

U.S. DEPARTMENT OF
ENERGY

Office of
**ENERGY EFFICIENCY &
RENEWABLE ENERGY**

2017 Distributed Wind Market Report: Summary

Alice Orrell, Nik Foster, Juliet Homer, Scott Morris, Danielle Prezioso, Eric Poehlman
Pacific Northwest National Laboratory

August 2018



2017 Distributed Wind Market Report

Purpose, Scope, and Data:

- Publicly available annual report summarizing the U.S. distributed wind market
- Analyzes distributed wind projects of all sizes and details the U.S. small wind market
- Separate DOE-funded reports on land-based and offshore wind
- Data sources include AWEA, FAA, EIA, USDA, U.S. Treasury, state agencies, turbine manufacturers, installers, and others detailed in Appendix B of report

Report Authors

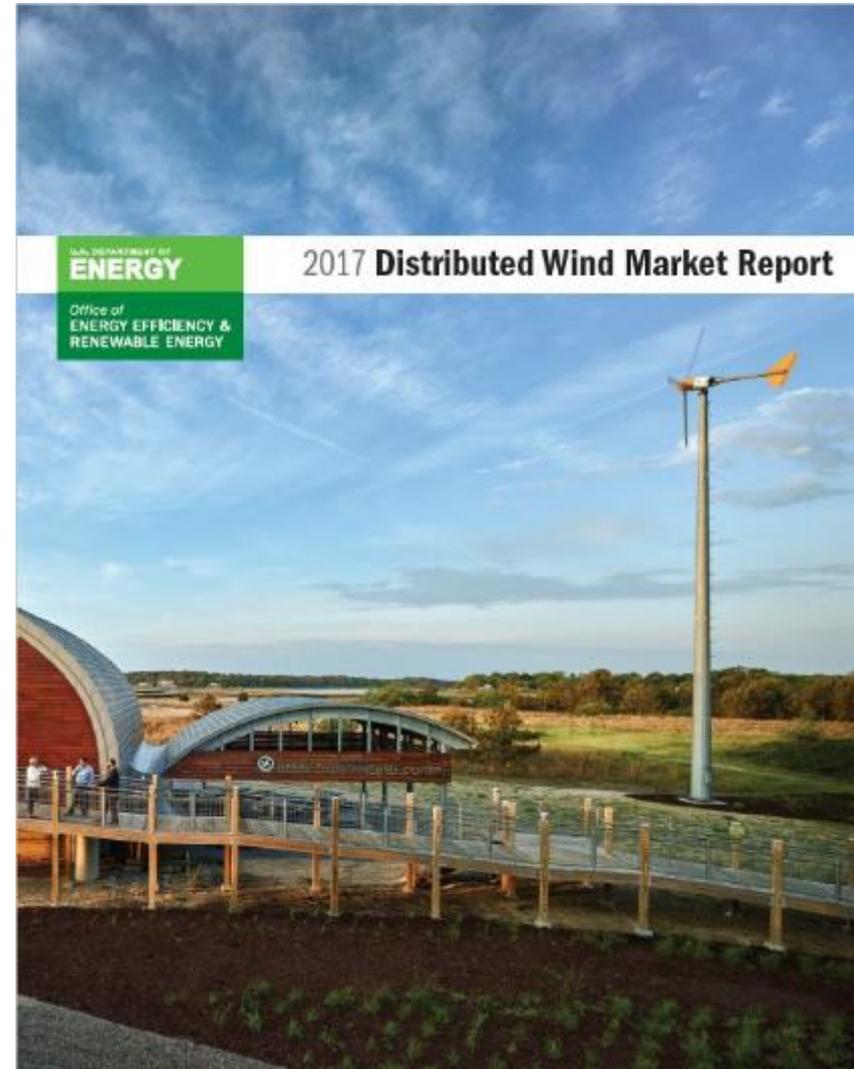
- Primary Author: Alice Orrell; Pacific Northwest National Laboratory (PNNL)
- Contributing Authors: Nikolas Foster, Juliet Homer, Scott Morris, Danielle Prezioso, Eric Poehlman; PNNL

Funded by: U.S. DOE Wind Energy Technologies Office

Available at: <http://energy.gov/eere/wind>

Report Contents

- U.S. Distributed Wind Deployment
- Domestic Sales, Imports, Exports, and the Global Market
- Policies, Incentives, and Market Insights
- Installed and Operations and Maintenance (O&M) Costs
- Performance
- Levelized Cost of Energy
- Distributed Wind Markets
- Small Wind Manufacturing
- Outlook

