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Distributed Wind Market Report: 2022 Edition

EXECUTIVE SUMMARY

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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. Key findings for this year's report include the following:

Installed Capacity

Cumulative U.S. distributed wind capacity installed from 2003 through 2021 now stands at 1,075 megawatts (MW) from over 89,000 wind turbines across all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin 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 2021, 15 states added a total of 11.7 MW of new distributed wind capacity from 1,751 turbine units representing a $41 million investment. The deployed capacity is down from 21.9 MW ($44 million, 11 states) in 2020 and 20.4 MW ($59 million, 22 states) in 2019. The 2020 distributed wind capacity amount is higher than initially reported because it now captures some projects that had late 2020 operational dates.

Of the 11.7 MW installed in 2021, 8.7 MW came from distributed wind projects using large-scale turbines (greater than 1 MW in size), 1.2 MW came from projects using mid-size turbines (101 kilowatts [kW] to 1 MW in size), and 1.8 MW came from projects using small wind turbines (up through 100 kW in size).

The 8.7 MW from projects using turbines greater than 1 MW is down from the 20 MW documented for 2020 and the 18.2 MW documented for 2019. Large-scale wind turbines continue to account for most of the distributed wind capacity additions; however, the total annual deployed capacity using large-scale turbines continues to jump around year to year as these projects have longer project-development cycles than smaller distributed wind energy projects.

Projects using mid-size turbines continue to represent a small part of the distributed wind market as there are a limited number of mid-size turbines commercially available and larger turbines can be more cost effective. However, the 1.2 MW of mid-size capacity from three projects deployed in 2021 was an increase from 0.28 MW from two projects in 2020 and 0.9 MW from one project in 2019.

A total of 1.8 MW of small wind was deployed in the United States in 2021 from 1,742 turbine units representing a $9.2 million investment. Small wind deployment has been fairly flat for the past few years, but the 2021 capacity deployment is an increase from 2020. There was 1.6 MW of small wind deployment documented for 2020 and 1.3 MW in 2019. The increase can be attributed to a slight increase in domestic sales from both U.S.-based and foreign small wind turbine manufacturers, the inclusion of two turbine manufacturers that PNNL had not previously tracked, and sales of early designs from additional turbine manufacturers.

Rhode Island, Kansas, and Minnesota led the United States in new distributed wind capacity additions as a result of one project in each state, which combined, represent 75% of the annual distributed wind capacity installed in 2021. The Rhode Island and Minnesota projects serve utility customers, and the Kansas project directly serves an industrial customer, an ethanol plant.

Minnesota led the United States in 2021 small wind capacity additions with 305 kilowatts. This can be attributed to Eocycle's push to sell its EOX-S16 turbine model to farmers in Minnesota and the decline of installations in New York with the discontinuation of its state incentive program. New York had led the United States in annual small wind capacity additions since 2017. Eocycle has focused on the agricultural market segment, with a start in Minnesota, because the company believes that many farms are in wind-rich areas, wind has a smaller land footprint than solar photovoltaics, winter wind energy production can match farm energy consumption trends, and wind turbines can 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 from 2012 through 2021. The other large-scale turbine models deployed in distributed wind projects in 2021 were from Goldwind (China) and Vensys (Germany).

Refurbished turbines continue to account for most of the mid-size market. Of the six projects using mid-size turbines in 2019, 2020, and 2021, at least four are refurbished models. Demand from customers for whom mid-size turbines are a good fit for their energy needs and the limited availability of newly manufactured turbine models explain the use of refurbished turbines in this size sector and Siva Wind's return to the U.S. market in 2021 with its 250-kW turbine model.

Small wind retrofits continue to account for a significant portion of new small wind capacity deployment. Retrofits are new turbines installed on existing towers and foundations to replace nonfunctioning turbines or to upgrade the technology. In 2021, small wind retrofits represented 42% of total installed small wind capacity, compared to 68% in 2020 and 27% in 2019.

Small wind turbine manufacturers and installers report an increased interest in microgrids and hybrid systems from potential customers. Microgrids are becoming more common, but not many are being installed with wind. There is also an interest in larger hybrid power plants. For example, the Red Lake Falls Community Hybrid project installed in 2020 includes 4.6 MW of distributed wind and 1 MW of solar photovoltaics interconnected to serve a utility's distribution system in Minnesota.

From 2012 through 2021, 90% of all documented distributed wind projects, on average, were interconnected for on-site use with the remaining 10% deployed to serve local loads on distribution systems. While the majority of distributed wind projects are interconnected for on-site use, they represent less of the deployed capacity. The percent of total installed project capacity documented as local use from 2012 through 2021 was 55% with the remaining 45% for on-site use.

