Pacific Northwest
NATIONAL LABORATORY

2019 Distributed Wind Data Summary

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This 10-kW Bergey Excel wind turbine replaced a 20-kW wind turbine on a lattice tower at a residence in Massachusetts.
Photo Credit: Gary Harcourt / Great Rock Windpower

2019 Distributed Wind Data Summary

- What is Distributed Wind?
  - Wind technology, of any size, can be a distributed energy resource.
  - Distributed wind systems are often used to generate electricity for remote communities or offset a portion of energy costs for grid-connected customers.
  - As a result, distributed wind systems can be part of an isolated grid or a grid-connected microgrid, or can be connected on the distribution side of a grid system as either behind-the-meter for self-consumption or on the distribution grid to serve local loads.
- Purpose, Scope, and Data
  - Summarizes publicly available U.S. distributed wind annual data.
  - Analyzes distributed wind projects of all sizes.
  - Provides DOE-funded data that is separate from land-based and offshore wind.
  - Includes data from turbine manufacturers, project installers, state agencies, American Wind Energy Association (AWEA), U.S. Energy Information Administration, Federal Aviation Administration, U.S. Department of Agriculture (USDA), U.S. Treasury, U.S. Wind Turbine Database, and others.

Key Findings

- 18 MW of new distributed wind capacity in 2019 was added in 17 states, representing 2,166 turbine units and $67 million in investment.
  - From Pennsylvania to California, distributed wind systems were installed to serve agricultural, commercial, government, industrial, institutional, residential, and utility customers.
  - As in 2018, most installed capacity was for utility and industrial customers.
- Of the 18 MW, 16.6 MW was from distributed wind projects using turbines with a capacity rating greater than 100 kW.
- A total of 1.4 MW was from small wind—projects using turbines rated up through 100 kW.
  - Much of the new small wind capacity installed in 2019 came from retrofit projects.
  - New turbines are being installed on existing towers and foundations to replace nonfunctioning turbines or to upgrade the technology.
- Cumulative U.S. distributed wind installed capacity is just over 1.1 GW.

Content Summary

- Capacity Additions
- Sales and Exports
- Incentives
- Small Wind Certification
- Installed Costs
- Levelized Cost of Energy and Performance Capacity Factors
- Customers
- Technology Trends
- Turbines
- Summary

This 1.85-MW GE wind turbine powers an industrial vineyard operation in California.
Photo Credit: Foundation Windpower

U.S. Distributed Wind Capacity Additions

- In 2019, cumulative distributed wind capacity reached 1,145 MW from over 85,000 wind turbines across all 50 states, Puerto Rico, the U.S. Virgin Islands, and Guam.
- The 18 MW of capacity additions in 2019 represents $67 million in investment.
  - 15.7 MW came from projects using large-scale turbines (greater than 1 MW in size).
  - 900 kW came from projects using mid-size turbines (101 kW – 1 MW in size).
  - 1.4 MW came from projects using small wind turbines (up through 100 kW in size).

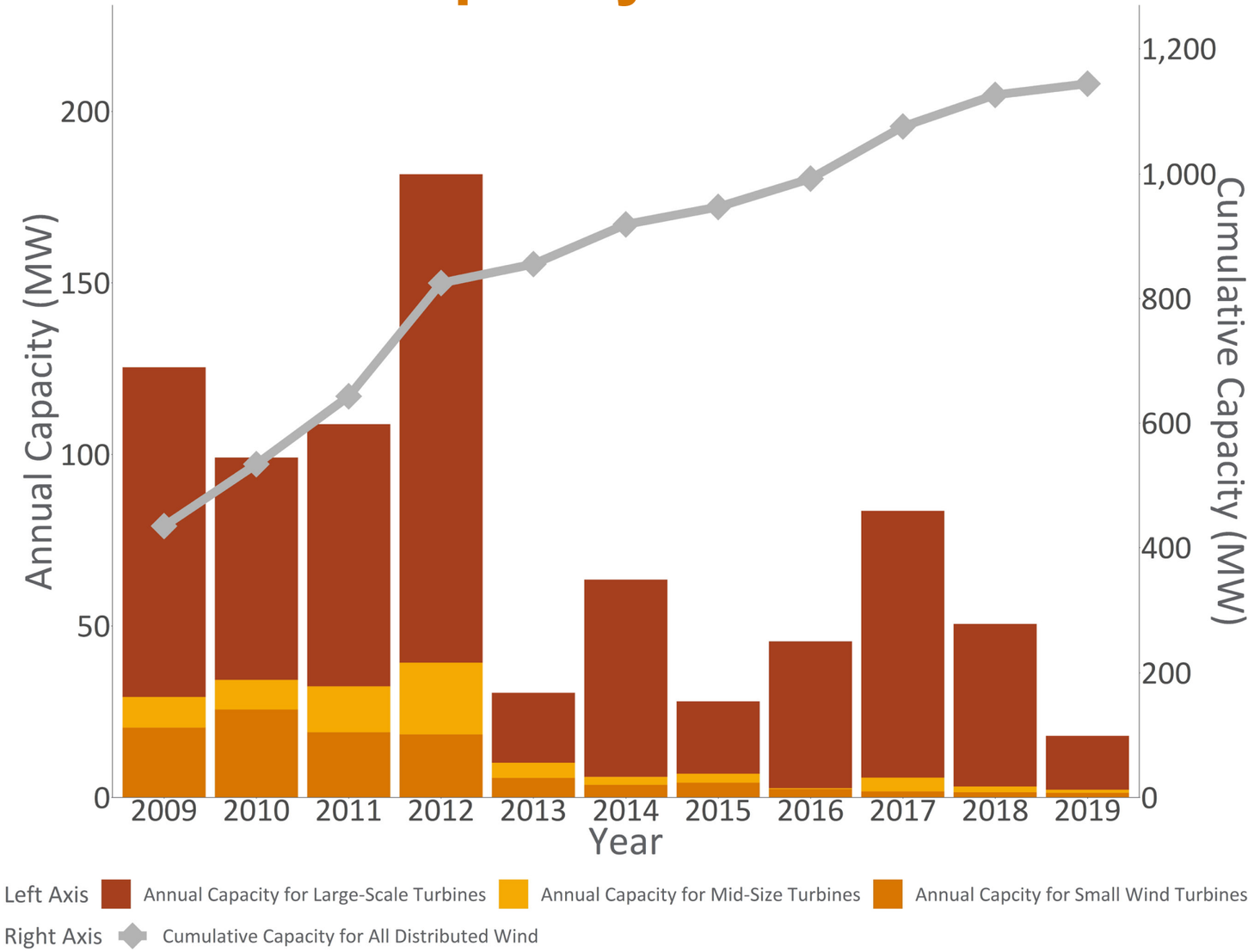

Figure 1: U.S. distributed wind capacity

U.S. Distributed Wind Capacity Additions

- In 2019, new distributed wind projects were documented in 17 states.
- Ohio led the United States in new distributed wind power capacity in 2019 as a result of large-scale turbine projects installed by One Energy Enterprise LLC.

