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Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Distributed Wind Market Report: 2023 Edition

EXECUTIVE SUMMARY

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Cover Photo: This is one of two 2.82-MW GE wind turbines powering a Dole Fresh Vegetables facility in Soledad, California. Photo from Foundation Windpower, LLC.

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Executive Summary

The annual Distributed Wind Market Report provides stakeholders with market statistics and analysis along with insights into market trends and characteristics for wind technologies used as distributed energy resources. This report presents the distributed wind market from 2003 through 2022. Key findings with respect to installed capacity, deployment trends, customer types, incentives, policies, installed costs and performance, and the future outlook are presented below.

Installed Capacity

Cumulative U.S. distributed wind capacity installed from 2003 through 2022 now stands at 1,104 megawatts (MW) from over 90,000 wind turbines across all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, the Northern Mariana Islands, and Guam. Distributed wind turbines are connected at the distribution level of an electricity system, or in off-grid applications, to serve specific or local loads.

In 2022, 13 states added 29.5 MW of new distributed wind capacity from 1,755 turbine units representing $84 million in investment. This compares to 11.7 MW of deployed capacity across 15 states from 1,751 turbines representing $41 million in investment in 2021 and 21.9 MW in 11 states from 1,497 turbine units representing $44 million in investment in 2020.

Of the 29.5 MW installed in 2022, 27.2 MW came from distributed wind projects using large-scale turbines (greater than 1 MW in size). No capacity came from projects using midsize turbines (101 kilowatts [kW] to 1 MW in size) and 2.3 MW came from projects using small wind turbines (up through 100 kW in size).

The 27.2 MW from four projects using 10 turbines greater than 1 MW is an increase from 8.7 MW (three projects with five turbines) in 2021 and 20 MW (five projects with eight turbines) documented in 2020. Large-scale wind turbines continue to account for most of the distributed wind capacity additions. The annual deployed capacity using large-scale turbines fluctuates from year to year because these projects have longer project-development cycles than smaller distributed wind energy projects and large-scale turbine technology continues to increase in nameplate capacity. Over the last five years, the average turbine size of turbines greater than 100 kW in distributed wind projects increased from 2.2 MW to 2.7 MW.

There were no reported distributed wind projects in 2022 that used midsize turbines (101 kW to 1 MW in size). Projects using midsize turbines have regularly represented a small part of the distributed wind market. In 2021, a total of 1.2 MW of midsize capacity from three projects using four turbines was deployed representing $2 million of investment, compared to 0.28 MW from two single-turbine projects in 2020 representing $0.4 million of investment.

A total of 2.3 MW of small wind turbines (up through 100 kW in size) was deployed in the United States in 2022 from 1,745 turbine units, representing $14.6 million in investment.

This is up from 1.8 MW from 1,742 turbine units and $9.2 million in investment in 2021, and 1.6 MW from 1,487 turbine units and $7.2 million in investment in 2020. All small wind manufacturers and suppliers who responded to the Pacific Northwest National Laboratory (PNNL) data request reported higher sales in 2022 than in 2021.

Iowa, California, and Nebraska led the United States in new distributed wind capacity additions because of two large projects in Iowa and one large project each in California and Nebraska that collectively represent 92% of the distributed wind capacity installed in 2022. ConEdison Development installed two 7.94-MW projects connected to load-serving distribution lines owned by Interstate Power & Light in Iowa. Foundation Windpower installed a 5.64-MW behind-the-meter project for Dole Fresh Vegetables, Inc. in California. And Bluestem Energy Solutions installed a 5.64-MW project connected to a load-serving distribution line owned by Southern Public Power District in Nebraska.

Minnesota added the most small wind capacity in 2022 with 327 kW. This can be attributed to Eocycle's continued push to sell its EOX-S16 turbine model to farmers in Minnesota to provide a decarbonization solution for the emissions-heavy agriculture industry.

Deployment Trends

General Electric (GE) Renewable Energy has been the only consistent U.S.-based manufacturer of large-scale turbines used in distributed wind projects over the past 10 years and was the only large-scale turbine provider for distributed wind projects in 2022.

Small wind repowers accounted for a reduced portion of new small wind capacity deployment in 2022 compared to previous years. Repowers are new turbines installed on existing towers and foundations to replace nonfunctioning turbines or to upgrade the technology. In 2022, small wind repowers represented just 8% of total installed small wind capacity, compared to 36% in 2021 and 79% in 2020.

In 2022, 90% of distributed wind projects were deployed to provide energy for on-site use and 10% of projects were interconnected to a distribution grid to provide energy for local use. Historically, while most of the distributed wind projects documented are interconnected for on-site use, they make up less of the total deployed distributed wind capacity. In 2022, the projects for on-site use accounted for 22% of the deployed distributed wind capacity while 78% of the capacity was from projects connected to the distribution grid.

Customer Types

In 2022, projects for agricultural customers accounted for 33% of the number of all projects installed. Residential and commercial customers each represented 26%, utility customers represented 10%, and industrial and institutional customers each represented just under 3% of installed projects.

Distributed wind deployed for utility customers represented the largest share of total distributed wind capacity installed in 2022, accounting for 78% of the documented capacity. Industrial customers represent the second largest percentage of distributed wind capacity installed in 2022, accounting for 20% of installed capacity. Three of the four projects using large-scale wind turbines were for utilities—the other was for an industrial customer. Distributed wind for agricultural, residential, commercial, institutional, and government customers each accounted for 1% or less of the distributed wind capacity installed in 2022.

