Report 2022
USA

A six-turbine wind farm provides energy for Unalakleet, Alaska, a remote village on the coast of the Bering Sea, about 400 miles northwest of Anchorage. *Photo by Werner Slocum, National Renewable Energy Laboratory (NREL).*

Authors *U.S. Department of Energy's Wind Energy Technologies Office; National Renewable Energy Laboratory, United States.*

Two new federal laws ushered in significant funding and support for U.S. wind energy in 2022. The Infrastructure Investment and Jobs Act (IIJA) of late 2021 provides more than 100 million U.S. dollars (USD) (93.2 million EUR) for wind energy [1].

This includes 60 million USD (55.4 million EUR) for research on land-based, offshore, and distributed wind energy systems, advanced manufacturing, and grid integration; as well as 40 million USD (37.2 million EUR) for wind system recycling.

The Inflation Reduction Act (IRA), signed in August 2022, provides a variety of tax and investment credits for renewable energy projects [2] and includes direct federal financing of clean energy, such as 40 billion USD (37 billion EUR) in loans for innovative clean energy projects [3].

Wind power facilities account for the largest share of the country's renewable energy production, providing 10.2% of electricity generated in 2022 [4]. Total installed wind power capacity in the United States in 2022 stood at more than 144 GW,

with the majority coming from land-based wind turbines. By the end of 2022, 10 states had set offshore wind procurement targets totalling more than 81 GW [5].

Highlight(s)

- More than 100 million USD (93 million EUR) in new research and recycling funding, in addition to 114 million USD (106 million EUR) budgeted for Fiscal Year 2022 (October 1, 2021, through September 30, 2022) [6].
- Key production and investment tax credits extended.
- New target to deploy 15 GW of floating offshore wind capacity by 2035.
- Wind power share of electricity exceeded 10%.

Market Development

Targets and Policy

Wind energy continues to play a crucial role in achieving U.S. targets of 100% clean electricity by 2035 and net-zero carbon emissions by 2050 [7]. To that end, the funding and incentives provided by the IRA and IIJA will support further efforts to deploy wind power projects, develop new wind energy technologies, and reduce costs. The credits provided through the IRA include:

- Long-term extensions of both the Renewable Energy Production Tax Credit (in 2023, 0.0275 USD/kWh, or 0.0256 EUR/kWh), a primary driver of land-based wind deployment, and the 30% Investment Tax Credit, a driver of U.S. offshore wind energy development.
- Bonus tax credits for developing wind energy projects in "energy communities" historically dependent on fossil fuels [8] or with high percentages of domestic content.
- Manufacturing tax credits for investment in new domestic clean energy manufacturing and the domestic production of certain clean energy components such as wind turbine blades, nacelles, towers, offshore wind foundations, and specialised offshore wind vessels [9].

In addition to the existing goal to reach 30 GW of offshore wind energy by 2030, which will be met largely by using fixed-bottom technology, the Biden administration announced in 2022 a target to deploy 15 GW of floating offshore wind capacity by 2035 [10]. Through its new Floating Offshore Wind Shot™ [11], the administration aims to reduce the costs of floating offshore wind technologies by more than 70% to 45 USD (41.9 EUR) per MWh also by 2035. Deep-water areas that require floating platforms are home to two-thirds of America's offshore wind energy potential [12].

Progress and Operational Details

The United States added 8.6 GW of wind power capacity in 2022, including partial repowerings, where equipment is replaced at existing facilities [13]. As of December 2022, there are 96 land-based wind energy projects underway, comprising 20.8 GW of generation capacity. Half of that capacity is under construction, while the other half is in advanced development. Four states lead the offshore wind projects currently in development: New York with 4.2 GW, New Jersey with 3.8 GW, Massachusetts with 3.2 GW, and Virginia with 2.6 GW [14].

The U.S. Department of the Interior completed two milestone auctions of 11 leases for offshore wind areas in 2022. Six leases offshore New York and New Jersey covering over 488,000 acres drew winning bids for a total of approximately 4.37 billion USD (4.07 billion EUR) [15]. Five leases offshore California, which marks the first offshore U.S. wind leases in the Pacific region, covered 373,268 acres and drew 757.1 million USD (705.6 million EUR) [16].