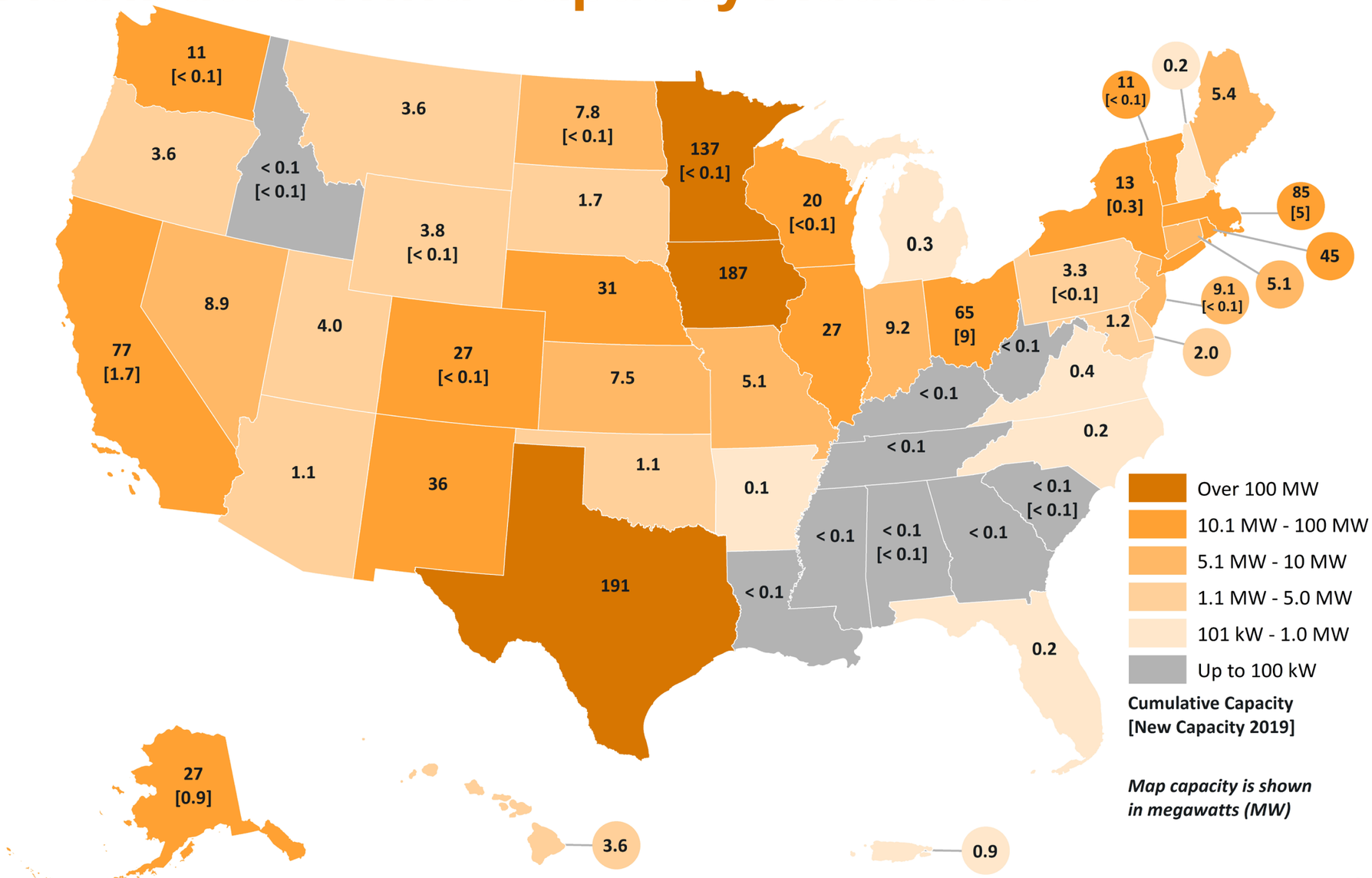

Figure 2: U.S. cumulative (2003–2019) capacity and 2019 capacity additions for distributed wind by state

U.S. Distributed Wind Sales: Turbines Greater than 100 kW

- Goldwind wind turbines accounted for 84% of the 2019 capacity additions as a result of being used in three out of the five 2019 projects using **turbines greater than 100 kW** .
- Goldwind and GE Energy wind turbines have had the most consistent sales presence in recent years, but small project sample sizes means manufacturer representation can vary year to year.

