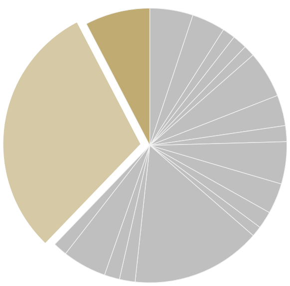
Federal Energy RD&D: Basic Energy Sciences

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

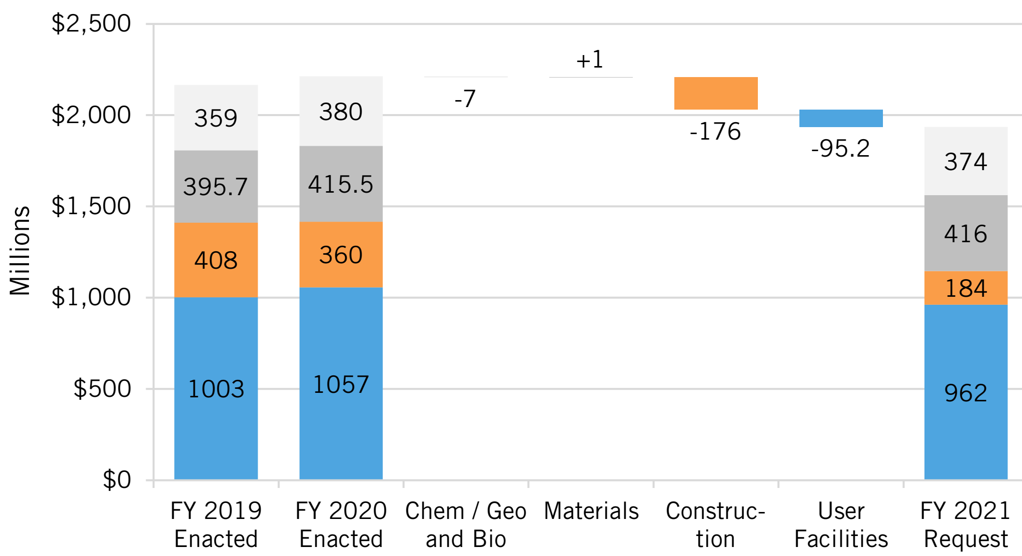
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



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

Basic Energy Sciences (BES) supports fundamental research into understanding, predicting, and controlling matter and energy, thereby helping to build the foundation for new energy technologies. BES research—in condensed matter and materials physics, chemistry, geosciences, and aspects of biosciences—touches virtually every important facet of energy production, conversion, transmission, storage, and waste mitigation. BES also operates open-access scientific "user facilities" that enable researchers from private industry, national laboratories, and universities to use advanced instruments and tools that are too expensive for a single university lab or private company to own and operate.[1]

Figure 1: The FY 2021 budget request would cut basic energy sciences R&D by 13 percent[2]



What's at Risk

Research in BES is a key component of the energy innovation ecosystem, and comprises 27 percent of the energy research and development (R&D) budget. In 2018, the BES Advisory Committee produced a retrospective report, "A Remarkable Return on Investment in Fundamental Research," identifying some of the groundbreaking discoveries made as a result of BES funding. Many have resulted in the commercialization of new technologies that shape the way we produce and consume energy—years, and often decades, later after the initial research was done.[3] The National Academy of Sciences has called for a doubling of basic science research, including BES, as a means of addressing challenges to U.S. competitiveness.[4] And House Republicans, led by Rep. Frank Lucas (R-

OK), put forward legislation in 2020 to double funding for BES to accelerate clean energy innovation over a ten-year period.[5]

BES supports 46 Energy Frontier Research Centers (EFRCs), which are partnerships among universities, national laboratories, and industry that integrate the talents and insights of leading scientists and engineers to confront critical energy challenges across sectors. BES also houses two energy innovation hubs: the Joint Center for Artificial Photosynthesis (i.e., solar fuels hub) at the California Institute of Technology, which seeks to generate fuels directly from sunlight, carbon dioxide, and water in a manner similar to natural photosynthesis; and the Joint Center for Energy Storage Research (i.e., batteries and energy storage hub) at Argonne National Laboratory, which researches nanoscale phenomena to develop next-generation, beyond-lithium-ion-energy storage systems. Annually, BES's 12 user facilities provided nearly 16,000 industry, government, and academic researchers access to advanced research capabilities, including X-ray lasers, accelerators, neutron sources, and tools to probe matter on the nanoscale.[6]

Basic Energy Sciences R&D Activities

R&D in basic energy is distributed across four subprograms:[7]

- **Materials Sciences and Engineering** supports research on materials synthesis, behavior, and performance for a wide range of energy-generation and end-use challenges, with a focus on the origin of macroscopic-material behaviors; their fundamental connections to atomic, molecular, and electronic structures; and their evolution as materials move from nanoscale building blocks to mesoscale systems.

- **Chemical Sciences, Geosciences, and Biosciences** supports research on chemical reactivity and energy conversion, which is the foundation for energy-relevant chemical processes—such as catalysis, synthesis, and light-induced chemical transformation—to achieve a fully predictive understanding of complex chemical, geochemical, and biochemical systems at the same level of detail as simple molecular systems.