Also, in 2022, 13 states added 29.5 MW of new distributed wind capacity from 1,755 turbine units, representing an 84 million USD (78 million EUR) investment.

From 2003 through 2022, over 90,000 wind turbines have been deployed in distributed applications across all 50 states, as well as the District of Columbia, Puerto Rico, the U.S. Virgin Islands, the Northern Mariana Islands, and Guam, totalling 1.1 GW in cumulative capacity [17].

Matters Affecting Growth and Work to Remove Barriers

Wind power installations in 2022 fell 37% compared to 2021 [18]. This decline was expected, given the phase-down of the federal production tax credit at the end of 2021. The IRA extends this tax credit, allowing wind energy facilities placed into service through 2024 to claim a federal income tax credit on every kWh of electricity sold to an unrelated party for a period of 10 years. Owners and developers of wind energy facilities can elect to take either the production tax credit or the investment tax credit. This allows projects that begin construction before the 1st of January 2025 to take a one-time credit based on the dollar amount of capital investment. In 2025, the tax credits for wind will be replaced with technology-neutral credits for low-carbon electricity generation [18].

Lingering supply chain challenges and delayed approvals for grid interconnections also contributed to the 2022 slowdown in wind energy capacity growth [13]. At least 247 GW of wind capacity, nearly one-third of which is offshore wind power, was awaiting interconnection at the end of 2021 [19]. To address this bottleneck, the U.S. Department of Energy's (DOE) Wind Energy Technologies

Office (WETO) and Solar Energy Technologies Office launched a new initiative in October 2022, the Interconnection Innovation e-Xchange, which aims to develop solutions for faster, simpler, and fairer interconnection of clean energy resources [20]. In December, WETO also released a 28 million USD (26 million EUR) funding opportunity to lower costs and broadly address barriers to the deployment of offshore, land-based, and distributed wind energy, including solutions for high-voltage direct-current transmission, distributed wind permitting, offshore wind social science and community engagement, and bat deterrence [21].

RD&D Activities

National Priorities and Budget

WETO funds a diverse portfolio of wind energy research and development to advance offshore, land-based, and distributed wind energy. In 2022, Congress directed DOE to allocate 114 million USD (106.2 million EUR) in funds for wind energy research. This was an increase of 4 million USD (3.7 million EUR) over 2021 funding [22]. Other DOE offices, including the Advanced Research Projects Agency–Energy [23] and the Advanced Materials and Manufacturing Technologies Office, also fund wind energy research. IIJA funding in 2022 went toward addressing barriers to wind energy deployment, as mentioned earlier; anchoring and mooring systems for floating offshore wind [24]; and grid services [25], among other topics.

DOE organised its 2022 wind energy research priorities into several categories:

Offshore wind: In early 2022, the National Offshore Wind Research and Development Consortium announced six new projects to receive a total of 3.4 million USD (3.2 million EUR) for supply chain efficiency, asset monitoring, and inspection [26]. In addition to the announcement of the Floating Offshore Wind Shot, the FLoating Offshore Wind Read-INess (FLOWIN) Prize, established in 2022, offered a 7 million USD (6.5 million EUR) investment to pave the way for cost-effective domestic manufacturing and deployment of commercial-scale floating offshore wind energy technologies [27]. The White-House-led Federal-State Offshore Wind Implementation Partnership between East Coast regional and federal officials established a first-of-its-kind collaboration to build a strong, U.S.-based supply chain for offshore wind [28]. *The Demand for a Domestic Offshore Wind Energy Supply Chain* report outlined supply chain needs required to reach the U.S. 30 GW offshore wind goal [29]. This and other research support U.S. efforts to reduce the levelised cost of energy (LCOE) for fixed-bottom and floating offshore wind by 40% to 50% by 2030 [30].