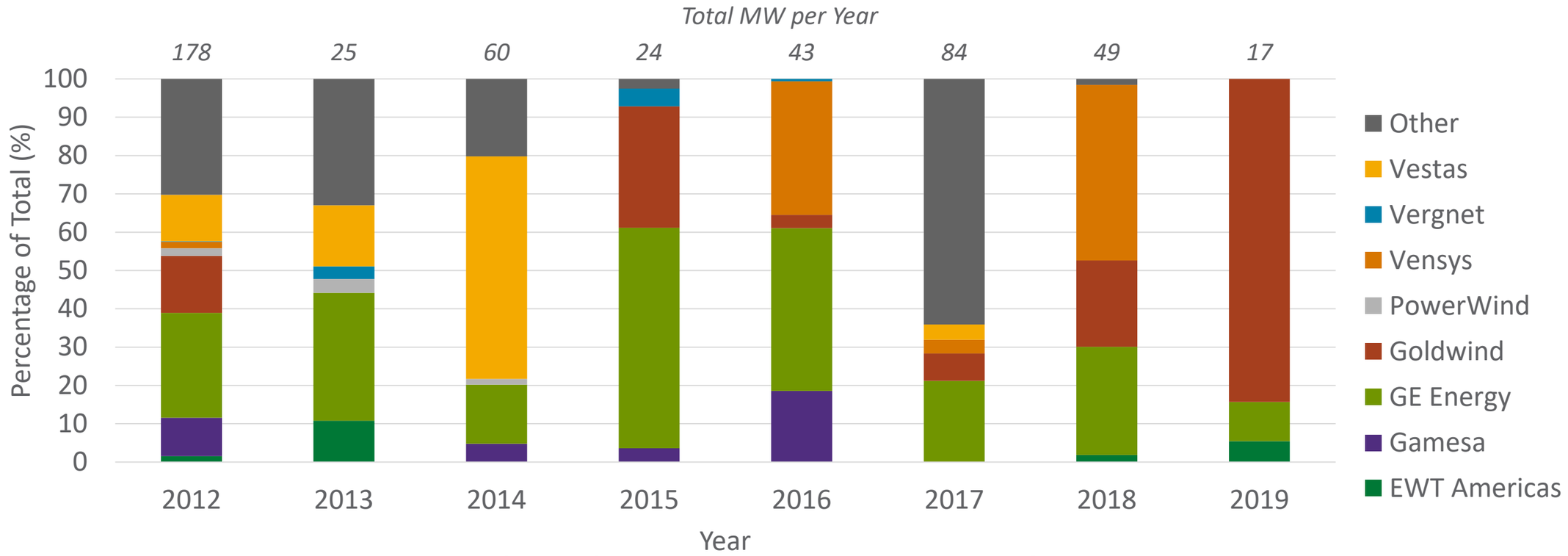

Figure 3: Wind turbine manufacturers for turbines greater than 100 kW with a United States sales presence, 2012-2019

U.S. Distributed Wind Sales: Small Wind

- U.S.-based **small wind** manufacturers accounted for 92% of the 2019 U.S. domestic small wind sales capacity.

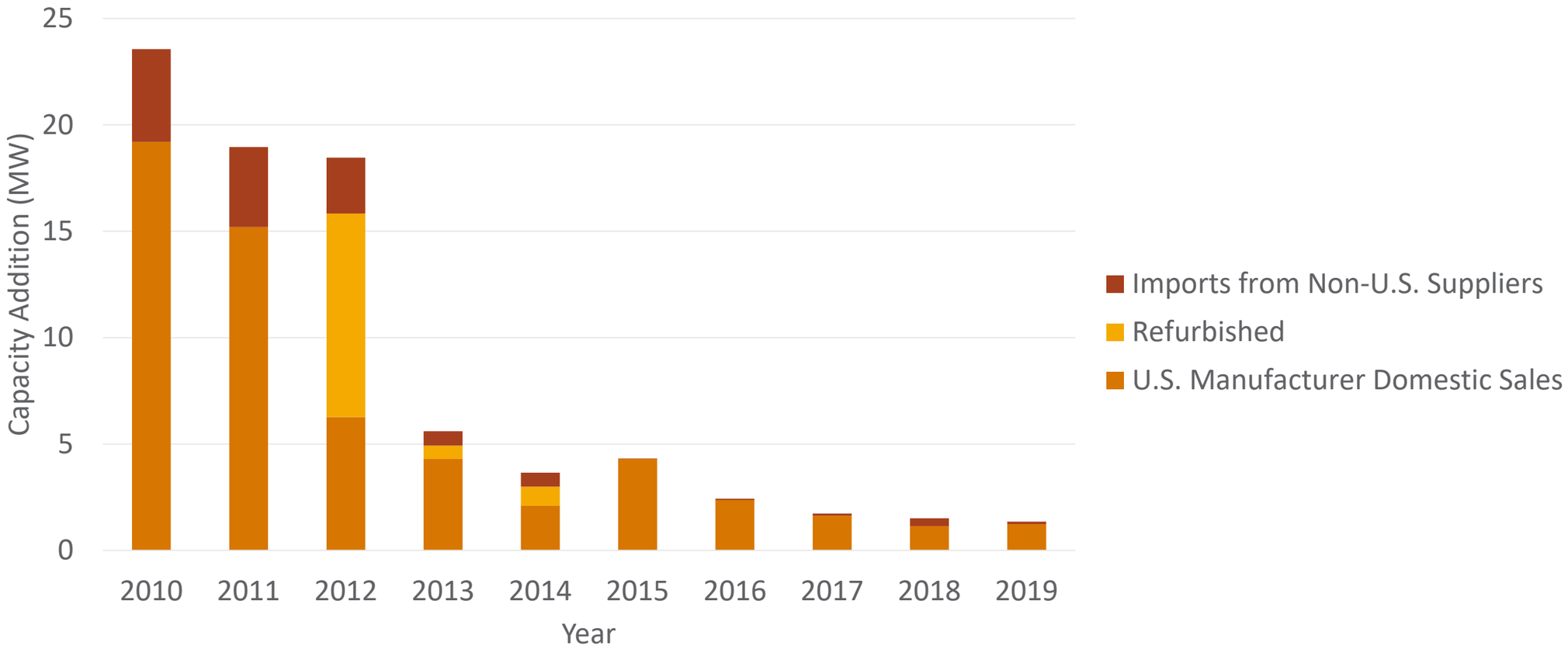

Figure 4: U.S. small wind turbine sales, 2010–2019

U.S. Small Wind Exports

- Italy, the United Kingdom, and Japan had been key export markets for U.S. **small wind** turbine manufacturers due to those countries' feed-in tariff programs that are now reduced or discontinued.