Incentives and Policies

The Inflation Reduction Act (IRA) of 2022 enacted long-term incentives for distributed wind that will be available for at least the next decade. The IRA extends the Residential Renewable Energy Tax Credit applicable to small wind turbines through 2034. The IRA also extends the Business Energy Investment Tax Credit (ITC) through 2024. Starting in 2025, the current technology-specific ITCs and Production Tax Credit (PTC) options will be replaced with a technology-neutral ITC and PTC that will be available to all energy-generation technologies with zero or net-negative carbon emissions before beginning to phase out in 2032 or when U.S. power sector emissions have dropped by at least 75% compared with 2022 levels, whichever comes later. The extended and new tax credits have new provisions for additional, stackable bonus credits of 10 percentage points for the ITC and 10% for the PTC for locating facilities in "energy communities" or for meeting domestic content requirements. Further ITC bonuses up to 20 percentage points are available on a limited, competitive basis for wind or solar projects less than 5 MW (and from 2025 on for other clean energy) that are located in or benefit low-income communities or are located on tribal lands. The IRA also includes direct-pay provisions for non-tax paying entities that will enable access to the credits for organizations like municipal utilities and rural electric cooperatives.

The IRA also provides significant new loan and grant authority from which distributed wind could benefit. The U.S. Department of Agriculture's (USDA) Rural Energy for America Program (REAP) received a funding allocation of over $2 billion, with $303 million set aside for underutilized technologies and technical assistance. Wind is an eligible underutilized technology. The new IRA provisions for REAP also doubled the maximum allowable grant size from $500,000, or 25% of costs, to $1,000,000, or up to 50% of costs, for renewable energy projects.

Distributed wind projects across eight states received a total of $5 million in state-level PTCs and USDA REAP grants in 2022. This is roughly the same as the $5.2 million paid across eight states in 2021 and the $4.8 million paid across six states in 2020, although those past year totals include other incentive payments in addition to USDA REAP grants and state PTCs.

While at least 23 different small wind turbine models have been certified to the American Wind Energy Association (AWEA) 9.1-2009 standard or the International Electrotechnical Commission (IEC) 61400 standards since 2011, a total of nine small wind turbine models have current certifications as of June 2023. Small wind turbine manufacturers must renew

certifications annually. Manufacturers may opt not to renew if they no longer want to participate in the U.S. market or if the company has discontinued operations. Small wind turbines must meet either of these standards to be eligible to receive the federal Business Energy ITC per the U.S. Internal Revenue Service.

The American Clean Power Association (ACP), the successor to AWEA, published its new American National Standards Institute (ANSI) consensus standard, ANSI/ACP 101-1-2021, in October 2022. The Distributed Wind Energy Association and the U.S. Department of Energy have recommended that the U.S. Internal Revenue Service recognize legacy certifications to AWEA 9.1-2009 new certifications to ANSI/ACP 101-1 going forward for small wind Business Energy ITC eligibility.

Installed Costs and Performance

The overall average capacity-weighted installed cost for new small wind projects from 2013 through 2022 was $10,670/kW. Small sample sizes for cost data in 2018, 2020, and 2022, along with high variance in distributed wind project costs, prevent clear identification of cost trends for small wind turbine installations over time.

The overall average capacity-weighted installed cost for projects using turbines greater than 100 kW for the period of 2013 through 2022 is $4,050/kW. The PNNL team documented four distributed wind projects using turbines greater than 100 kW for 2022 and only one of them has a reported installed cost, so no average cost was calculated for 2022.

The overall average capacity factor in 2022 for a sample of small wind projects was 15%. Observed capacity factors ranged from 1% to 37% for the sample of 101 turbines totaling 1.4 MW in rated capacity.

The overall average capacity factor in 2022 for a sample of distributed wind projects using turbines greater than 100 kW was 23%. Observed capacity factors ranged from 6% to 39%. The sample includes 27 distributed wind projects installed from 2005 to 2018, across 14 states, totaling 95 MW in combined capacity with turbine nominal capacities ranging from 600 kW to 3 MW.

A total of 60% of the distributed wind projects PNNL analyzed had higher capacity factors in 2022 than in 2021. This can largely be attributed to a stronger wind resource year in the Midwest and Northeast United States. Of the 122 distributed wind projects using turbines of all sizes that PNNL analyzed, a total of 73 had capacity factors in 2022 that exceeded their capacity factors in 2021 (with 25 of them in the Midwest and 20 in the Northeast). A total of 28 projects underperformed in 2022 relative to their capacity factors in 2021 and the remaining 21 projects performed similarly between the two years.

Future Outlook

With the passage of the IRA and associated long-term incentives for distributed wind, the outlook for future distributed wind deployment looks much improved. The National Renewable Energy Laboratory's *Distributed Wind Energy Futures Study* estimates distributed wind economic potential at 919 gigawatts (GW) for behind-the-meter installations and 474 GW for front-of-the-meter installations in a 2022 baseline scenario. Economic potential increases substantially to 1.7 TW for behind-the-meter applications and more than 4 TW for front-of-the-meter installations in a 2035 future scenario that includes reduced barriers to permitting and an extension of the federal ITC roughly equivalent to that provided under the IRA.

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Cover details: This is one of two 2.82-megawatt GE wind turbines powering a Dole Fresh Vegetables facility in Soledad, California. Photo from Foundation Windpower, LLC.