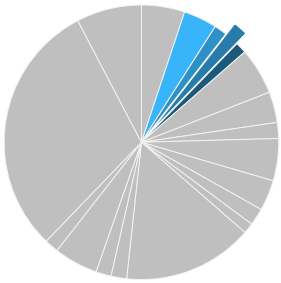
Federal Energy R&D: Water Power

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

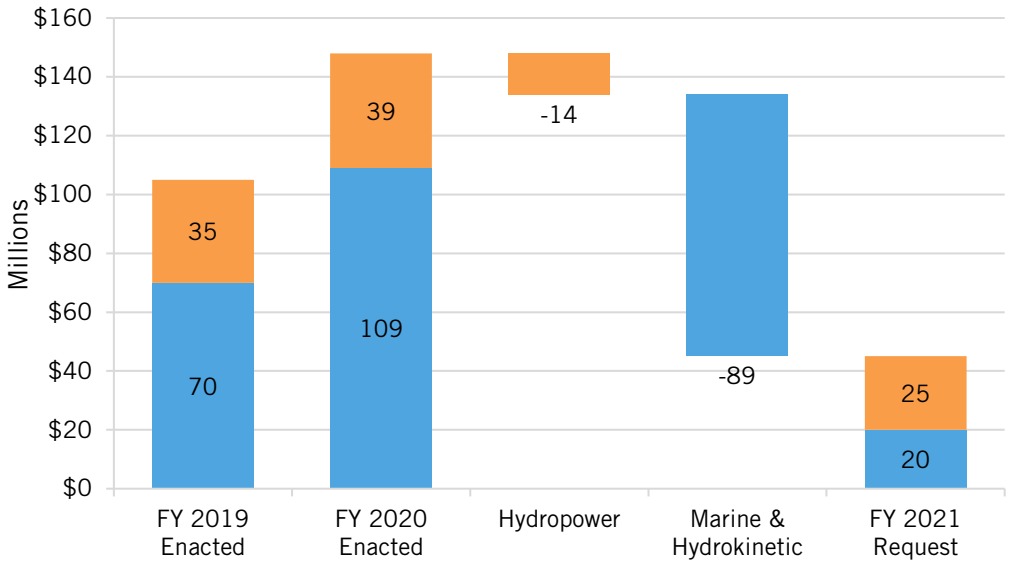
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



Water (blue)
Other Renewables (blue)
Energy R&D (light grey)

The Department of Energy's (DOE) Water Power program supports research and development (R&D) of two types of technologies: conventional hydropower (including pumped storage), and marine and hydrokinetic (MHK) energy. Conventional hydropower uses a dam or other structure to convert the kinetic energy of flowing water into electricity, while MHK technologies convert the energy of waves, tides, and currents.[1]

Figure 1: The FY 2021 budget request would cut water power R&D by 70 percent.[2]



What's at Risk

Hydropower is the second-largest source of renewable energy, providing nearly 7 percent of the nation's electricity (and 18 percent of its carbon-free electricity) for the first 11 months of 2019.[3] And pumped-storage hydropower accounts for more than 90 percent of U.S. grid-scale electricity storage, far more than lithium-ion batteries.[4] However, installed capacity of conventional hydropower and pumped-storage hydropower has stalled at about 100 gigawatts (GW), and innovation is needed to jump-start growth in hydropower. DOE's 2016 "Hydropower Vision" report identified up to 50 GW of new hydropower capacity that could be gained from upgrading and modernizing the existing fleet, installing generation on non-powered dams, and developing new, small hydropower and pumped-storage technologies. Near-term growth of hydropower generation through 2030 is estimated at 9.4 GW, while approximately 16.2 GW in new pumped-storage hydropower could also become available.[5] DOE recently launched the Hydropower and Water

Innovation for a Resilient Electricity System (HydroWIRES) to improve conventional hydropower and pumped-storage hydropower's contributions to the grid, and to roadmap future research directions.[6]

National resource assessments have found 1.25–1.85 terawatt-hours per year (TWh/yr) of untapped, technically extractable MHK potential, or the equivalent of 30 percent of the total electricity generated in the United States.[7] MHK technologies are at an early stage of development due to the fundamental scientific and engineering challenges of generating power from complex low-velocity/high-density dynamics in a corrosive ocean environment. Although they could potentially provide a low-carbon energy alternative for the 28 coastal and Great Lake states, additional cost reductions are needed to make them cost competitive with other sources of electricity.

