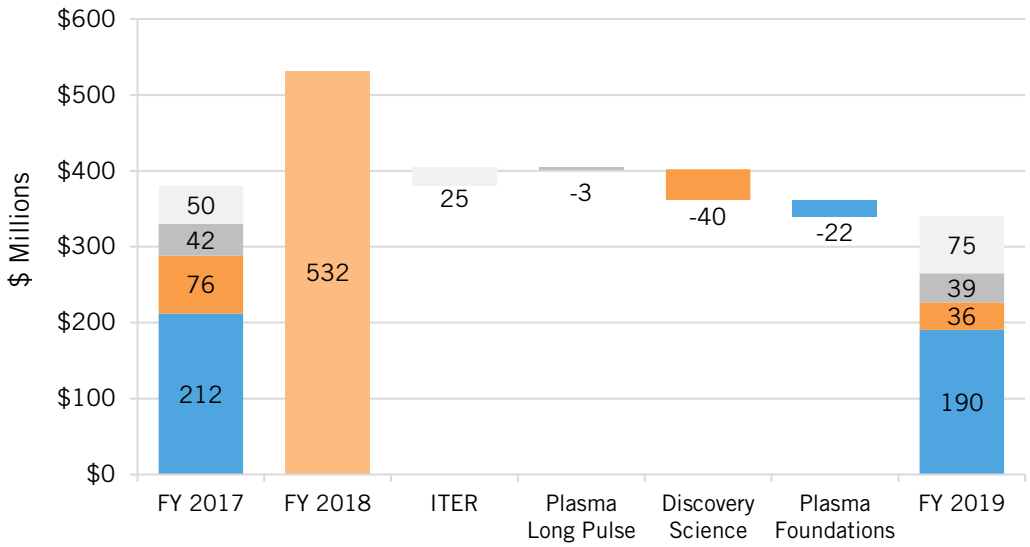
Fusion Energy & Energy R&D
Basic Science R&D
Defense R&D



Fusion Energy Sciences,
Energy, Basic Science,
Defense, Environ Mngmt,
Other DOE

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 2019 Budget Request Would Cut Fusion Energy Sciences R&D by 36 Percent



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.[2] 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:

- **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 international partnership among seven governments (China, the European Union, India, Japan, the Republic of Korea, the Russian Federation, and the United States) that demonstrates the scientific and technological feasibility of fusion power for electricity generation.

Key Elements of the FY 2019 Budget Proposal

- **A 10-percent reduction in Basic Plasma Science: Foundations**, including reductions in the spherical-tokamak user facility at Princeton, New Jersey, as well as to the theory and simulations program that works to develop the predictive capability needed for sustainable fusion.
- **A 7-percent reduction in Basic Plasma Science: Long Pulse**, including reductions in superconducting stellarators and long-pulse tokamaks, as well as reductions in the fusion nuclear science and materials R&D that seeks to understand how plasmas interact with the materials that might be used in future fusion facilities.
- **A 53-percent reduction in Discovery Plasma Science,** including elimination of R&D 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—as well as reductions in R&D in general plasma science, which explores low-temperature plasma science and engineering, and high energy density plasma science, which explores the behavior of matter at extreme conditions of temperature, density, and pressure.

- **Increased contribution to the International Thermonuclear Experimental Reactor (ITER).** Although U.S. investment in ITER is less than 10 percent of construction costs, the United States has 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.

ENDNOTES

1. DOE, "FY 2019 Congressional Budget Justification," volume 4, DOE/CF-0142 (Washington, D.C.: DOE Chief Financial Officer, February 2018) 149, https://www.energy.gov/sites/prod/files/2018/03/f49/DOE-FY2019-Budget-Volume-4_0.pdf.
2. 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.

ABOUT THE AUTHORS

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