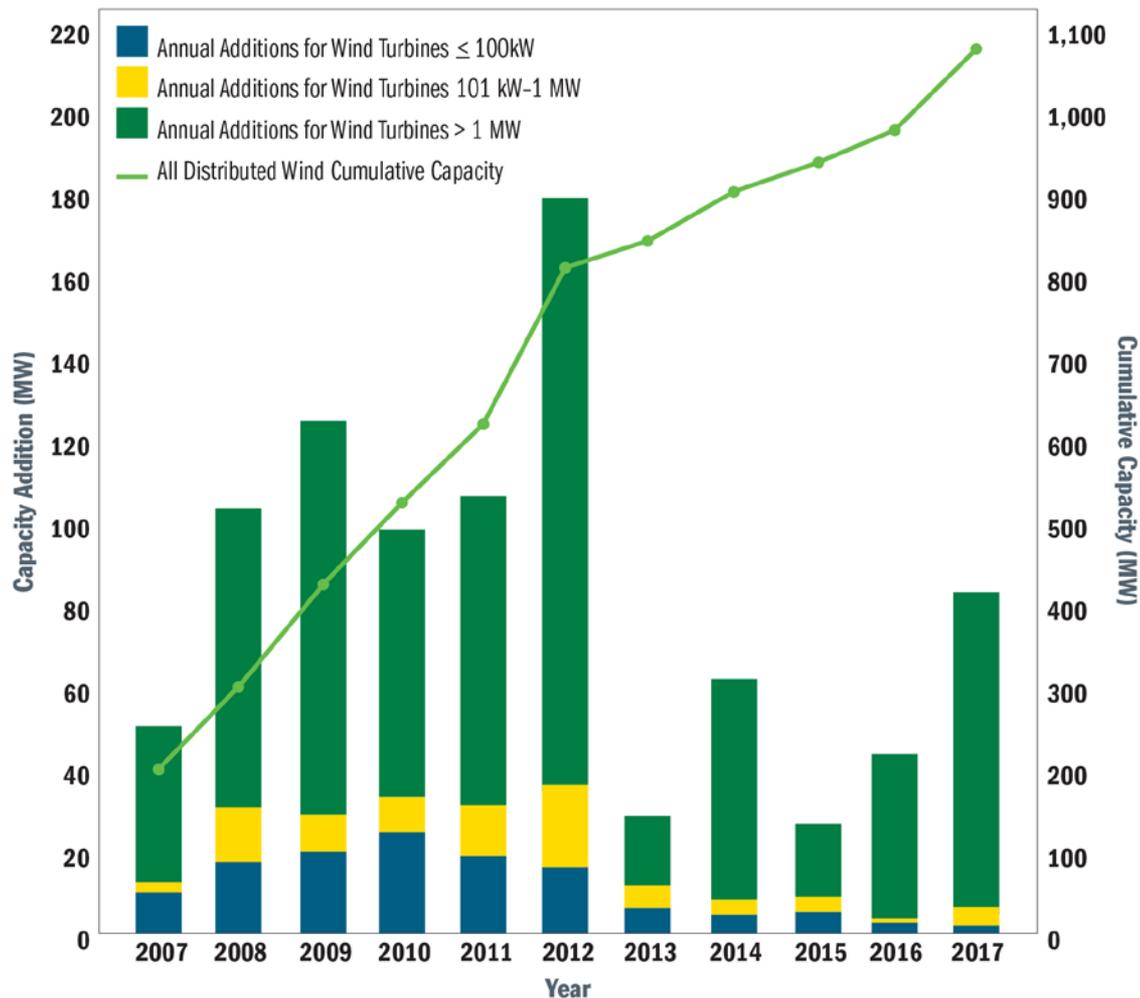


Key Findings

- 21 states added 83.7 MW of new distributed wind capacity in 2017, representing 3,311 units and \$274 million in investment
- Driven by large-scale turbines installed to power a variety of distributed generation needs in 2017, cumulative U.S. distributed wind installed capacity surpassed 1 GW
 - A significant amount of distributed wind projects using large-scale turbines (greater than 1 MW) were installed behind the meter and to serve utility loads on local distribution grids, particularly in Iowa
 - Distributed wind for utilities accounted for 32% of capacity installed in 2015, 60% in 2016, and 83% in 2017
- A total of 1.7 MW of small wind (turbines up through 100 kW) capacity was deployed in 2017, down from 2.4 MW in 2016 and 4.3 MW in 2015
 - To counter the declining domestic small wind market, small wind manufacturers are exploring different business expansion or realignment opportunities, such as energy storage and new turbine models, and pursuing export markets
 - The reinstated Residential Renewable Energy Tax Credit for small wind turbines and extended Business Energy Investment Tax Credit for small wind projects from the Bipartisan Budget Act of 2018 could bolster small wind sales in the near term

U.S. Distributed Wind Deployment

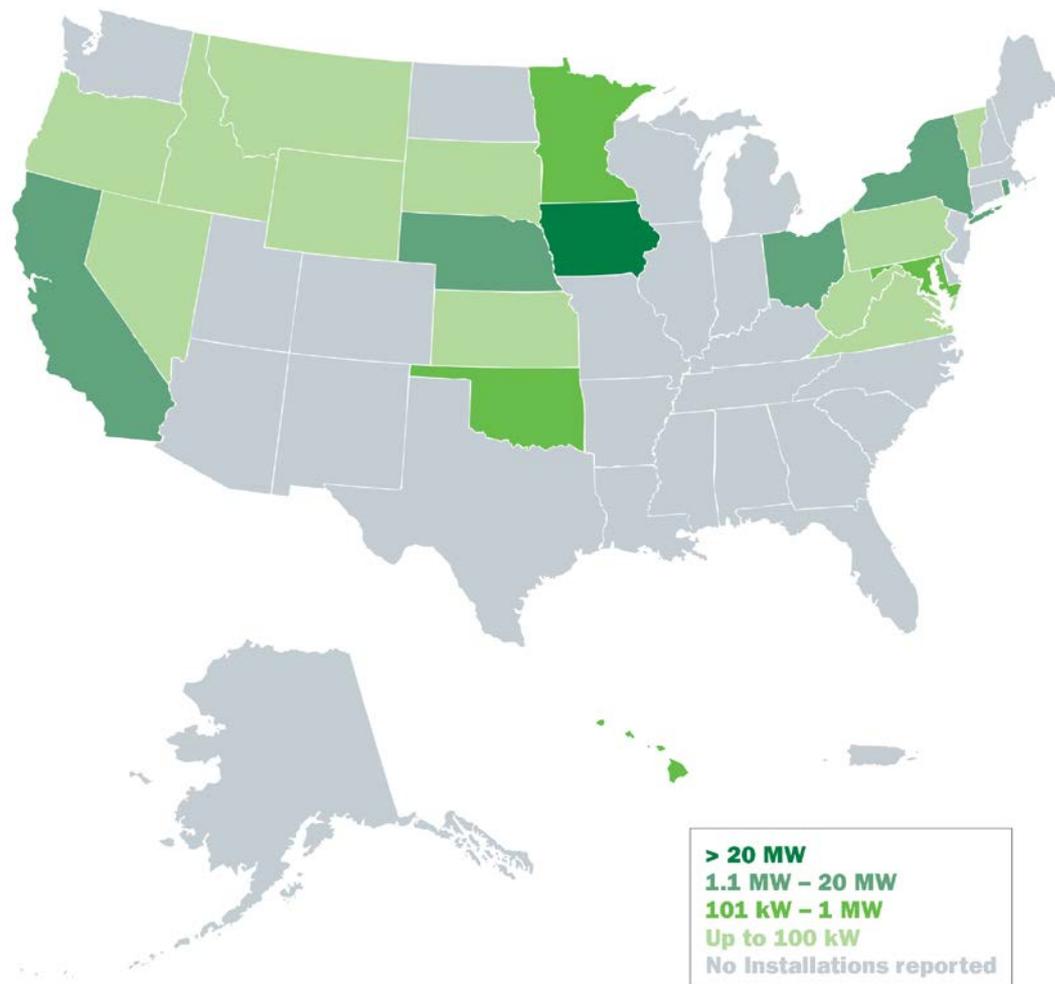
- In 2017, cumulative distributed wind capacity reached 1,076 MW from over 81,000 wind turbines across all 50 states, Puerto Rico, the U.S. Virgin Islands, and Guam
- Of the 83.7 MW of distributed wind capacity installed in 2017, 78 MW came from distributed wind projects using turbines greater than 1 MW, 4 MW came from projects using turbines 101 kW to 1 MW in size, and 1.7 MW came from projects using small wind turbines up through 100 kW



