Federal Energy RD&D: Wind Energy

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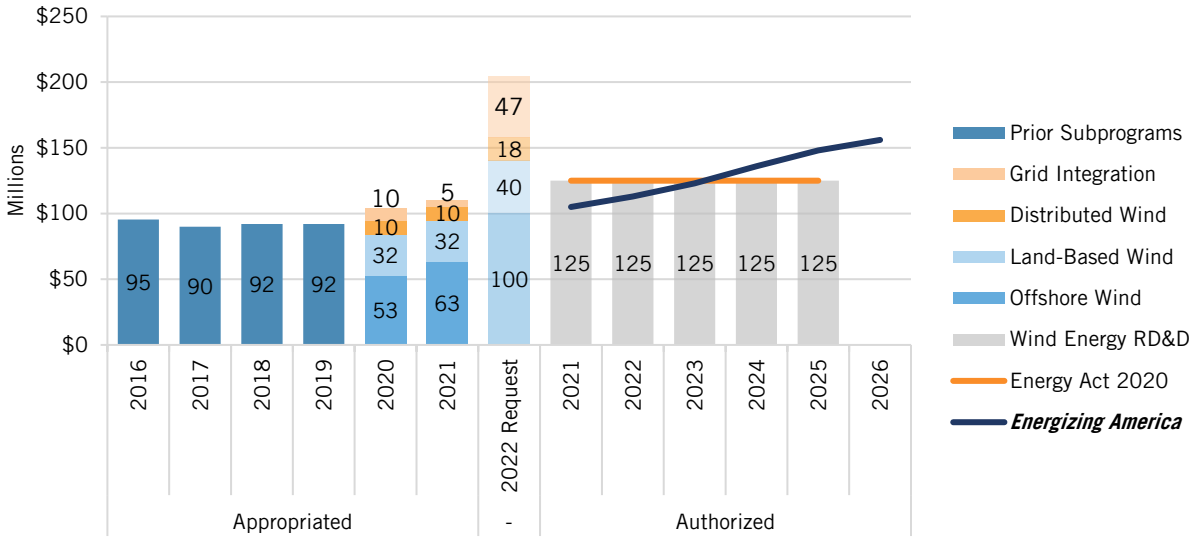
The Department of Energy's (DOE) Wind Energy program targets innovations in onshore, offshore, and distributed wind power to capture the kinetic energy in wind and turn it into electricity via spinning generators. The program also works to integrate wind generation more effectively into the bulk power system to enable wind farms to provide more reliable power output and essential reliability services to the grid.[1]

Figure 1: *Energizing America* recommends ramping up wind energy research, development, and demonstration (RD&D) by 50 percent by FY 2026.[2]



What's at Stake

DOE's Wind Energy program has contributed to substantial cost reductions and technology improvements that have enabled the rapid expansion of land-based wind power. The cost of energy from land-based wind power decreased from 55 cents per kilowatt-hour ($0.55/kWh) in 1980 to a national average for new wind projects built in 2018 of just $0.034/kWh, enabling the expansion of wind power to more than 40 states.[3] Despite the economic contraction caused by the COVID-19 pandemic, wind power installations reached a record of almost 17 gigawatts (GW) of capacity in 2020.[4] Wind power now accounts for 8 percent of U.S. electricity generation, up from less than 1 percent a decade ago.[5]

DOE should build on this success to improve performance and reduce costs much further until unsubsidized wind power becomes competitive across more parts of the country. DOE's "Wind Vision" report provides a path to reducing the cost of energy from unsubsidized land-based wind to $0.023/kWh and achieving a 50 percent reduction from the 2017 level in the cost of energy from offshore and distributed wind by 2030. Achieving these goals could enable up to 200 gigawatts GW of total wind capacity by 2030, thereby contributing to energy affordability and security while also reducing carbon emissions.[6]