Land-based wind: The American WAKE experimeNt (AWAKEN), which launched in 2022, is a massive effort to capture precise data on how winds shift as they travel from one wind turbine to another or from one wind plant to another [31]. The data has the potential to help facilities produce more energy from the same winds, increase profits, and, eventually, reduce electricity prices for consumers. The Big Adaptive Rotor project, which aims to enable up to 100-metre blades for low-specific-power wind turbines, completed Phase I analysis [32]. The analysis confirmed significant value from such turbines, which improve power performance in less windy conditions. Other WETO-funded research has demonstrated how to deploy taller wind turbine towers at lower prices using innovative manufacturing techniques such as spiral welding and 3D printing [33]. DOE's goal is to reduce LCOE for land-based wind by 40% to 45% by 2030 [30].

Distributed wind: A comprehensive analysis released in 2022, the *Distributed Wind Energy Futures Study*, showed that nearly 1,400 GW of distributed wind capacity could be profitably deployed across the United States today [34]. Several funding awards in 2022, totalling 2.9 million USD (2.7 million EUR), went to manufacturers of small- and medium-scale wind turbine technology [35]. DOE's goal is to halve the LCOE for a 100-kilowatt wind turbine by 2030 [30].

Systems integration: The Interconnection Innovation e-Xchange and funding for grid services research under the IIJA, both mentioned earlier in this chapter, are supporting DOE's goal of enabling cost-effective, cybersecure, reliable, and resilient operation of the energy system with increasing levels of wind.

Siting and environmental challenges: DOE aims to facilitate the development of solutions to minimise wildlife and environmental impacts and enable the efficient siting and operation of wind power plants [30]. This work includes the development of software that predicts raptor flight paths to inform wind turbine placement [36], projects to enhance community engagement [37], and bat deterrence research [38].

National Research Initiatives and Results

- A demonstration that DOE's National Renewable Energy Laboratory (NREL) conducted with General Electric confirmed that wind turbines can provide grid services by using controls that allow a wind turbine to electronically imitate the stabilising features of conventional generators [39].
- A WETO-funded project successfully scaled up a recovery process for fibreglass from decommissioned wind turbine blades. The process could divert thousands of tonnes of waste from landfills [40].
- With more than 7 million USD (6.5 million EUR) in DOE funding, the company Keystone Tower Systems demonstrated a spiral

Figure 1: With the help of WETO funding, Carbon Rivers has achieved 99.9% recycled glass fibre purity from different end-of-life waste streams like wind turbine blades. The high purity opens the potential for remelting—allowing recycled glass fibre to be incorporated into virgin fibreglass, thereby closing the material loop and creating a circular economy. *Photo from Carbon Rivers.*

welding technique to build some of the largest turbine towers on the market [41].

Test Facilities and Demonstration Projects

The IIJA is catalysing upgrades to NREL's Flatirons Campus near Boulder, Colorado, which provides a unique research environment by hosting real-world, kilowatt- and megawatt-scale renewable energy technologies to help develop, evaluate, and validate renewable energy technologies. As such, the Flatirons Campus is a crucial part of the Advanced Research on Integrated Energy Systems platform [42], which enables grid integration research at scale. The IIJA also created a new DOE Office of Clean Energy Demonstrations [43] to accelerate clean energy technologies from the lab to the market.

Collaborative Research

Researchers from NREL in 2022 led an effort with 100 wind energy experts worldwide to write a series of 10 articles for *Wind Energy Science* on grand challenges in the field. The articles covered topics such as wind resource characterisation, wind turbine designs and manufacturing, digitalisation of wind energy, among others [44].

U.S. Secretary of Energy Jennifer M. Granholm co-led the 2022 U.S.-EU Energy Council High-Level Business Forum with European Union Commissioner for Energy, Kadri Simson. The forum facilitated engagement between the private sector and government leaders in the United States and European Union about policies needed to accelerate U.S. offshore wind energy projects and manufacturing [45].