U.S. distributed wind capacity

U.S. Distributed Wind Deployment

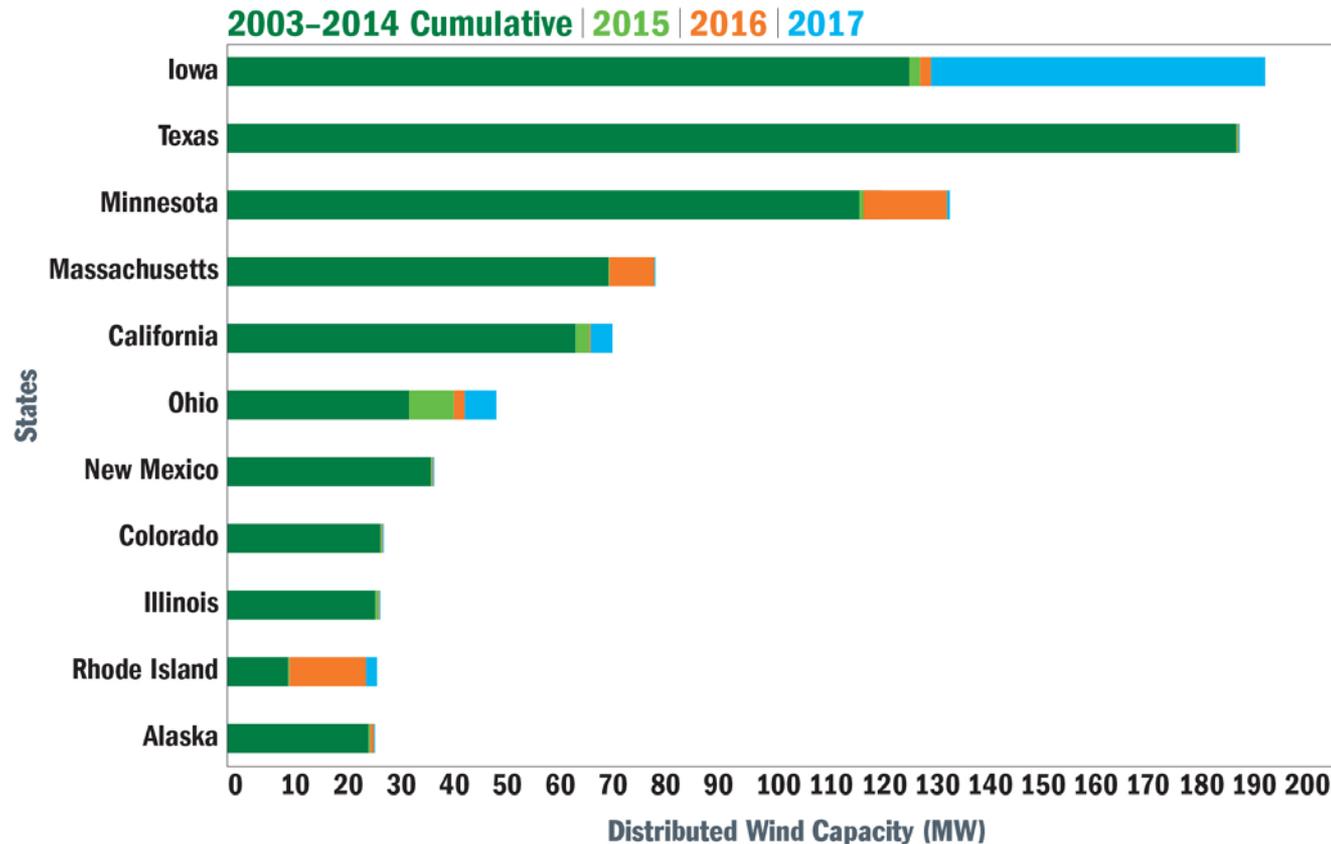
- In 2017, new distributed wind projects were documented in 21 states
- Iowa, Ohio, and California led the United States in new distributed wind power capacity installed in 2017 due to a number of projects using turbines greater than 1 MW installed behind the meter or to serve utility loads on local distribution grids



2017 U.S. distributed wind capacity additions by state

U.S. Distributed Wind Deployment

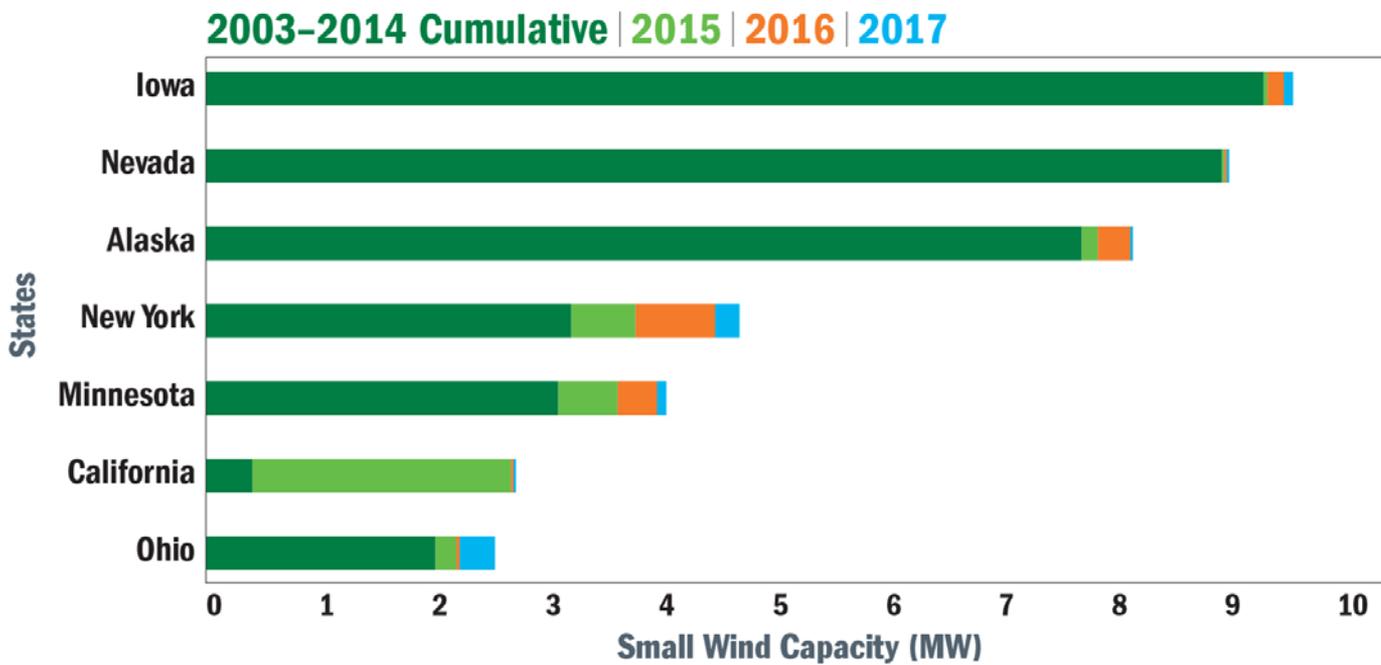
With 63.5 MW installed in 2017, Iowa is now the top state for cumulative distributed wind capacity