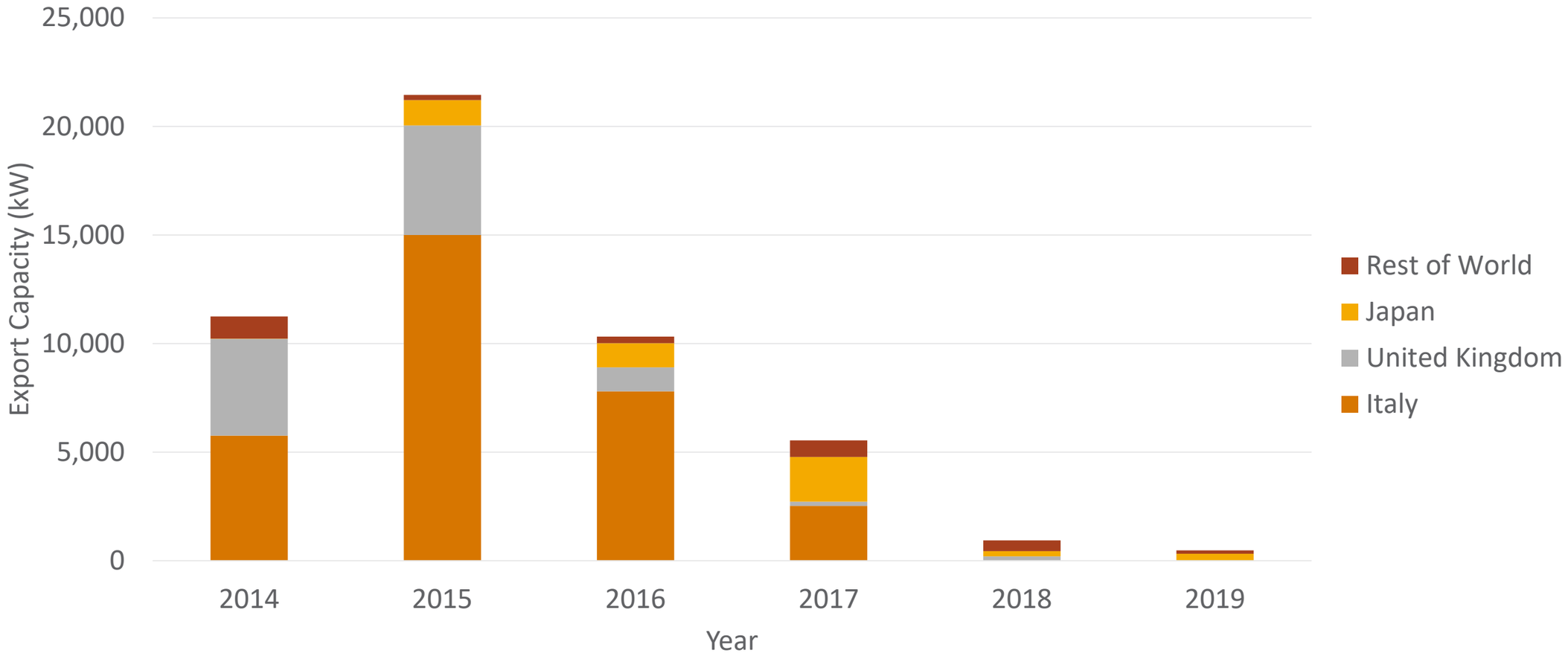

Figure 5: U.S. small wind turbine exports, 2014–2019

U.S. Distributed Wind Incentives in 2019

- The combined value of state rebates, production-based incentives, and production tax credits (PTC); and U.S. Department of Agriculture Rural Energy for America Program (USDA REAP) grants given to distributed wind projects in 2019 was just over $7 million.

Table 1: 2019 U.S. distributed wind incentive awards

State	Award Source	Award(s) Value ($)	# of Awards
California	State Rebate Program	750,000	1
Iowa	State PTC Program	3,860,429*	55
New Mexico	State PTC Program	1,278,150*	3
New York	State Rebate Program	999,279	23
New York	USDA REAP	111,250	1
Minnesota	USDA REAP	15,947	1
Vermont	USDA REAP	44,035	1
Washington	USDA REAP	16,844	1

*Estimated

U.S. Distributed Wind Incentives: USDA REAP Wind Grants, 2009-2019

- USDA REAP wind grants have decreased significantly since a peak in 2010, while grants to solar PV projects have increased.