Customer Types

In 2021, agricultural customers accounted for 55% of the number of all projects installed, followed by residential customers who represented 16% of installed projects. However, agricultural and residential end-use customers accounted for only a combined 12% of the documented capacity installed in 2021, compared to 3% in both 2020 and 2019. The increase in percentage of project capacity for these two customer types can be attributed to the use of mid-size turbines for agricultural customers in 2021.

Utility customers represented the largest share of total distributed wind project capacity, 56%, installed in 2021, compared to 60% in 2020 and 42% in 2019. Industrial customers represent the second largest percentage of distributed wind capacity installed in 2021, accounting for roughly 25% of capacity installed, compared to 36% in 2020 and 54% in 2019.

Distributed wind provides energy for a diverse group of customers. For example, documented government projects include wind turbines for military operations, municipal water systems, prisons, parks, and tribal governments. Most institutional customers are schools, including colleges and universities, but wind turbines have also been deployed at local unions and religious establishments. Documented commercial projects include wind turbines for warehouses, a taxidermist, hotels, and a radio station.

Incentives and Policies

The combined value of U.S. Department of Agriculture Rural Energy for America Program (USDA REAP) grants, state rebates, and state production tax credits given to distributed wind projects in 2021 was $5.2 million in eight states. This is up slightly from $4.8 million in six states in 2020 and down from $7 million in 2019 in seven states. Incentive awards from the New York State Energy and Research Development Agency's Small Wind Incentive Program were down in 2021 because of the discontinuation of that program, but distributed wind grants from USDA REAP were slightly up and awarded in more states in 2021.

While at least 24 different small wind turbine models have been certified to the American Wind Energy Association (AWEA) 9.1-2009 standard or International Electrotechnical Commission (IEC) 61400 standards since 2011, a total of seven small wind turbine models have current certifications as of July 2022. Small wind turbines must meet either of these standards to be eligible to receive the federal Business Energy Investment Tax Credit per the U.S. Internal Revenue Service (IRS). 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 all operations.

The American Clean Power Association (ACP), the successor to AWEA, has developed a new American National Standards Institute consensus standard, ACP 101-1. The Distributed Wind Energy Association and the U.S. Department of Energy have recommended that the IRS recognize certification to either AWEA 9.1-2009 or ACP 101-1 going forward for tax credit eligibility.

Installed Costs and Performance

The average capacity-weighted installed cost for new small wind projects in 2021 was $5,120/kW, based on 16 projects (each having one turbine) in three states for a combined rated capacity of 396 kW. The overall annual average capacity-weighted installed cost for new projects in PNNL's dataset had been relatively flat through 2019 at approximately $9,970/kW, so the 2021 average is a notable decrease from past years' averages. This decrease may be attributable to the sample of projects with reported costs for 2021 only including turbines in the size segment of 11–100 kW, which tend to have a lower cost per kW than turbines in the size segment of 1–10 kW, although there was also an increase in sales in the size segment of 11–100 kW in 2021.

The average capacity-weighted installed cost for small wind retrofit projects in 2021 was approximately $3,400/kW, based on 17 projects (each having one turbine) in eight states for a total rated capacity of 494 kW. This is down from an average of $3,900/kW in 2020 (13 projects, 371 kW, 6 states) and $5,300/kW in 2019 (10 projects, 89 kW, 2 states) for small wind retrofits. Some retrofit projects use refurbished turbine units, and refurbished turbines represent the low end of the retrofit installed cost range. In 2021, six of the retrofit projects with reported costs used refurbished turbines, compared to three in 2020 and none reported in 2019, largely driving the drops in the annual average capacity-weighted installed costs over those years.

The average capacity-weighted installed cost for projects using turbines greater than 100 kW in 2021 was approximately $2,900/kW, based on just three projects using five turbines for a combined capacity of 6,250 kW. This is down from an average of $3,100/kW documented in 2019 (5 projects, 14.6 MW, 5 states), and $4,300/kW documented in 2018 (14 projects, 32.9 MW, 6 states). However, the small sample sizes and range of project sizes represented must be considered when reviewing these averages.

The overall average capacity factor in 2021 for a sample of small wind projects was 13%. The sample includes 105 turbines totaling 1.1 MW in rated capacity ranging from 2.1 kW to 56 kW in size installed from 2009 through the beginning of 2021. Observed capacity factors ranged from 1% to 33%.

Small wind projects with reported performance data for 2021 produced lower generation amounts in 2021 than the generation amounts that were initially estimated for the projects.

Historical data indicates that 2021 was generally a below average wind resource year and that is one contributing factor to the low turbine performance recorded in 2021 relative to expectations.

The overall average capacity factor in 2021 for a sample of distributed wind projects using turbines greater than 100 kW was 22%. The sample includes 25 distributed wind energy projects installed from 2005 to 2018 in 14 states totaling a combined 44 MW in capacity with turbine capacities ranging from 600 kW to 3 MW. Observed capacity factors ranged from 6% to 43%.