Impact of Wind Energy

Economic Benefits and Industry Development

Wind-energy-related U.S. job totals increased by 4.5% in 2022 to 125,580 full-time workers, benefitting from continued deployment. These jobs include, among others, those in construction (45,088) and manufacturing (23,543). Domestic manufacturing content is strong for wind turbine components such as nacelle assembly and wind turbine towers. However, for blades and hubs, the United States relies mostly on imports. Passage of the IRA, with its production-based tax credits for domestic manufacturing of key wind turbine components, holds promise for future supply-chain expansion [46].

The results of a multiyear study published in 2022 identified experience, geography, and hands-on training as key factors in the gap

Figure 2: A multiyear research study showed that gaining hands-on experience through internships can give entry-level job applicants an important edge over their competition. *Photo by Werner Slocum, NREL.*

between the available U.S. wind energy workforce and what will be needed to keep pace with industry growth [47]. A U.S. offshore wind workforce assessment published in 2022 outlined the needs in specific industry segments and offered guidance on the steps needed to meet workforce demand [48].

The annual Collegiate Wind Competition, a workforce development event that challenges teams of undergraduate students to offer a unique solution to a complex wind energy project, continues to draw undergraduate students from across the country. The 2022 competition focused on the challenges associated with fixed-bottom offshore wind energy projects [49].

Next Term

Another 7.1 GW of wind energy capacity is expected to come online in 2023 [50]. Investment and production tax credits from the IRA are expected to spur financing for new wind energy projects while funding opportunities created by the IIJA are ongoing. Both new laws are funding efforts that will continue to strengthen U.S. wind energy, including a West Coast Offshore Wind Transmission Study [51], energy projects in rural or remote areas [52]; and tax credits for projects that expand U.S. supply chains for clean energy technologies.

References

[1] U.S. Congress (2021–2022). H.R.3684 – Infrastructure Investment and Jobs Act. https://www.congress.gov/bill/117th-congress/house-bill/3684

[2] U.S. White House (undated). *Clean Energy Tax Provisions in the Inflation Reduction Act.* https://www.whitehouse.gov/cleanenergy/clean-energy-tax-provisions/

[3] U.S. Department of Energy (DOE) (2022). *Inflation Reduction Act of 2022.* https://www.energy.gov/lpo/inflation-reduction-act-2022

[4] U.S. Energy Information Administration (EIA) (undated). *Electricity Data Browser.* https://www.eia.gov/electricity/data/browser/

[5] American Clean Power (ACP) (2023). *Clean Power Annual Market Report 2022.* https://cleanpower.org/resources/clean-power-annual-market-report-2022/

[6] DOE Wind Energy Technologies Office (WETO) (undated). *Wind Energy Technologies Office Budget.* https://www.energy.gov/eere/wind/wind-energy-technologies-office-budget

[7] U.S. White House (2021). *FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies.* https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/

[8] U.S. Department of the Treasury (2023). *Treasury Releases Guidance to Drive Investment to Coal Communities.* https://home.treasury.gov/news/press-releases/jy1383

[9] WETO (2023). *U.S. Wind Industry Federal Incentives, Funding, and Partnership Opportunities Fact Sheet.* https://www.energy.gov/eere/wind/articles/us-wind-industry-federal-incentives-funding-and-partnership-opportunities-fact

[10] U.S. White House (2022). FACT SHEET: *Biden-Harris Administration Announces New Actions to Expand U.S. Offshore Wind Energy.* https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/15/fact-sheet-biden-harris-administration-announces-new-actions-to-expand-u-s-offshore-wind-energy/

[11] WETO (undated). F*loating Offshore Wind Shot.* https://www.energy.gov/eere/wind/floating-offshore-wind-shot

[12] National Renewable Energy Laboratory (NREL) (2022). *Offshore Wind Energy Technical Potential for the Contiguous United States.* https://www.nrel.gov/docs/fy22osti/83650.pdf

[13] ACP (2022) *Annual Market Report.* https://cleanpower.org/resources/clean-power-annual-market-report-2022