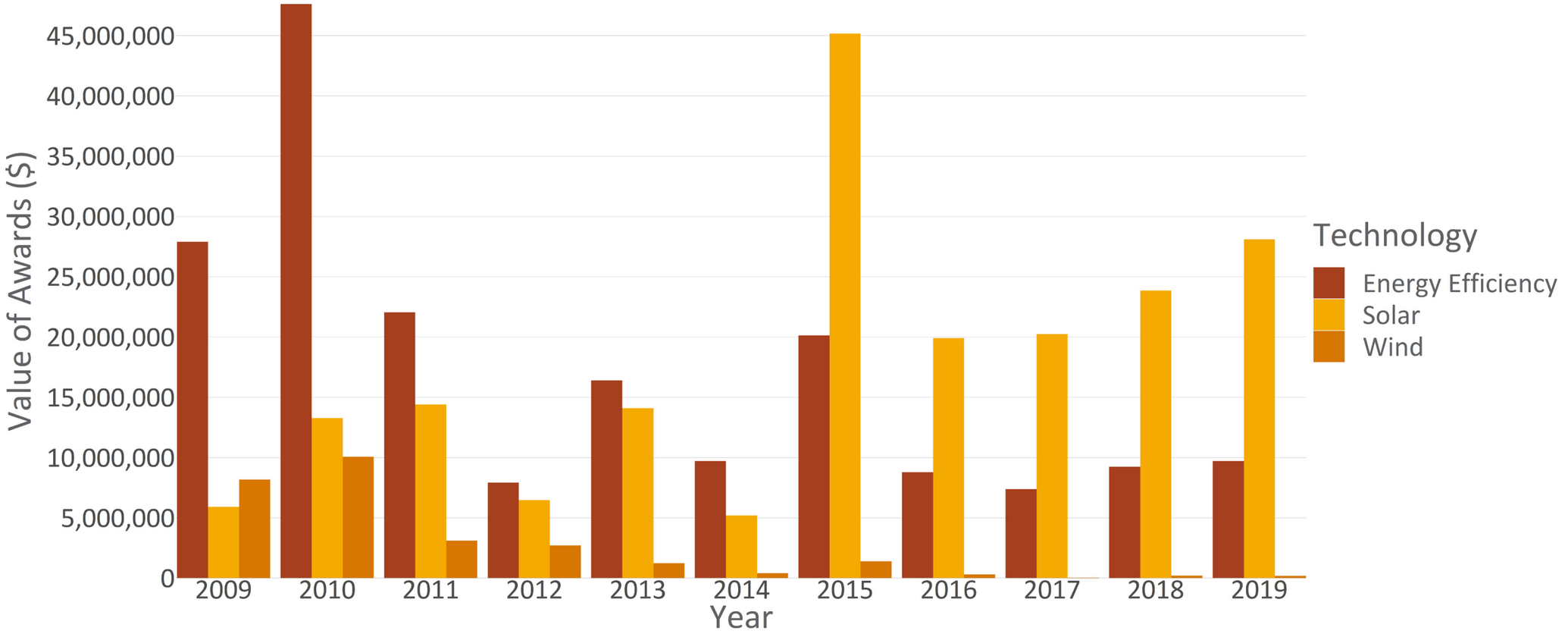

Figure 6: USDA REAP Grants by Technology, 2009-2019

Small Wind Certification

- Nine **small wind** turbines are currently certified to AWEA 9.1-2009 or IEC 61400-1, -2, and -11 standards.

Table 2: Certified Small Wind Turbines

Applicant	Turbine	Date of Initial Certification	Certified Power Rating[a] @ 11 m/s (kW)	Certification Standard
Bergey WindPower	Excel 10[b]	11/16/2011	8.9	AWEA
Bergey WindPower	Excel 15[b]	6/2/2019[1] (partial)	15.6	AWEA
Bestwatt B.V.	Bestwind 30[b]	1/13/2017[2]	27.2	AWEA
Eveready Diversified Products (Pty) Ltd.	Kestrel e400nb[b]	2/14/2013[3] (renewed)	2.5	AWEA
Eocycle Technologies, Inc.	EO20/E025[c]	3/21/2017	22.5/28.9	AWEA
HI-VAWT Technology Corporation / Colite Technologies	DS3000[b]	5/10/2019	1.4	AWEA
Primus Wind Power	AIR 30/AIR X[d]	1/25/2019	0.16	IEC
Primus Wind Power	AIR 40/Air Breeze[d]	2/20/2018	0.16	IEC
SD Wind Energy, Ltd.	SD6[b]	6/17/2019	5.2	AWEA

a 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).
b Certified by International Code Council-Small Wind Certification Council (ICC-SWCC).
c Certified by SGS.
d Certified by DEWI-OCC (now part of UL).
1 The Excel 15 has completed the power performance test and ICC-SWCC has certified those results, but the turbine model must complete the duration test before ICC-SWCC can grant full certification.
2 Bestwatt B.V. was formerly Lely Aircon B.V. and the Bestwind 30 turbine model was formerly the LA30 turbine model.
3 This model's certification was renewed with ICC-SWCC in 2020.

U.S. Distributed Wind Installed Costs: Small Wind

- Annual average capacity-weighted installed costs for **small wind** projects range from around $5,000 to $15,000 per kW with the 2019 capacity-weighted average cost around $8,300 per kW. The small sample sizes and high variance in project-specific costs both contribute to this wide cost range. The majority of 2019 small wind reported projects were retrofits, but reported installed costs here only include new, full projects.

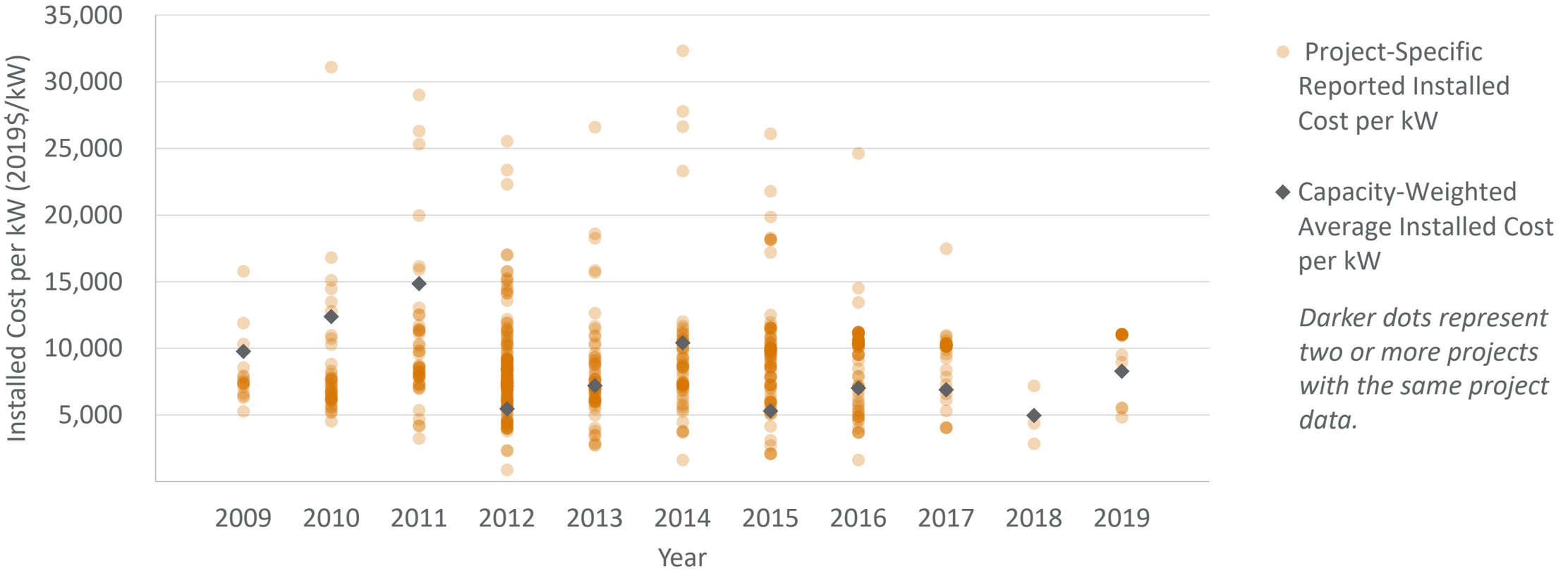

Figure 7: Average small wind installed project costs, 2009-2019

U.S. Distributed Wind Installed Costs: Turbines Greater than 100 kW

- Annual average capacity-weighted installed costs for projects using **turbines greater than 100 kW** range from around $2,000 to $5,000 per kW with the 2019 capacity-weighted average cost around $2,900 per kW. The small sample sizes and high variance in project-specific costs both contribute to this wide cost range, although the range is smaller than it is for small wind.