Top states for distributed wind capacity, 2003-2017

U.S. Distributed Wind Deployment

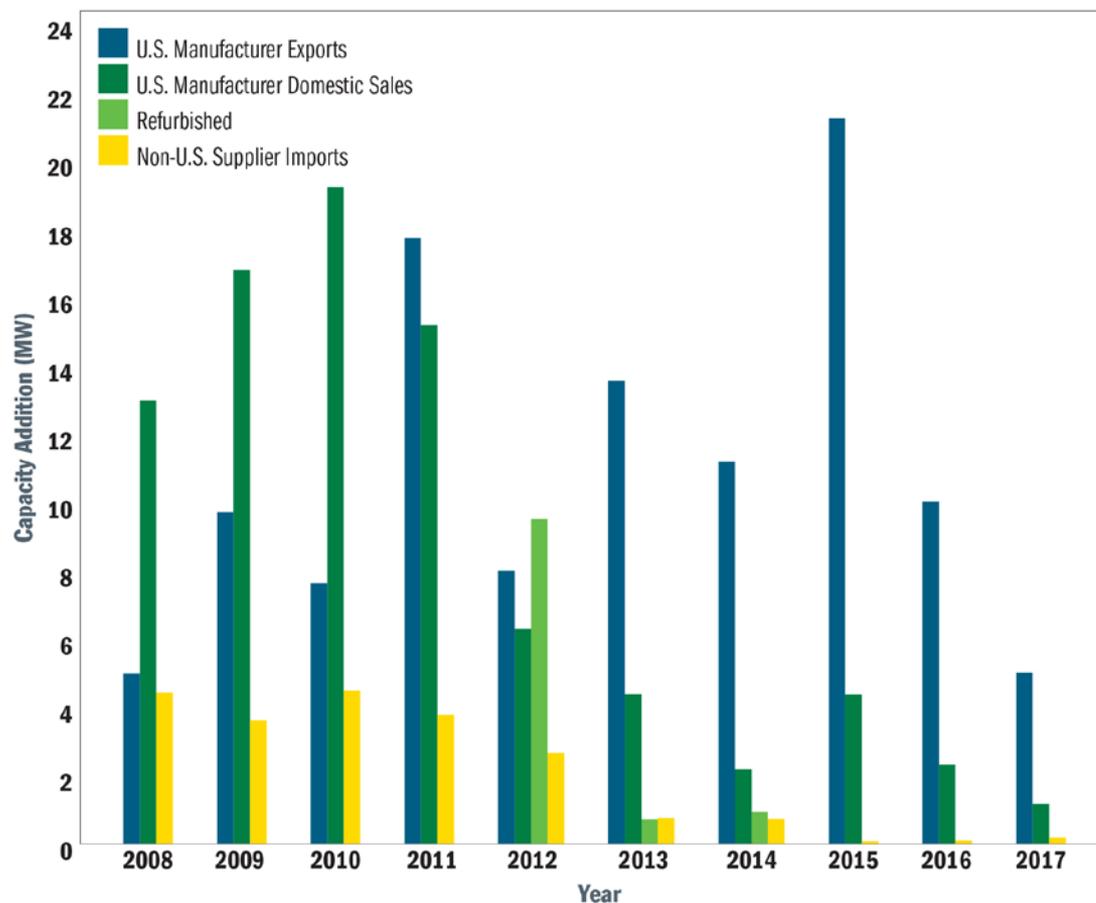
While Iowa is also the top state for cumulative small wind capacity, New York and Ohio installations accounted for 37% and 30%, respectively, of the 2017 documented small wind capacity



Top states for small wind capacity, 2003-2017

Domestic Sales, Imports, Exports, and the Global Market

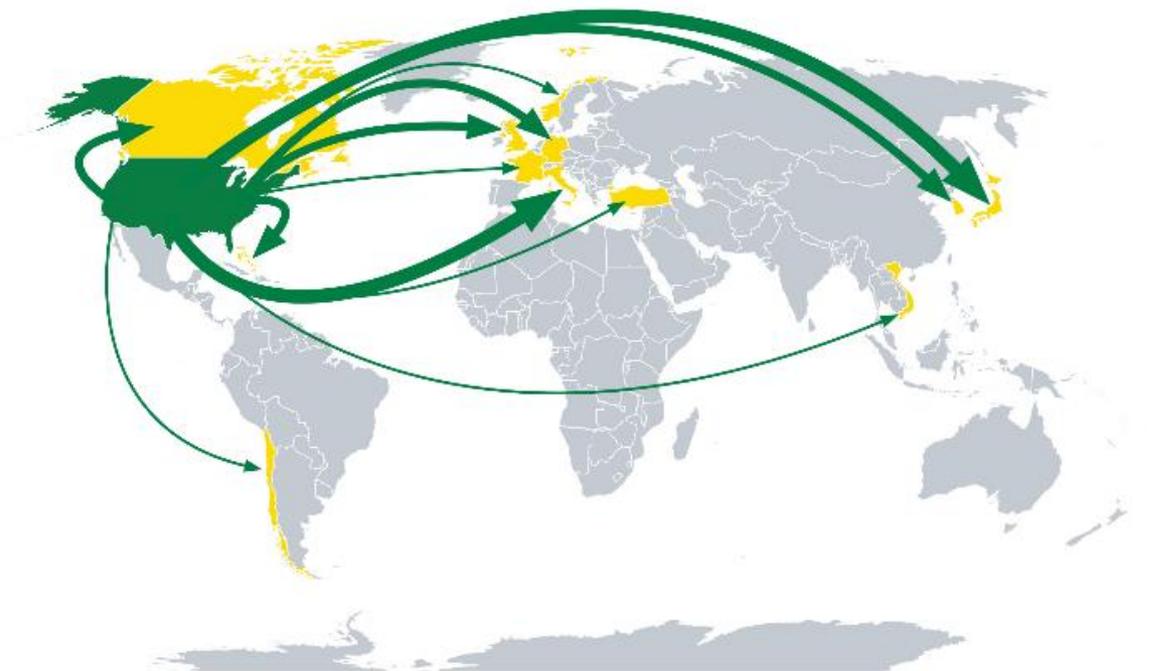
Domestic small wind manufacturers continue to export and account for the majority of domestic sales



U.S. small wind turbine sales and exports, 2008-2017

Domestic Sales, Imports, Exports, and the Global Market

In 2017, exports represented 75% of sales for U.S. small wind manufacturers



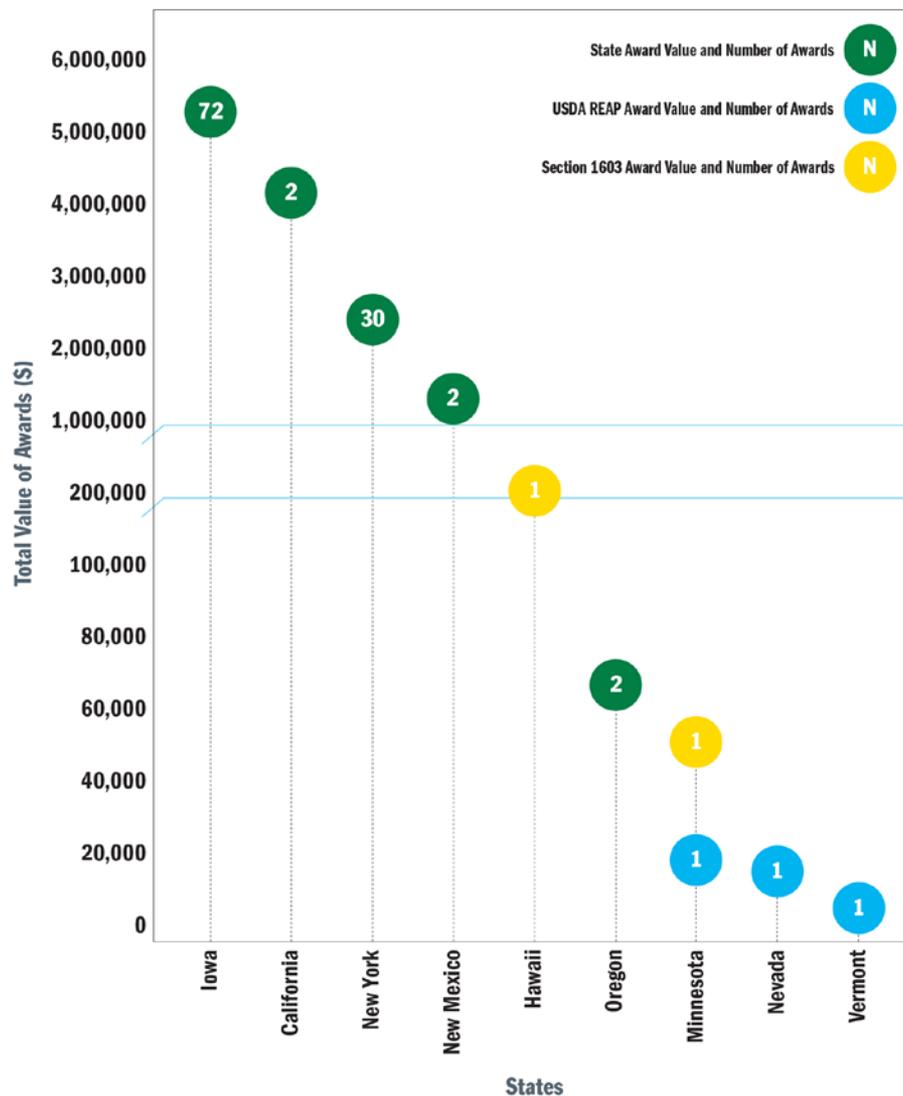
Total Small Wind Exports from the United States by Capacity