The nascent offshore wind industry is beginning to take off, with 28,521 megawatts (MW) of new offshore wind capacity in the development and operational pipeline as of 2019, of which 6,439 MW have begun permitting processes for construction.[7] In 2019, DOE, along with the New York State Energy Research and Development Authority (NYSERDA), committed $20.5 million to form a National Offshore Wind Research and Development Consortium. NYSERDA agreed to match the DOE commitment and has released the solicitation for an award.[8] Offshore wind could present a low-carbon energy alternative for the 28 coastal and Great Lakes states, although additional cost reductions will be needed to make it cost competitive with other sources of electricity—as it already is in parts of Europe. Validation and demonstration of new offshore wind technologies will provide investors with greater confidence in the growing array of energy projects in U.S. waters.[9]

Over 58 percent of offshore wind resources are located in areas with deep waters, primarily off the western coastal states, where fixed-bottom wind turbines are not practical.[10] Innovative floating offshore wind turbines, which are at an early stage of development, can enable access to deeper water depths and expand viable areas for offshore wind development. DOE has provided $10.7 million in funding for University of Maine's New England Aqua Ventus I, a floating offshore wind demonstration project of up to 12 MW off Monhegan Island, Maine.[11] Successful demonstration of the first utility-scale floating offshore wind project in federal waters could increase confidence from investors that the technology works as intended, potentially catalyzing greater private investment.

In March 2021, the Biden administration announced an ambitious new target to deploy 30 GW of offshore wind by 2030 and 110 GW by 2050. To reach this goal, DOE's Loan Program Office (LPO) expects to offer $3 billion in loan guarantees for offshore wind suppliers, developers, and other financing partners.[12] DOE loan guarantees are an important tool to bridge the innovative energy financing gap and backstop the risks commercial lenders are unwilling to bear. LPO has previously provided $1.6 billion for onshore wind projects, unlocking 1,000 MW of onshore wind capacity.[13]

The Energy Act of 2020 provides the first reauthorization of DOE's Wind Energy program in more than a decade, and focuses on innovation in onshore, offshore, distributed, and off-grid technologies. The bill authorizes projects that validate and demonstrate transformational wind energy technologies; research wind turbine integration in hybrid energy systems; and support the operation of offshore research facilities, including offshore support-structure testing facilities. The bill authorizes $125 million annually for FY 2021 through FY 2025.[14]

Figure 1 shows historical DOE investment in wind energy RD&D by subprogram, for FY 2016 through FY 2021, and the FY 2022 budget request. Prior to FY 2020, DOE structured its Wind Energy subprograms differently, so FY 2016 to 2019 subprograms (dark blue in figure 1) are not directly comparable. DOE made the change to the current structure to better comply with congressional direction. The orange line shows authorized funding levels from the Energy Act of 2020. The blue line shows recommended funding levels from the *Energizing America* report, which envisions a ramp-up in funding for wind energy RD&D of 50 percent over the next five years (see box 1).

Box 1: An Innovation Agenda for Wind

The *Energizing America* report co-authored by the Information Technology and Innovation Foundation (ITIF) and Columbia University's Center of Global Energy Policy offers several recommendations to drive wind energy innovation. Similarly, ITIF's December 2020 report "An Innovation Agenda for Advanced Renewable Energy Technologies" makes recommendations to DOE to improve DOE's Wind Energy programs:

- Congress should ramp up funding for wind energy RD&D by 50 percent over the next five years to ensure DOE can address the full range of technology challenges and meet its innovation targets for wind energy.[15]
- DOE should set a more ambitious 2030 cost target for offshore wind, currently set at $51/MWh, by 2030. The National Renewable Energy Laboratory's (NREL) 2020 Annual Technology Baseline suggests that costs could be reduced to less than $45/MWh for most offshore wind resource classes by 2030 in an advanced technology innovation scenario.[16]
- Congress and DOE should increase RD&D support for projects that improve manufacturing methods and increase turbine efficiency.[17]
- DOE should partner with wind developers to demonstrate novel wind turbine designs. Companies are risk averse and are typically unwilling to initiate the demonstration of immature wind technologies without federal support.[18]
- DOE should invest with industrial partners in cost-shared floating wind demonstration projects to ramp up industry adoption.[19]
- DOE should support the demonstration of microgrids and hybrid energy systems that integrate more power from wind energy systems.[20]

