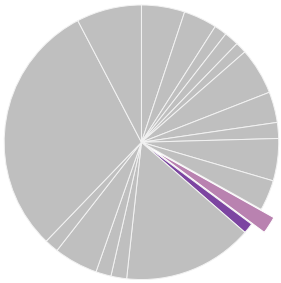
Federal Energy R&D: Grid Modernization

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

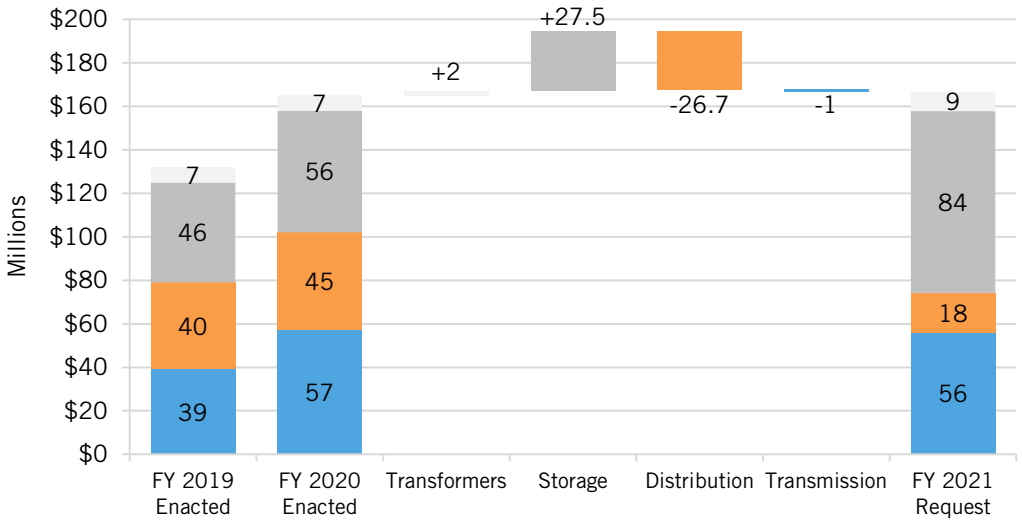
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



Grid Mod (lavender)
Energy TS&D (purple)
Energy R&D (gray)

The grid modernization research and development (R&D) programs in the Office of Electricity (OE) accelerate discovery and innovation in electricity transmission, storage, and distribution technologies to incorporate greater levels of distributed and variable energy resources, provide enhanced connectivity between systems and devices, and improve reliability and resilience. OE seeks to provide solutions to market, institutional, and operational failures that go beyond any one utility's ability to solve.[1] The program's work on resilience, threat assessment, risk management, and grid hardening is motivated by natural disasters, such as hurricanes Harvey and Maria and Superstorm Sandy, as well as the 2013–2015 drought and accompanying wildfires in the western United States. The OE-funded R&D into energy-storage technologies aims to enable greater stability, resiliency, and reliability in the electric grid, while also supporting increasing levels of variable renewable energy sources such as wind and solar.[2]

Figure 1: The FY 2021 budget request would increase grid modernization R&D by 1 percent[3]



What's at Stake

Grid modernization is critical to ensuring reliable and affordable energy delivery, sustaining economic growth, and mitigating risks to the security of the grid and other vital sectors that depend on the grid's services. In collaboration with the utility industry, the Department of Energy (DOE) established the Grid Modernization Initiative (GMI) to coordinate R&D activities. Through the initiative, a multiyear R&D roadmap outlining

six technical areas (devices and integrated systems testing; sensing and measurements; system operations, power flow, and control; design and planning tools; security and resilience; and institutional support) was created, which industry and government should jointly pursue to establish a resilient, secure, sustainable, and reliable grid.[4] For its part, DOE has set targets and performance measures in reliability and resilience, as well as cost and performance targets for new grid storage technologies.[5] In its latest round of funding in November 2019, DOE's GMI selected 23 projects at the national labs to receive $80 million over the next 3 years across topic areas ranging from resilience modeling to energy storage and system flexibility.[6]

DOE has also been ramping up its work in grid-scale energy storage. In the last budget cycle, it included a proposal to build a Grid Storage Launchpad at the Pacific Northwest National Laboratory (PNNL) to enable development, testing, and evaluation of batteries and other storage technologies for grid applications.[7] ITIF analysis has found that energy storage can enable better energy systems integration, and may be essential to incorporating greater shares of electricity from variable wind and solar.[8]

Grid Modernization R&D Subprograms

Grid modernization R&D is made up of four main subprograms:[9]