[14] ACP (2022). *Clean Power Quarterly Market Report; Q4 2022.* https://cleanpower.org/resources/clean-power-quarterly-market-report-q4-2022/

[15] U.S. Department of the Interior (DOI) (2022). *Biden-Harris Administration Sets Offshore Energy Records with $4.37 Billion in Winning Bids for Wind Sale.* https://www.doi.gov/pressreleases/biden-harris-administration-sets-offshore-energy-records-437-billion-winning-bids-wind

[16] DOI (2022). *Biden-Harris Administration Announces Winners of California Offshore Wind Energy Auction.* https://doi.gov/pressreleases/biden-harris-administration-announces-winners-california-offshore-wind-energy-auction

[17] WETO (2023). *Distributed Wind Annual Market Report.* https://www.energy.gov/eere/wind/articles/distributed-wind-market-report-2023-edition

[18] WETO (2023). *Advancing the Growth of the U.S. Wind Industry Federal Incentives, Funding, and Partnership Opportunities Fact Sheet.* https://www.energy.gov/sites/default/files/2023-04/eere-wind-weto-funding-taxday-factsheet-fy23.pdf

[19] Lawrence Berkeley National Laboratory (undated). *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection.* https://emp.lbl.gov/queues

[20] WETO (2022). *DOE Launches New Initiative To Improve Clean Energy Interconnection.* https://www.energy.gov/eere/wind/articles/doe-launches-new-initiative-improve-clean-energy-interconnection

[21] WETO (2022). *WETO Releases $28 Million Funding Opportunity to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind.* https://www.energy.gov/eere/wind/articles/weto-releases-28-million-funding-opportunity-address-key-deployment-challenges

[22] WETO (undated). *Wind Energy Technologies Office Budget.* https://www.energy.gov/eere/wind/wind-energy-technologies-office-budget

[23] U.S. Advanced Research Projects Agency – Energy (2020). *Untapped Resources and New Horizons – The ATLANTIS Program.* https://arpa-e.energy.gov/news-and-media/blog-posts/untapped-resources-and-new-horizons-atlantis-program

[24] WETO (2022). *DOE Requests Information on Floating Offshore Wind Energy Mooring and Anchoring.* https://www.energy.gov/eere/wind/articles/doe-requests-information-floating-offshore-wind-energy-mooring-and-anchoring

[25] WETO (2022). *DOE Announces New $26 Million Funding Opportunity.* https://www.energy.gov/eere/wind/articles/doe-announces-new-26-million-funding-opportunity

[26] WETO (2022). *National Offshore Wind Research and Development Consortium Announces New Projects Selected for Funding.* https://www.energy.gov/eere/wind/articles/national-offshore-wind-research-and-development-consortium-announces-new

[27] American-Made Challenges (undated). *FLOWIN Prize.* https://americanmadechallenges.org/challenges/flowin/

[28] DOE (2022). *DOE Joins New Federal-state Partnership to Grow Domestic Offshore Wind Supply Chain.* https://www.energy.gov/articles/doe-joins-new-federal-state-partnership-grow-domestic-offshore-wind-supply-chain

[29] NREL (2022). *The Demand for a Domestic Offshore Wind Energy Supply Chain.* https://www.nrel.gov/docs/fy22osti/81602.pdf

[30] WETO (2020). *Multi-Year Program Plan Fiscal Years 2021—2025.* https://www.energy.gov/sites/prod/files/2020/12/f81/weto-multi-year-program-plan-fy21-25-v2.pdf

[31] WETO (2022). *Mapping Atmospheric Mysteries.* https://www.energy.gov/eere/wind/articles/mapping-atmospheric-mysteries

[32] DOE Office of Energy Efficiency & Renewable Energy (EERE) (2021). *Flexing the Limits of Land-Based Wind Turbine Rotor Growth.* https://www.energy.gov/sites/default/files/2021/01/f82/bar-fact-sheet-2021.pdf

[33] WETO (2022). *Companies Reach Innovative New Heights to Expand Wind Technology.* https://www.energy.gov/eere/wind/articles/companies-reach-innovative-new-heights-expand-wind-technology