U.S. Small Wind Capacity Exports Map

Policies, Incentives, and Market Insights

- The combined value of state, USDA REAP, and Section 1603 awards for distributed wind projects in 2017 was \$13.3 million in nine states
- The Bipartisan Budget Act of 2018 reinstated the Residential Renewable Energy Tax Credit for small wind turbines placed in service 2017 through 2021 and extended the Business Energy Investment Tax Credit for wind projects placed in service by 2022



2017 U.S. distributed wind incentive awards

Policies, Incentives, and Market Insights

One additional small wind turbine (Primus AIR 40) completed the certification process since the last report

Certified small wind turbines

Applicant	Turbine	Date of Certification	Certified Power Rating ¹ @ 11m/s (kW)	Certification Standard
Bergey WindPower	Excel 10 ²	11/16/2011	8.9	AWEA
Eocycle Technologies, Inc.	E020 ³	3/21/2017	22.5	AWEA
Eveready Diversified Products	Kestrel e400nb ²	2/14/2013	2.5	AWEA
Kingspan Environmental	KW6 ²	6/17/2013	5.2	AWEA
Lely Aircon B.V.	LA10 ²	1/13/2017	9.6	AWEA
Lely Aircon B.V.	LA30 ²	1/13/2017	27.2	AWEA
Osiris Technologies	Osiris 10 ⁴	9/27/2013	9.8	AWEA
Pika Energy	T701 ²	1/25/2016	1.5	AWEA
Primus Wind Power	AIR 40/Air Breeze ⁵	2/20/2018	0.16	IEC
Sonkyo Energy	Windspot 3.5 ⁴	10/30/2012	3.2	AWEA
Sumec Hardware & Tools Co. LTD	PWB01-30-48 ⁴	5/20/2013	1.2	AWEA
Sumec Hardware & Tools Co. LTD	PWA03-44-250 ⁴	12/26/2012	3.2	AWEA
Sumec Hardware & Tools Co. LTD	PWB02-40-48 ⁴	5/20/2013	1.7	AWEA
Sumec Hardware & Tools Co. LTD	PWA05-50-280 ⁴	12/26/2012	5.0	AWEA
Xzeres Wind Corporation	442SR ²	2/6/2015	10.4	AWEA
Xzeres Wind Corporation	Skystream 3.7 ²	12/19/2011	2.1	AWEA

¹ Power output at 11 m/s (24.6 mph) at standard sea-level conditions. Manufacturers may describe or name their wind turbine models using a nominal power, which may reference output at a different wind speed (e.g. 10 kW Bergey Excel 10).

² Certified by SWCC

³ Certified by SGS

⁴ Certified by Intertek

⁵ Certified by DEWI-OCC, UL

Installed and O&M Costs

- The average cost of small wind projects installed in 2017 was \$10,117/kW based on 41 turbines totaling 672 kW of rated capacity across seven states
- The average installed cost for projects using turbines greater than 100 kW installed in 2017 was \$3,006/kW based on seven projects across five states, which used 20 turbines totaling 46.1 MW



Photo Credit: Buffalo Renewables

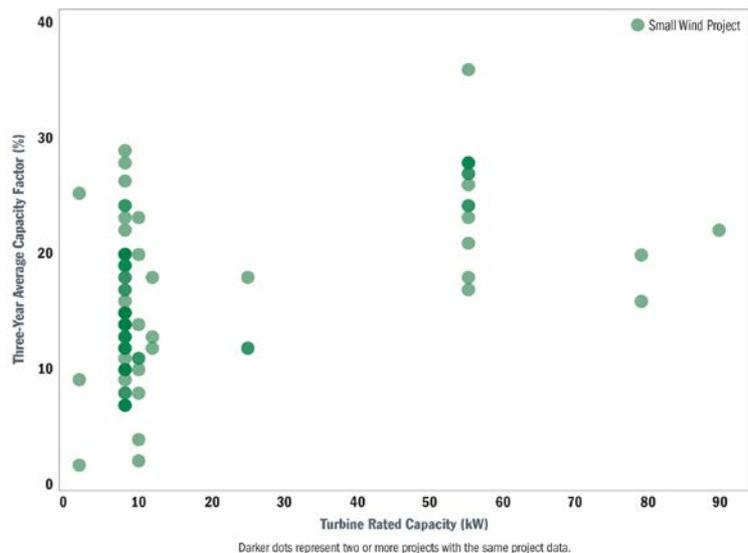


Photo Credit: Roger Dixon / Skylands Renewable Energy

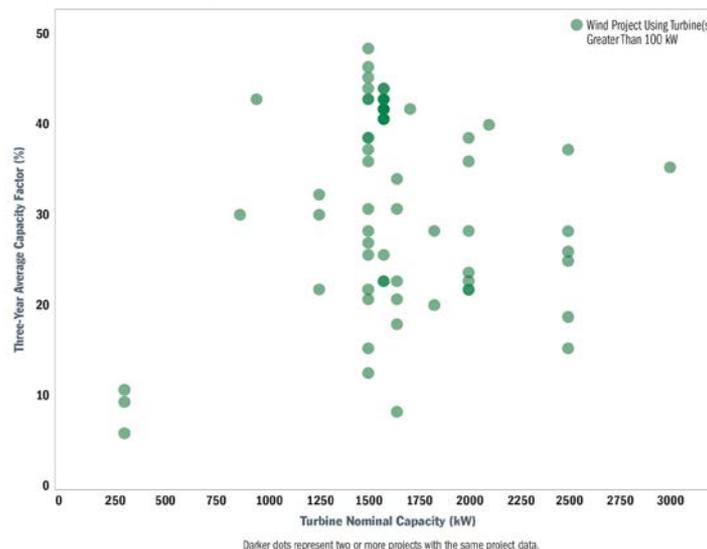
Performance

- Wind resource variability, turbine operational variability, turbine technology, and siting issues contribute to the wide range of capacity factors exhibited by distributed wind projects