- **Transmission Reliability and Resilience (TRR)** focuses on ensuring the reliability and resilience of the electric grid through R&D on measurement and control of the electrical system, and risk assessments to address challenges across integrated energy systems.
- **Resilient Distribution Systems (RDS)** pursues strategic R&D to improve reliability, resiliency, outage recovery, and operational efficiency of the distribution portion of the electricity-delivery system, with a focus on improved resilience against extreme weather and other natural and man-made hazards.
- **Energy Storage** focuses on the development of new materials and device technologies that both improve the cost and performance of utility-scale energy-storage systems and better integrate storage into the grid infrastructure.
- **Transformer Resilience and Advanced Components (TRAC)** supports modernization, hardening, and resilience of grid components, including transformers, power lines, and substation equipment.

Key Elements of the FY 2021 Budget Proposal[10]

- **A 59 percent reduction in Resilient Distribution Systems,** with reduced funding for the development of GridAPPS-D™, an open-source advanced distribution management system application platform that provides utilities with a standardized environment to develop and test grid applications; reduced funding for other Advanced Distribution Management Systems (ADMS) research; no new funding for the National Test Bed Laboratory for Coordinated Management of

Microgrids and Networked Distributed Energy Resources (COMMANDER); and reduced funding for the Situational Awareness Network (SAN).

- **A 49 percent increase in Energy Storage,** primarily due to a $39 million boost for construction of the Grid Storage Launchpad at PNNL. Funding for other research activities in this subprogram would be cut by $11.5 million, with the focus on deployment and validation of longer-term (6 or more hours) storage systems for defense infrastructure; deployment of energy storage systems for cooperatives; and R&D on lead-acid batteries for grid storage applications.

- **A 2 percent decrease in Transmission Reliability and Resilience,** including reduced funding for development of the North American Energy Resiliency Model, an integrated energy system model to improve planning and contingency analyses that address energy system vulnerabilities; reduced funding for synchrophasor-specific tools and technologies; no new funding for the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT), an engineering research center at the University of Tennessee; and flat funding for the remainder of the programs, including research in protective relaying, research on data uncertainty, and development of algorithms of reliability and resilience.

- **A 29 percent increase in Transformer Resilience and Advanced Components**, including an additional $2 million to expand R&D on solid-state power substations (SSPS)—which off the potential of greater standardization and improved resilience of grid components and systems—with a focus on developing modeling and testing capabilities, and establishing a consortium to lead SSPS technology development efforts.

ENDNOTES

1. For example, individual utilities and grid operators lack the wide-area visibility that could have minimized the 2003 Northeast blackout, or the modeling and analytical tools identified as necessary for containing the 2011 Southwest blackout.
2. U.S. Department of Energy (DOE), "FY 2021 Congressional Budget Request," Volume 3 Part 1, DOE/CF-0163 (Washington, D.C.: DOE Chief Financial Officer, February 2020), 255–312, https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1_1.pdf.
3. DOE, FY 2021 Congressional Budget Request Volume 3 Part 1, 265.
4. DOE, "Grid Modernization Multi-Year Program Plan" (Washington, D.C.: November 2015), https://www.energy.gov/sites/prod/files/2016/01/f28/Grid%20Modernization%20Multi-Year%20Program%20Plan.pdf.
5. DOE, "Fiscal Year 2017 Annual Performance Report/Fiscal Year 2019 Annual Performance Plan," 92–97 (DOE Chief Financial Officer DOE/CF-0147), https://www.energy.gov/sites/prod/files/2018/11/f57/fy-2017-doe-annual-performance-report-fy-2019-annual-performance-plan.pdf.
6. DOE, "2019 Grid Modernization Lab Call Awards," accessed February 20, 2020, https://www.energy.gov/2019-grid-modernization-lab-call-awards; DOE, "Department of Energy

Announces $80 Million For New Grid Modernization Lab Call Projects" (Washington, D.C.: November 6, 2019), https://www.energy.gov/articles/department-energy-announces-80-million-new-grid-modernization-lab-call-projects.

7. Faith M. Smith, "Why DOE's FY20 Budget Request Has Exciting News for Storage" (ClearPath, April 4, 2019), accessed March 7, 2020, https://clearpath.org/our-take/why-does-fy20-budget-request-has-exciting-news-for-storage/.
8. David M. Hart, "Making 'Beyond Lithium' a Reality: Fostering Innovation in Long-Duration Grid Storage" (Information Technology and Innovation Foundation, 2018), https://itif.org/publications/2018/11/28/making-beyond-lithium-reality-fostering-innovation-long-duration-grid.
9. DOE, FY 2021 Congressional Budget Request Volume 3 Part 1, 255–312.
10. Ibid.

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