- **Scientific User Facilities** supports the operation of 12 user facilities—5 light sources, 2 neutron scattering facilities, and 5 nanoscale science research centers—that provide thousands of researchers from universities, industry, and government laboratories unique tools to advance a wide range of scientific research. These user facilities are operated on an open-access, competitive merit review basis, enabling public and private researchers from every discipline to take advantage of the facilities' unique capabilities and instrumentation.

- **Construction** supports the development of new user facilities and upgrades to existing facilities, including the Linac Coherent Light Source-II, which will be the world's most powerful X-ray-free electron laser.

Key Elements of the FY 2021 Budget Proposal[8]

- **Funding most BES User Facilities at "91 percent optimum,"** which means most light sources would only be operated for 91 percent of the total potential operating time. Additionally, both BES-supported neutron sources, the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR), would operate at 91 percent optimum. This means 860 fewer researchers would be able to use the BES user facilities than in FY 2020, and 2,670 potential research hours would be unused.

- **A 71 percent, or $17 million, cut to the Established Program to Stimulate Competitive Research (EPSCoR),** a program to advance research capabilities in states and territories with historically lower levels of federal research funding.

- **A 50 percent cut to BES Construction,** including reduced funding for upgrades at the Advanced Photon Source, the Spallation Neutron Source, the Advanced Light Source, and the Linac Coherent Light Source-II.

- **Flat funding for the Batteries and Energy Storage innovation hub as well as the Fuels from Sunlight innovation hub.**

- **Near-flat funding for Materials Science and Engineering Research**. Scattering and instrumentation sciences research would get a $6 million cut; condensed matter and materials physics would get a $22 million boost; and materials discovery research would get a $2 million boost.

- **Near-flat funding for Chemical Sciences, Geosciences, and Biosciences.** Research in fundamental interactions would be cut by $2 million, and photochemistry and biochemistry by $8 million. Chemical transformations would get a $4 million boost; computational chemical sciences would receive flat funding.

ENDNOTES

1. DOE, "FY 2021 Congressional Budget Justification," Volume 4, DOE/CF-0165 (Washington, D.C.: DOE Chief Financial Officer, February 2020), 51–147, https://www.energy.gov/sites/prod/files/2020/02/f71/doe-fy2021-budget-volume-4.pdf.
2. Ibid, 54–55.
3. Basic Energy Sciences Advisory Committee (BESAC), "A Remarkable Return on Investment in Fundamental Research: 40 Years of Basic Energy Sciences at the Department of Energy" (DOE, June 2018), https://www.osti.gov/biblio/1545686.
4. National Academies of Sciences, Engineering, and Medicine, "Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5" (Washington, D.C. The National Academies Press, 2010), https://doi.org/10.17226/12999; Robert D. Atkinson, "An Innovation-Based Clean Energy Agenda for

America" (Information Technology and Innovation Foundation, Washington, D.C.: June 2015), http://www2.itif.org/2015-energy-innovation-agenda.pdf; Colin Cunliff, "An Innovation Agenda for Deep Decarbonization: Bridging Gaps in the Federal Energy RD&D Portfolio" (Information Technology and Innovation Foundation, November 2018), http://www2.itif.org/2018-innovation-agenda-decarbonization.pdf.

5. Securing American Leadership in Science and Technology Act of 2020, H.R. 5685, 116th Cong. (2020), https://www.congress.gov/bill/116th-congress/house-bill/5685.

6. DOE, "Scientific User Facilities (SUF) Division," accessed February 18, 2020, https://science.osti.gov/bes/suf; DOE, "DOE Energy Innovation Hubs," accessed February 18, 2020, https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs; DOE, "Office of Science User Facilities: Fiscal Year 2015" (DOE Office of Science), https://science.osti.gov/-/media/_/pdf/user-facilities/Reports/DOE-SC-User-Facilities-FY2015-report.pdf?la=en&hash=D7AC49453FB0EE861717409E3DD1C247994D7495; DOE, "Annual Report on the State of the DOE National Laboratories" (DOE, January 2017), https://www.energy.gov/downloads/annual-report-state-doe-national-laboratories; DOE, "FY 2021 Congressional Budget Justification," 85–88.

7. DOE, FY 2021 Congressional Budget Justification, 54–106.

8. Ibid.

ACKNOWLEDGMENTS

The authors wish to thank David M. Hart for providing input to this report. Any errors or omissions are the authors' alone.

ABOUT THE AUTHOR

Colin Cunliff is a senior policy analyst for clean energy innovation with the Information Technology and Innovation Foundation. He previously worked at the U.S. Department of Energy (DOE) on energy sector resilience and emissions mitigation. He holds a Ph.D. in physics from the University of California, Davis.

Batt Odgerel is a policy fellow for clean energy innovation at the Information Technology and Innovation Foundation. He previously worked for the Energy Policy Research Foundation and Smart Electric Power Alliance, and holds a master's degree in energy policy from Johns Hopkins University.

ABOUT ITIF