Small wind capacity factors



Capacity factors for projects using turbines greater than 100 kW



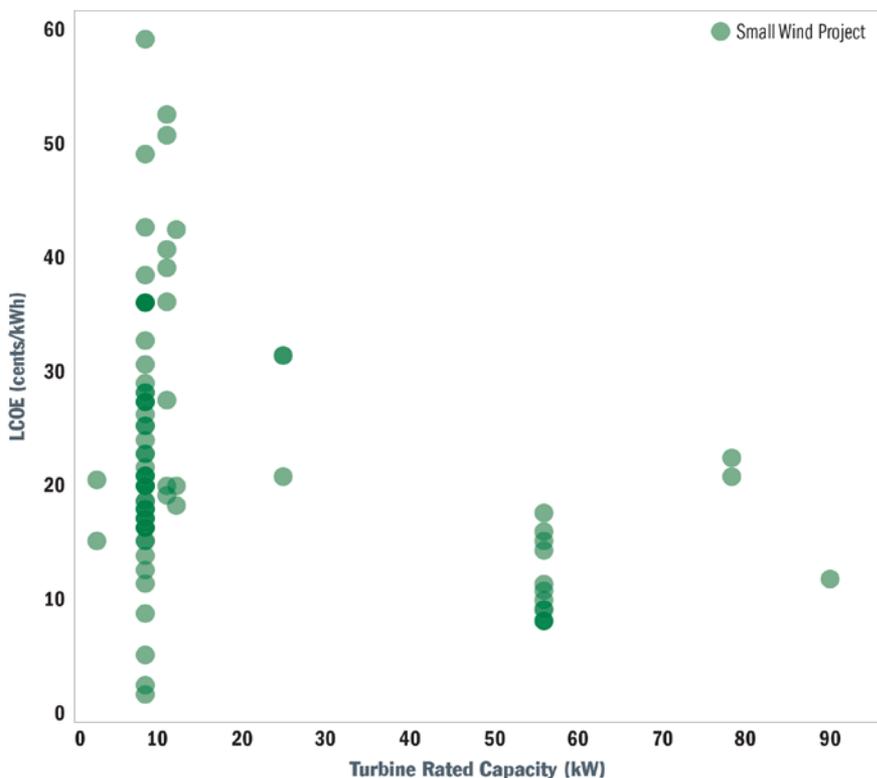
- Actual performance does not always reach projected performance, and non-certified small wind turbines are likely to underperform considerably

Actual performance as a percentage of projected performance by turbine size

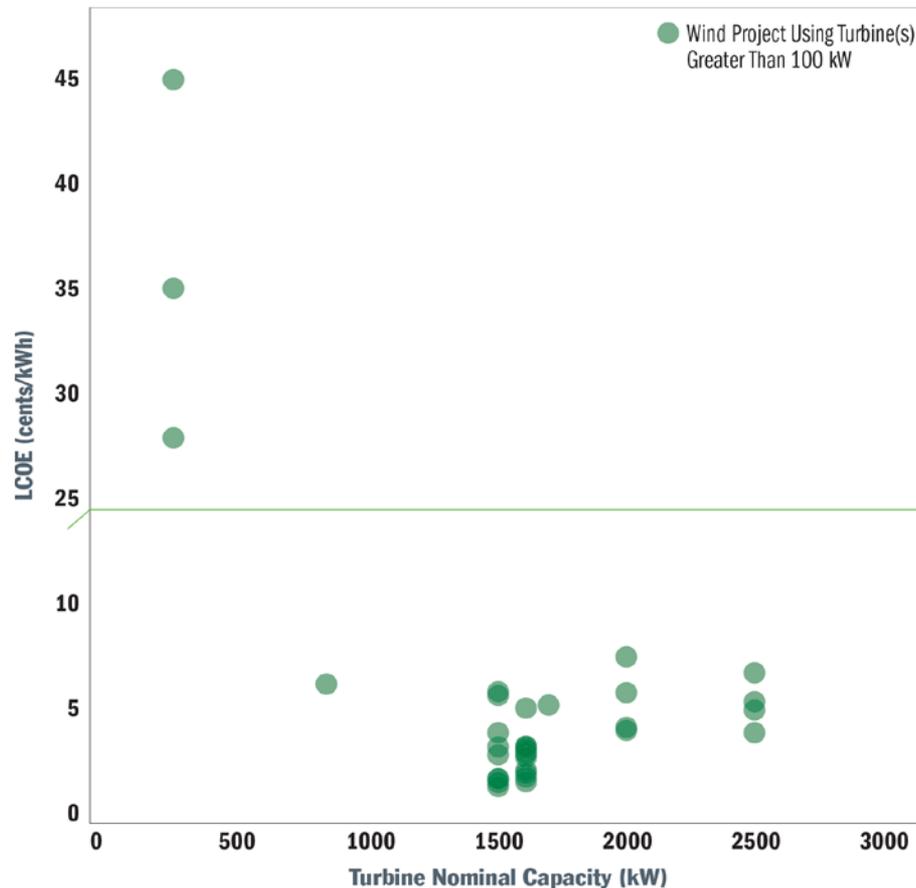
Turbine Size	Average Percent of Projected Production (%)	Number of Projects
Small Certified	92	66
Small Non-Certified	62	76
Mid-Size	70	3
Large	134	11

Levelized Cost of Energy

Distributed wind projects also show significant LCOE spread, particularly for small and mid-size turbines