Wind Energy RD&D Subprograms

RD&D in the Wind Energy program is divided into four subprograms:[21]

- **Offshore Wind** focuses on reducing offshore wind technology costs and risks, and improving wind-plant performance, operation, and maintenance given the unique offshore environment in the United States. The subprogram implements the Atmosphere to Electrons initiative, aimed at improving predictions of wind/wave resources in offshore wind development areas; and will continue the existing Wind-Plant Integrated System Design & Engineering Model (WISDEM™) to support offshore wind turbine and plant optimization.

- **Land-Based Wind** RD&D focuses on tall wind turbine technology innovations—including those that enable higher hub heights, larger rotors, light-weight components, and improved energy capture—that have the potential to reduce the cost of utility-scale land-based wind, while seeking technical solutions to environmental and siting challenges to land-based wind energy. The subprogram also supports Sandia's Scaled Wind Farm Technology (SWiFT), which uses multiple wind turbines to measure turbine performance in a wind-farm environment. [22]

- **Distributed Wind** focuses on the integration of distributed wind energy with other distributed energy resources in hybrid plants and microgrids. To that end, the subprogram supports research in a range of areas, including balance-of-system cost reduction and atmospheric physics for site assessments.

- **Systems Integration**, which includes the former Grid Integration & Analysis program, promotes RD&D in ensuring a cost-effective, reliable, and resilient power system with growing levels of supply from land-based, offshore, and distributed wind energy resources.

Key Elements of the FY 2022 Budget Proposal[23]

The budget proposal seeks $204.87 million for the Wind Energy program, an 86 percent boost from FY 2021 enacted levels. Some highlights include:

- **A 59 percent increase in Offshore Wind,** including funding for competitively-awarded projects to improve offshore wind resource characterization and forecasting; for offshore development and demonstration projects, including floating turbine, platform, and wind farm controls; to improve the recycling and recovery of critical materials; for research to evaluate the environmental impacts of floating and fixed-bottom offshore wind projects; and for advanced materials manufacturing RD&D to reduce the lifecycle costs and improve the performance of wind turbine components. The Offshore Wind subprogram aims to reduce the levelized cost of energy for offshore wind from $0.08/kWh in 2019 to $0.05/kWh by 2030.
- **A 26 percent increase in Land-Based Wind,** with continued support for test facilities at NREL Flatirons Campus and Sandia's SWiFT facility, which would be kept in standby mode; continued funding for adaptive load control technologies within the Big Adaptive Rotor initiative; increased funding for environmental and siting R&D to support technologies that minimize the impacts of wind development on grouse species; and continued support for the American Wake Experiment (AWAKEN), a planned international wake observation and validation campaign for wind-farm modeling.
- **An 837 percent increase in Systems Integration**, including new efforts to identify transmission infrastructure needs for offshore wind, develop new energy storage technologies in support of the Energy Storage Grand Challenge, and validate and demonstrate hydrogen production with wind energy.

- **A 78 percent increase in Distributed Wind,** with continued funding for testing and reliability; the launch of the Wind Innovations for Rural Economic Development (WIRED) networks to reduce the soft costs and overcome barriers to deployment in rural communities; continued support for the Microgrids, Infrastructure, Resilience, and Advanced Controls Launchpad (MIRACL) focused on the integration and control of distributed wind hybrid systems; and new funding to support the inclusion of wind in the Energy Transitions Initiative Partnership Project.

Further Reading

- Varun Sivaram et al., *Energizing America: A Roadmap to Launch a National Energy Innovation Mission* (ITIF and Columbia University SIPA Center on Global Energy Policy, 2020), http://www2.itif.org/2020-energizing-america.pdf.
- Robert Rozansky, "An Innovation Agenda for Advanced Renewable Energy Technologies" (ITIF, 2020), http://www2.itif.org/2020-advanced-renewables-energy.pdf.

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ENDNOTES

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