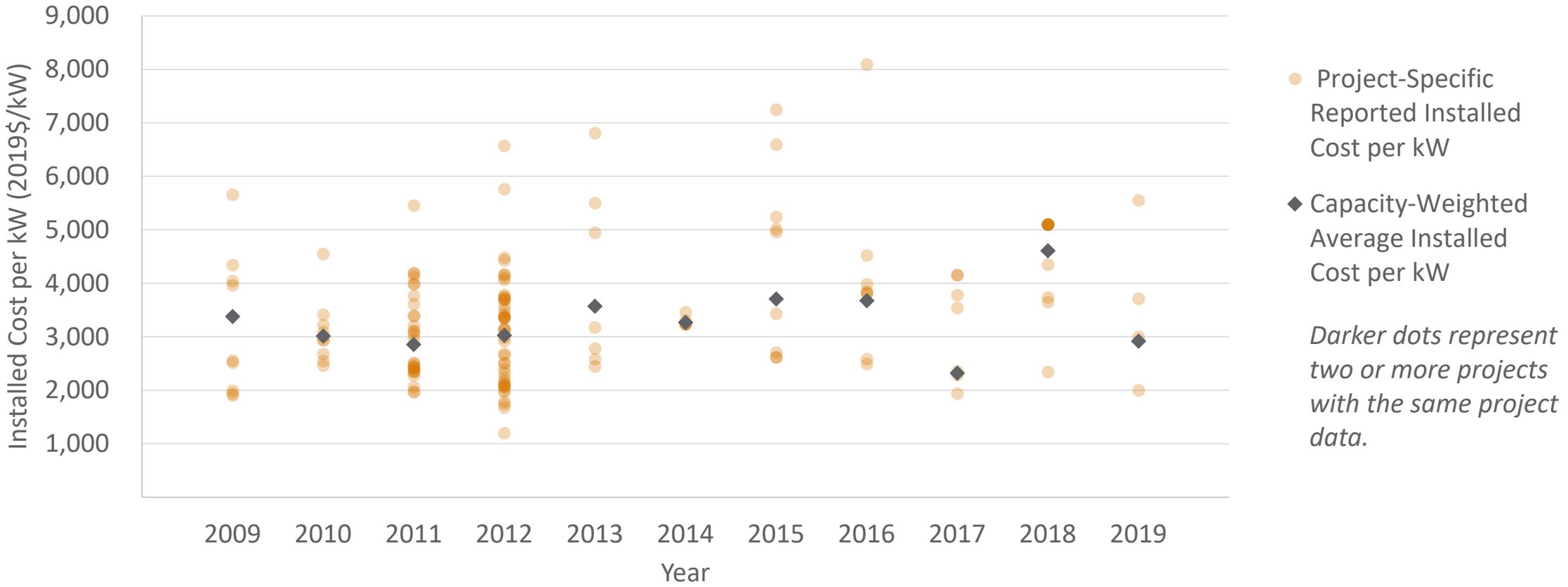

Figure 8: Average installed costs for projects using turbines greater than 100 kW, 2009-2019

Levelized Cost of Energy and Performance

- In general, the higher the project's capacity factor, the lower the LCOE. Large-scale turbine projects tracked for this report are more likely to have both higher capacity factors and lower LCOEs.

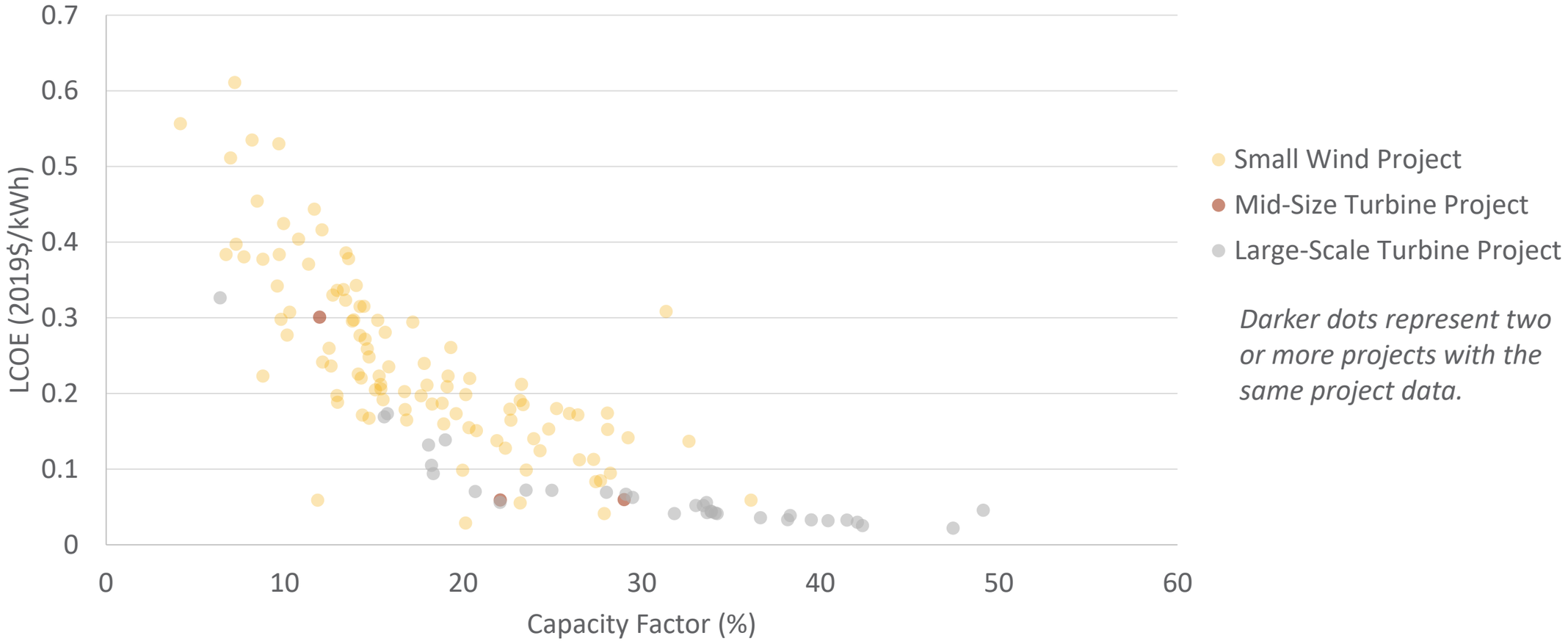

Figure 9: Levelized costs of energy (after incentives) and capacity factors

U.S. Distributed Wind Customers

- Agricultural and residential end-use customers have consistently represented most of the distributed wind installations by *number of projects.*

