Federal Energy R&D: Nuclear Energy

BY DAVID M. HART AND COLIN CUNLIFF | APRIL 2018

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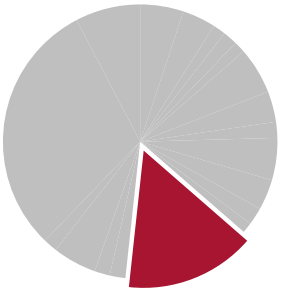
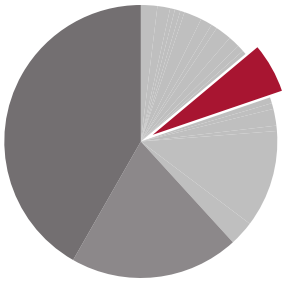
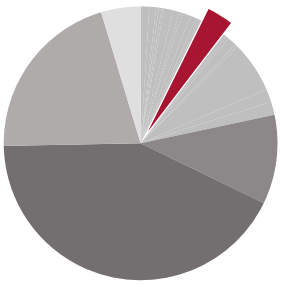


Nuclear Energy R&D (red)
Energy R&D (gray)



Nuclear Energy & Energy R&D
Basic Science R&D
Defense R&D



Nuclear Energy & Energy
Basic Science
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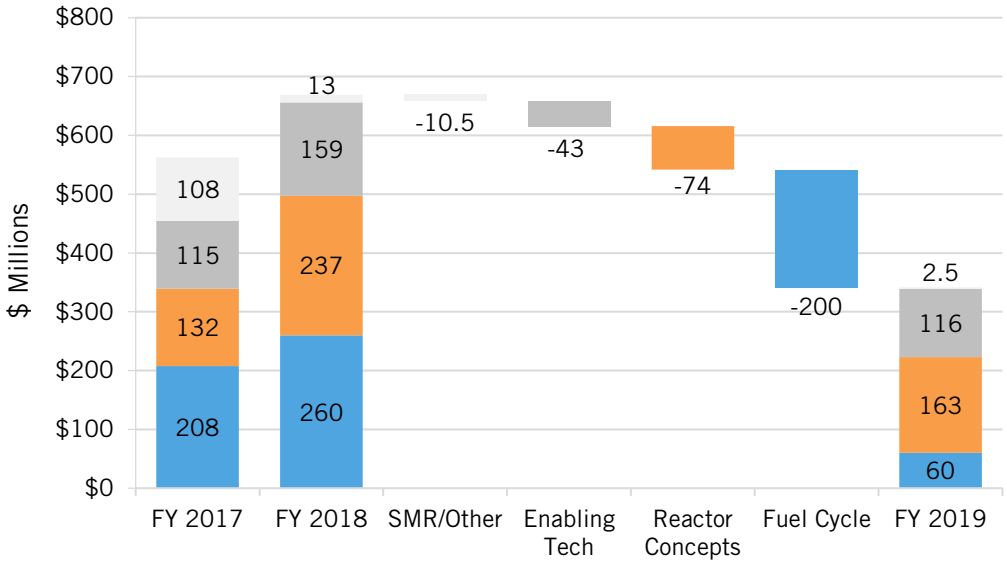
Nuclear power accounts for 20 percent of the electricity generated in the United States, and 54 percent of all carbon-free electricity.[1] Despite this success, the existing nuclear fleet is being challenged by low-cost natural gas and renewables, as Russia and China surpass the United States in the development of advanced nuclear reactors. To address these challenges, the Department of Energy's (DOE) nuclear energy (NE) program conducts R&D on technical challenges that may threaten the maintenance of the existing reactor fleet, and on the development of a robust pipeline of advanced reactor designs and supply-chain capabilities.