Additionally, marine energy can provide new capabilities, such as onboard energy generation and remote recharging, in areas far from land-based power grids. In April 2019, DOE released a new report, "Powering the Blue Economy," that identifies non-grid applications and opportunities for marine renewable energy in order to tap into new markets and provide new energy services.[8] However, the proposed budget cuts threaten to stall the progress currently being made to extract significant energy value from this rich national resource.

Water Power R&D Subprograms

R&D in the Water Energy program is spread across two subprograms:[9]

- **Hydropower R&D** seeks to reduce the site-specific costs of construction, powerhouse design/installation, and environmental mitigation of new hydropower at non-powered dams; develop turbine designs that generate more power at given water flows or increase operational ranges with reduced impacts for existing hydropower facilities; optimize modes of operation for grid stabilization; and develop novel closed-loop pumped-storage designs that can be deployed at a wider range of sites.

- **Marine and Hydrokinetic (MHK) Technologies** focuses on researching controls to maximize power production over a range of ocean conditions; improving and validating modeling tools and methodologies to optimize device and array performance and reliability across operational and extreme conditions; and investigating new approaches to safe and cost-efficient installation, grid integration, operations, maintenance, and decommissioning of MHK projects. MHK is currently developing an open-water wave-energy test facility—to be begin operation between 2021 and 2022—that will allow testing and validation of industry-developed MHK energy-conversion components and systems.[10] MHK is also exploring the ability of marine energy to provide non-grid energy services in areas where access to an electric grid is limited.[11]

Key Elements of the FY 2021 Budget Proposal[12]

- **An 82 percent reduction in the MHK Technologies subprogram**, including no new funding for infrastructure upgrades at the three National Marine Renewable Energy Centers in Oregon, Hawaii, and Florida; no funding for technical assistance in MHK technologies to remote communities; no funding for the development of advanced materials or durability testing; no funding for university partnerships to support foundational R&D in marine energy systems development; and reduced funding for development and testing of MHK systems and components, as well as wave-powered desalination systems.

- **A 36 percent reduction in the Hydropower Technologies subprogram**, including reduced R&D funding for advanced manufacturing techniques for modular hydropower technologies; no new funding to develop a low-impact hydropower test facility; the elimination of incentives for deployment of hydropower at existing non-powered dams; and increased funding for grid integration R&D through the HydroWIRES Initiative.

ENDNOTES

1. U.S. Department of Energy (DOE), "About the Water Power Program," https://www.energy.gov/eere/water/about-water-power-program, accessed February 25, 2020.
2. DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 1, 128 (DOE Chief Financial Officer DOE/CF-0163, February 2020), https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1.pdf.
3. Energy Information Administration, Monthly Energy Review Table 7.2a, https://www.eia.gov/totalenergy/data/monthly/, accessed February 25, 2020.
4. Fred Mayes, "Most Pumped Storage Electricity Generators in the U.S. were Built in the 1970s," *Today in Energy* (October 31, 2019) https://www.eia.gov/todayinenergy/detail.php?id=41833.
5. DOE, "Hydropower Vision: A New Chapter for America's 1st Renewable Electricity Source" (Washington, D.C.: DOE, July 2016). https://www.energy.gov/sites/prod/files/2018/02/f49/Hydropower-Vision-021518.pdf.
6. DOE, "HydroWIRES Initiative," accessed March 4, 2020, https://www.energy.gov/eere/water/hydrowires-initiative.
7. DOE, "Quadrennial Technology Review" (Washington, D.C.: DOE, September 2015), https://www.energy.gov/sites/prod/files/2017/03/f34/quadrennial-technology-review-2015_1.pdf.
8. DOE, "Powering the Blue Economy: Exploring Opportunities for Marine Renewable Energy in Maritime Markets" (DOE EERE, April 2019), https://www.energy.gov/sites/prod/files/2019/03/f61/73355.pdf.
9. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 130–140 (DOE/CF-0163, February 2020), https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1.pdf.
10. DOE, accessed February 4, 2020, "PacWave," https://www.energy.gov/eere/water/pacwave.
11. DOE, "Powering the Blue Economy."
12. DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 1, 125–140.

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 AUTHORS

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) Office of Energy Policy and Systems Analysis (EPSA), with a portfolio focused 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 (EPRINC) and Smart Electric Power Alliance (SEPA). Batt holds a master's degree in energy policy from Johns Hopkins University's School of Advanced International Studies, Washington, D.C.

ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized as the world's leading science and technology think tank, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

FOR MORE INFORMATION, VISIT US AT WWW.ITIF.ORG.