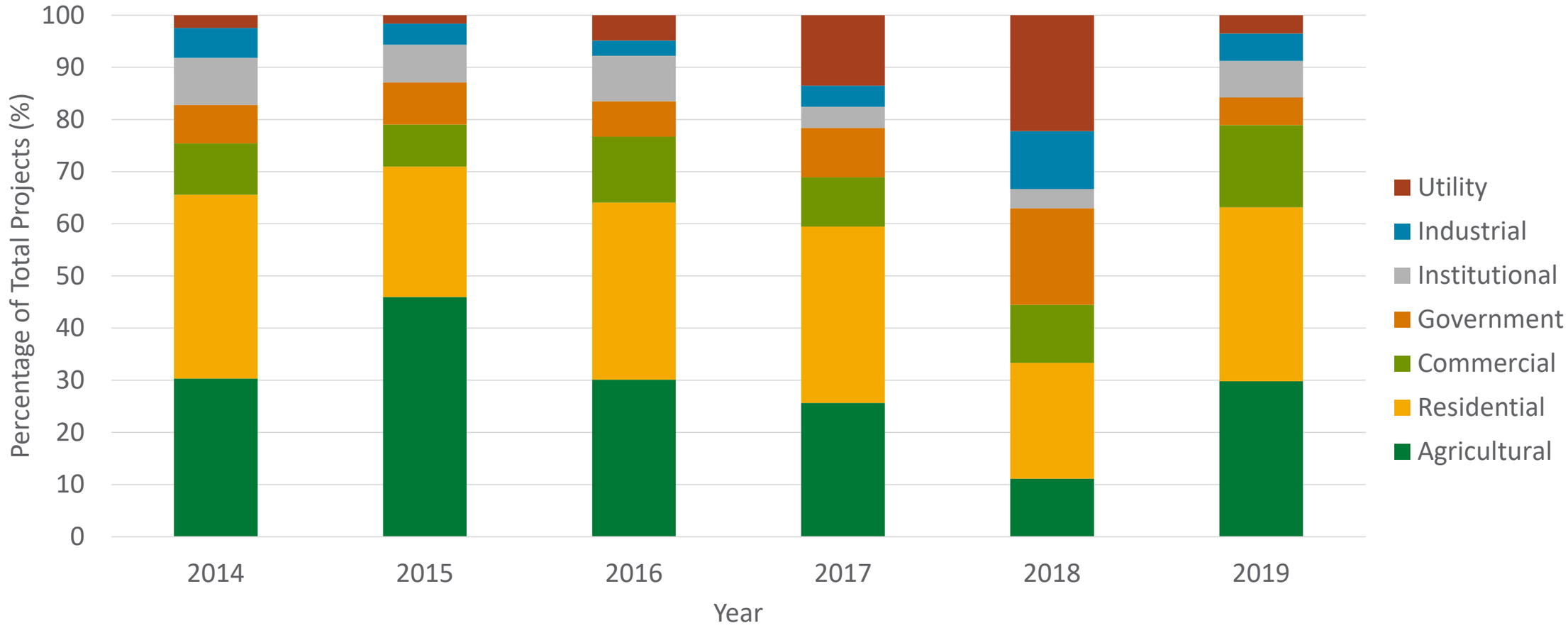

Figure 10: Distributed wind end-use customers by number of projects, 2014-2019

U.S. Distributed Wind Customers

- Utility and industrial end-use customers represent a fewer number of projects, but account for a majority of megawatts of *capacity* installed.