Figure 1: The FY 2019 Budget Request Would Cut Nuclear Energy R&D by 49 Percent



What's At Risk

Nuclear energy has unique regulatory challenges that limit the ability of the private sector to conduct full-scale R&D on its own. Plus, many of the facilities necessary for R&D are capital-intensive and lie beyond the financial capacity of potential nuclear innovators. DOE has had success working with industry to develop small modular reactors (SMRs) based on current light-water-reactor technologies. The SMR Licensing Technical Support program, for example, addressed first-of-a-kind costs associated with design certification and licensing, resulting in the submission of the first SMR license application to the Nuclear Regulatory Commission in January 2017.[2]

DOE is exploring advanced, non-light-water reactor designs that could operate at higher temperatures (allowing for greater efficiency and provision of other energy services, such as process heating), produce lower volumes of waste, incorporate passive safety features, and reduce proliferation risks. However, DOE has conducted R&D in advanced reactors since the late 1990s, and so far no advanced reactor concepts have progressed to full-scale demonstration, let alone commercialization.[3] The department has established aggressive targets to develop and demonstrate advanced reactors by the early 2030s, but is unlikely to meet this goal without greater levels of sustained funding for R&D.

Nuclear Energy R&D Subprograms

Nuclear energy R&D is conducted in the following subprograms:

- **Reactor Concepts RD&D** develops new and advanced reactor designs and technologies, including advanced SMRs, fast reactors using liquid-metal coolants, high-temperature reactors, and light-water-reactor technologies.
- **Fuel Cycle R&D** studies advanced fuel-cycle technologies that have the potential to enhance safety, improve resource utilization, reduce waste generation, and limit risk of proliferation.
- **Nuclear Energy Enabling Technologies** works to develop cross-cutting technologies in reactor materials; advanced sensors and instrumentation; advanced manufacturing methods; and modeling and simulation—and provides support for nuclear-science user facilities.
- **Other NE R&D** includes contributions to the cross-cutting Supercritical Transformational Electric Power (STEP) program, which develops supercritical carbon dioxide Brayton cycle technologies (which are potentially applicable to nuclear, concentrated-solar, bio-, geothermal, and fossil-fuel power), as well as nuclear-workforce training and education programs.

Key Elements of the FY 2019 Budget Proposal

- **A 77-percent reduction in Fuel Cycle R&D**, including the transfer of used-nuclear-fuel-disposal R&D and integrated waste-management systems to a new Yucca Mountain and Interim Storage Program, as well as reduced funding for advanced nuclear fuels, material recovery and waste-form development, and elimination of systems analysis and integration.
- **A 31-percent reduction in Reactor Concepts R&D**, including reduced funding for light-water-reactor sustainability and advanced-reactor technologies; the proposal includes the creation of a new Advanced Small Modular Reactor program to develop advanced (i.e., non-light-water) SMRs as well as a small increase in funding for the Versatile Advanced Test Reactor.

- **A 27-percent reduction in Nuclear Energy Enabling Technologies**, including elimination of the Energy Innovation Hub for Modeling and Simulation; R&D for cross-cutting technologies—including advanced sensors and instrumentation, advanced manufacturing methods, cooling technologies, and hybrid energy systems—and R&D in advanced modeling and simulation would see modest increases.

- **Elimination of NE participation in STEP and nuclear-workforce development programs.**

ENDNOTES

1. EIA, "Monthly Energy Review," Table 7.2a, (Washington, D.C.: EIA, 2018), http://www.eia.gov/mer. Accessed April 14, 2018.
2. Karen Thomas, "NuScale files US' first SMR License Application as Suppliers Await Tender," *Nuclear Energy Insider*, January 10, 2017, https://analysis.nuclearenergyinsider.com/nuscale-files-us-first-smr-license-application-suppliers-await-tender.
3. A Abdulla et al., "A Retrospective Analysis of Funding and Focus in US Advanced Fission Innovation," Environmental Research Letters, 084016, 2017, 12, https://doi.org/10.1088/1748-9326/aa7f10.

ABOUT THE AUTHORS

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