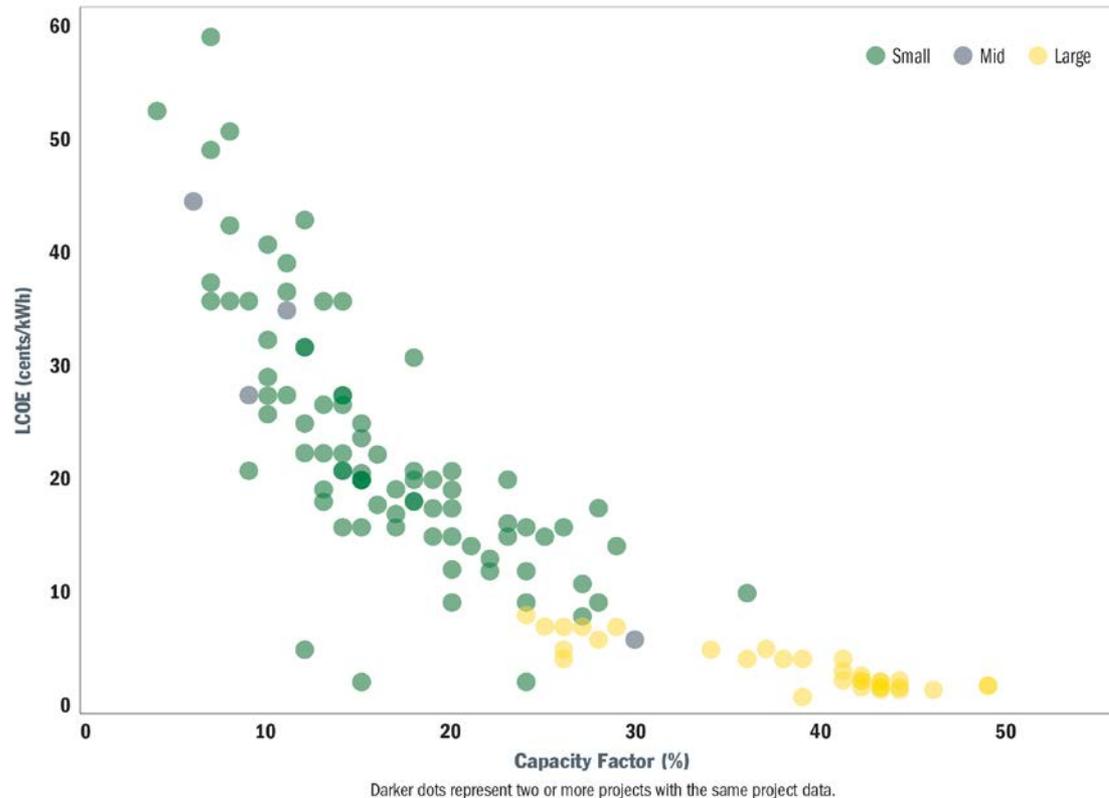
Small wind LCOEs



LCOEs for projects using turbines greater than 100 kW

Levelized Cost of Energy and Performance

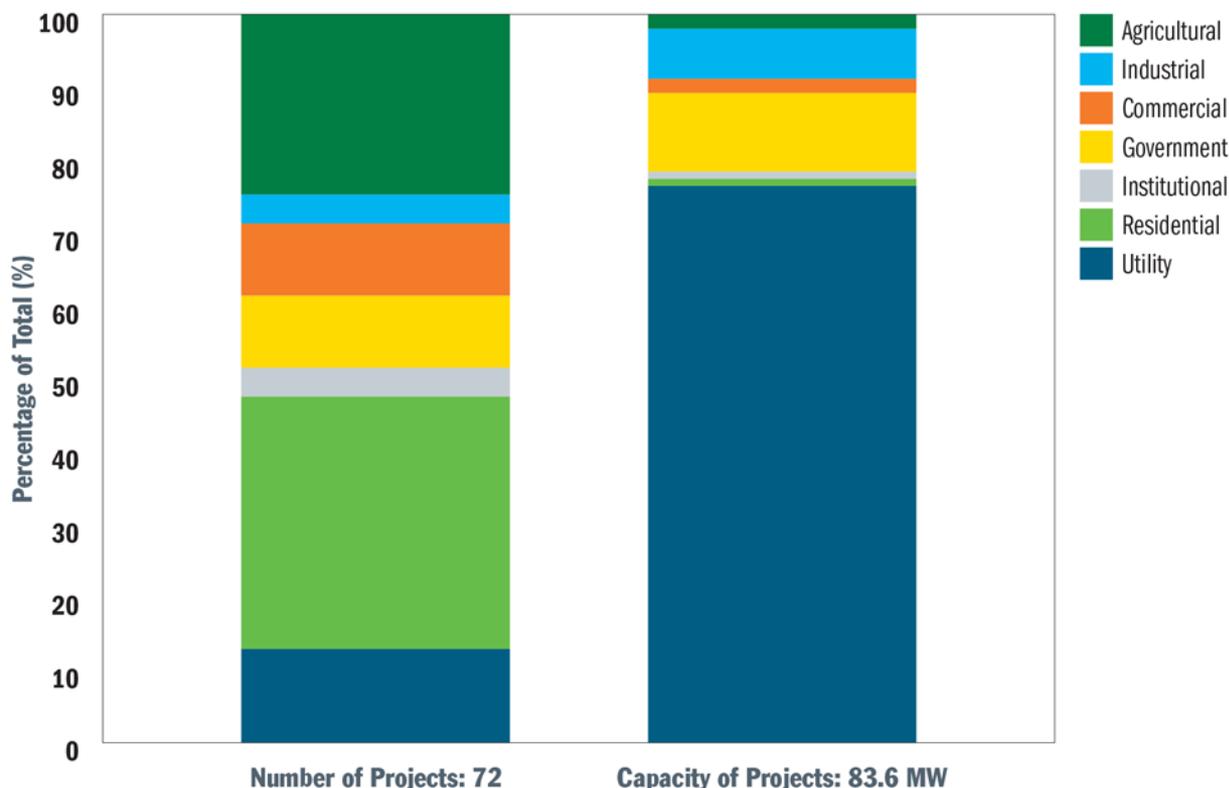
In general, the higher the capacity factor, the lower the LCOE



Distributed Wind System LCOE and Capacity Factors

Distributed Wind Markets

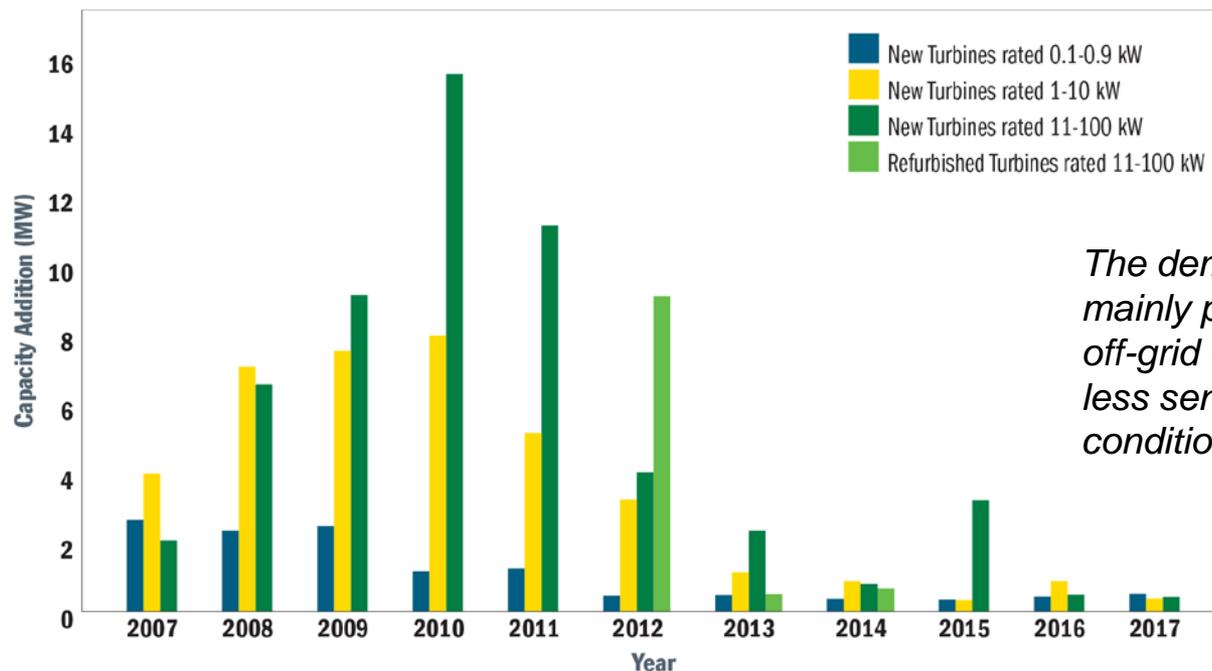
A small number of utility projects using turbines greater than 1 MW represents the majority of distributed wind capacity installed in 2017