[34] WETO (2022). *Unlocking Distributed Wind Energy's Potential.* https://www.energy.gov/eere/wind/articles/unlocking-distributed-wind-energys-potential

[35] NREL (2022). *NREL Selects Manufacturers of Small- and Medium-Sized Wind Turbine Technology for 2022–2023 Funding.* https://www.nrel.gov/news/program/2022/nrel-selects-manufacturers-of-small-and-medium-sized-wind-turbine-technology-for-2022-2023-funding.html

[36] WETO (2022). *NREL Tool Aims To Predict Interactions Between Soaring Eagles and Wind Turbines.* https://www.energy.gov/eere/wind/articles/nrel-tool-aims-predict-interactions-between-soaring-eagles-and-wind-turbines

[37] EERE (2022). *Sea Grant, DOE, NOAA Fisheries Fund Six Projects for the Coexistence of Offshore Energy with Northeast Fishing and Coastal Communities.* https://www.energy.gov/eere/articles/sea-grant-doe-noaa-fisheries-fund-six-projects-coexistence-offshore-energy-northeast

[38] WETO (2022). *Environmental Impacts and Siting of Wind Projects.* https://www.energy.gov/eere/wind/environmental-impacts-and-siting-wind-projects

[39] WETO (2022). *Wind Turbines Can Stabilize the Grid.* https://www.energy.gov/eere/wind/articles/wind-turbines-can-stabilize-grid

[40] WETO (2022). *Carbon Rivers Makes Wind Turbine Blade Recycling and Upcycling a Reality With Support From DOE.* https://www.energy.gov/eere/wind/articles/carbon-rivers-makes-wind-turbine-blade-recycling-and-upcycling-reality-support

[41] EERE (2022). *EERE Success Story—How Spiral Welding Is Revolutionizing Wind Turbine Manufacturing.* https://www.energy.gov/eere/articles/eere-success-story-how-spiral-welding-revolutionizing-wind-turbine-manufacturing

[42] NREL (undated). *ARIES: Advanced Research on Integrated Energy Systems.* https://www.nrel.gov/aries/

[43] DOE Office of Clean Energy Demonstrations (undated). *Homepage.* https://www.energy.gov/oced/office-clean-energy-demonstrations

[44] European Academy of Wind Energy (undated). *Grand Challenges in Wind Energy Science.* https://eawe.eu/organisation/committees/publications-committee/grand-challenges/

[45] DOE (2022). *U.S.–EU High-Level Business Forum on Offshore Wind Power.* https://www.energy.gov/articles/us-eu-high-level-business-forum-offshore-wind-power

[46] Lawrence Berkeley National Laboratory (2023). *Land-Based Wind Market Report.* https://www.energy.gov/eere/wind/articles/land-based-wind-market-report-2023-edition

[47] NREL (2022). *Reasons Behind Wind Energy Workforce Gap Identified.* https://www.nrel.gov/news/program/2022/reasons-behind-wind-energy-workforce-gap-identified.html

[48] NREL (2022). *U.S. Offshore Wind Workforce Assessment.* https://www.nrel.gov/docs/fy23osti/81798.pdf

[49] EERE (2022). *Collegiate Wind Competition 2022.* https://www.energy.gov/eere/collegiatewindcompetition/collegiate-wind-competition-2022

[50] EIA (2022). *Wind, solar, and batteries increasingly account for more new U.S. power capacity additions.* https://www.eia.gov/todayinenergy/detail.php?id=55719

[51] DOE (2023). *U.S. Department of Energy Announces New Actions to Accelerate U.S. Floating Offshore Wind Deployment.* https://www.energy.gov/articles/us-department-energy-announces-new-actions-accelerate-us-floating-offshore-wind-deployment

[52] DOE Office of Clean Energy Demonstrations (2023). *Coming Soon: Up to $300 Million for Energy Projects in Rural or Remote Communities.* https://www.energy.gov/oced/articles/coming-soon-300-million-energy-projects-rural-or-remote-communities