Distributed wind customer types by number and capacity of projects

Distributed Wind Markets

While deployed small wind capacity has decreased in recent years, the number of small wind units has increased, primarily in the less than 1-kW turbine size segment

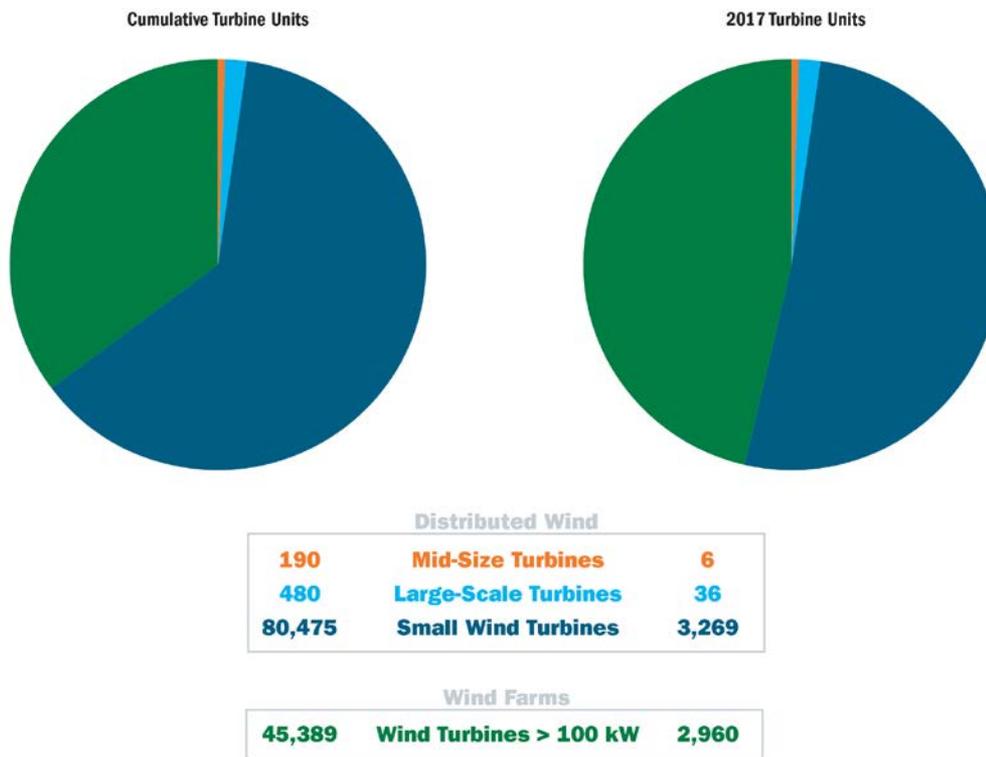


The demand for remote power, mainly provided by the smaller, off-grid wind turbine units, is less sensitive to market conditions.

U.S. small wind sales capacity by turbine size

Distributed Wind Markets

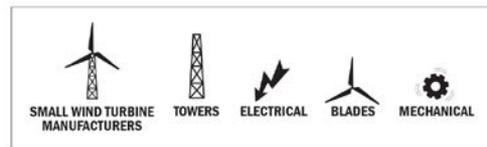
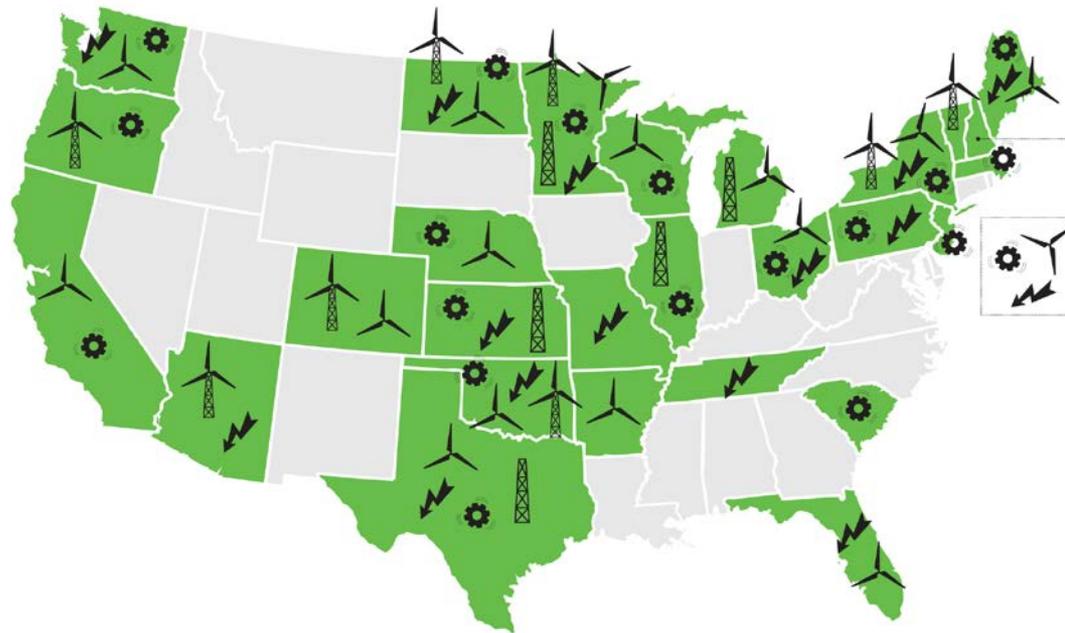
Wind turbines in distributed applications account for 64% of all wind turbines deployed in the United States, driven by the smaller units typically used off-grid



Cumulative (2003-2017) and 2017 wind farm and distributed wind turbine units

Small Wind Manufacturing

U.S. small wind manufacturers and their supply chain vendors are located in at least 27 states



States with small wind manufacturing

Outlook

- Year to year, distributed wind deployments by turbine size and customer type vary significantly
- After a steady decline in small wind deployment since a peak in 2012, reinstatement of federal tax credits could bolster the small wind market in the near term
- The pending expirations of the federal PTC in 2019 and ITC in 2022 will also likely continue to drive the near-term growth of distributed wind projects using large-scale turbines
- To counter the declining domestic small wind market, small wind manufacturers are exploring different opportunities and export markets
- Behind-the-meter projects and projects on the distribution grid using large-scale turbines are becoming more common



Photo Credit: Patsy McEnroe Photography

For More Information

See full report for additional findings and details:

<https://www.energy.gov/eere/wind/downloads/2017-distributed-wind-market-report>

To contact primary author:

Alice Orrell, PNNL

509-372-4632

alice.orrell@pnnl.gov

PNNL is operated by BATTELLE for the UNITED STATES
DEPARTMENT OF ENERGY under Contract DE-AC05-76RL01830