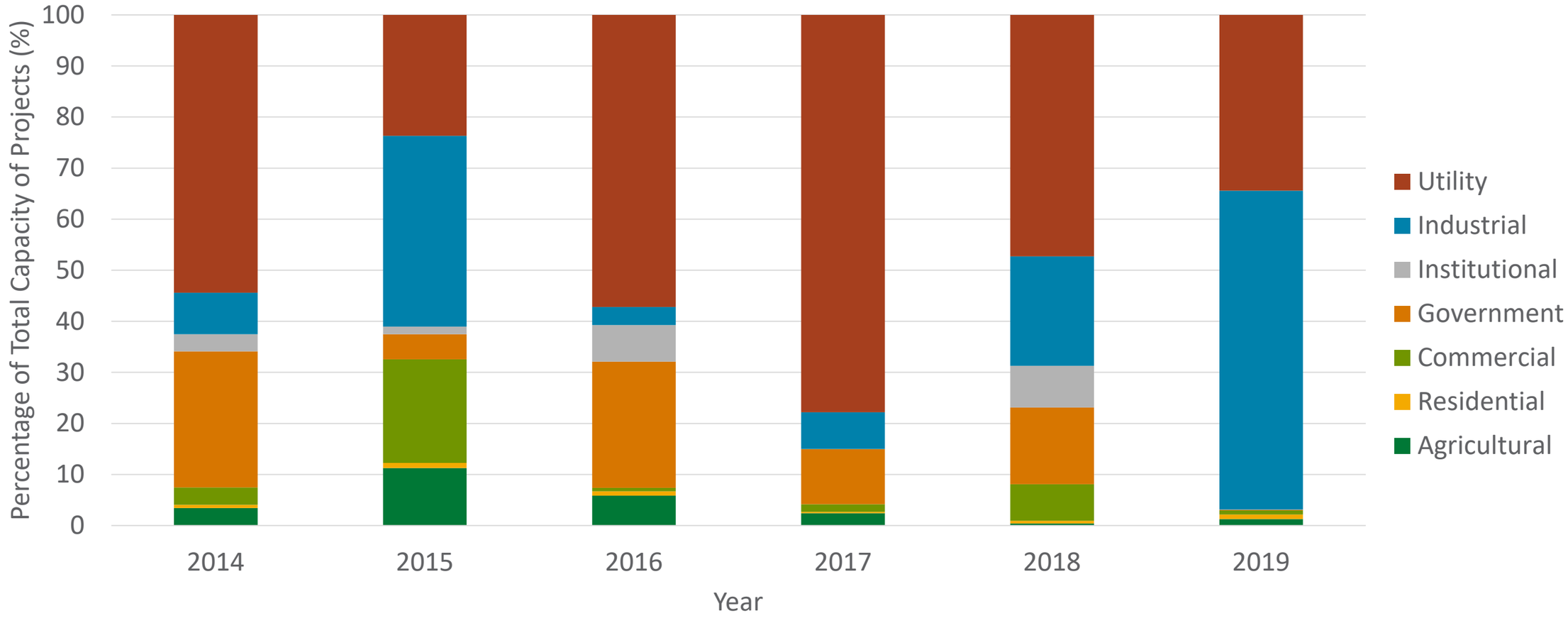

Figure 11: Distributed wind end-use customers by capacity of projects, 2014-2019

U.S. Distributed Wind Technology Trends

- Based on data collection results, U.S. industry stakeholders indicate an increasing customer interest in using microgrids and hybrid energy systems to provide resilient and secure energy.
- DOE WETO investments reflect this trend as well. Through DOE's Competitiveness Improvement Project and the Wind Innovations for Rural Economic Development initiative, the distributed wind industry and its stakeholders are exploring new products and solutions and researching how to better integrate distributed wind into microgrids and distribution systems with other distributed energy resources such as solar photovoltaics and battery storage.

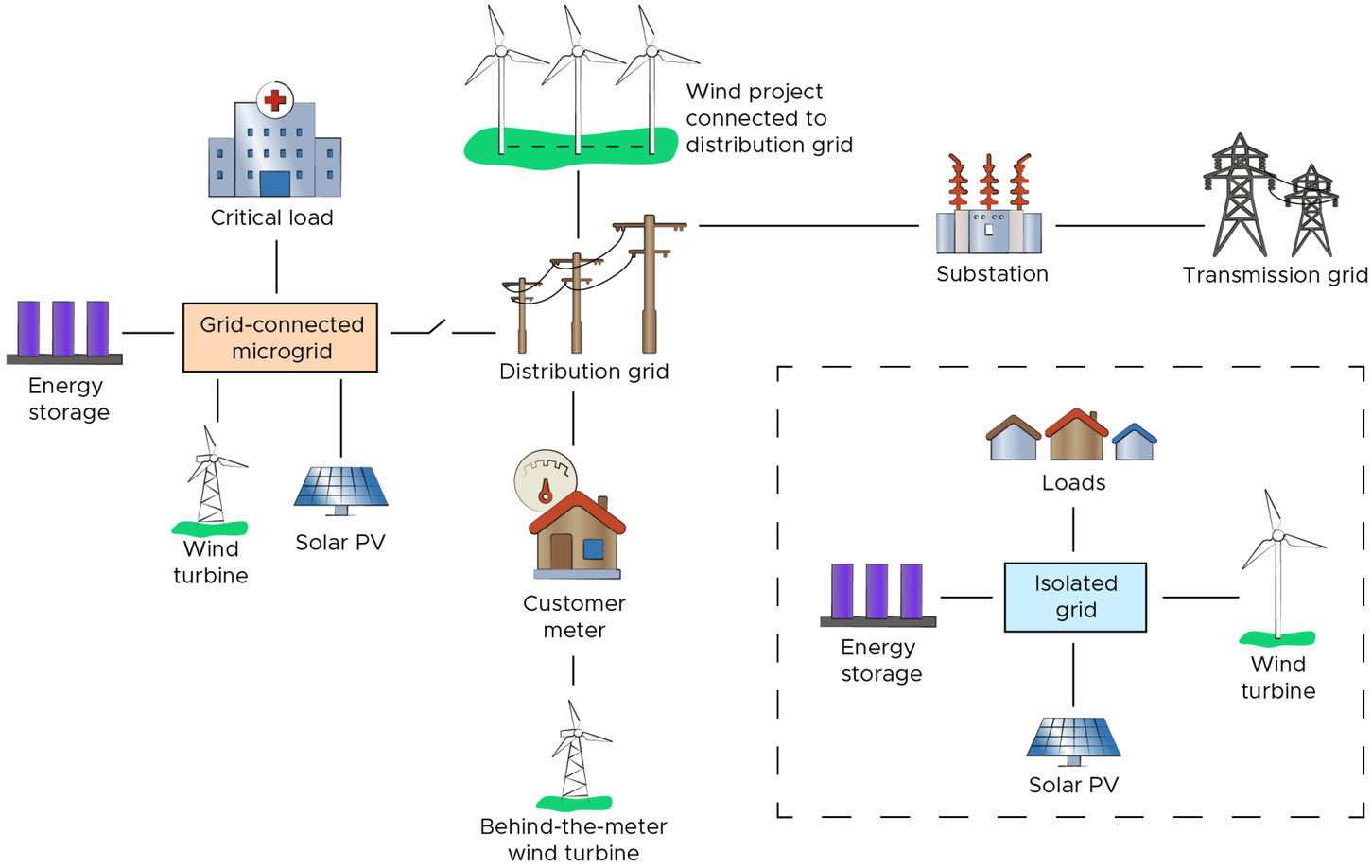

Figure 12: Wind turbines in distributed applications

U.S. Distributed Wind Turbines: Turbines Greater than 100 kW

- As more customers use higher capacity large-scale turbines, the average nameplate capacity of **turbines greater than 100 kW** in distributed wind projects has increased. Most distributed wind projects are single turbine projects, so a significant variation between average project size and average turbine size in a given year indicates that the dataset sample includes multi-turbine projects.

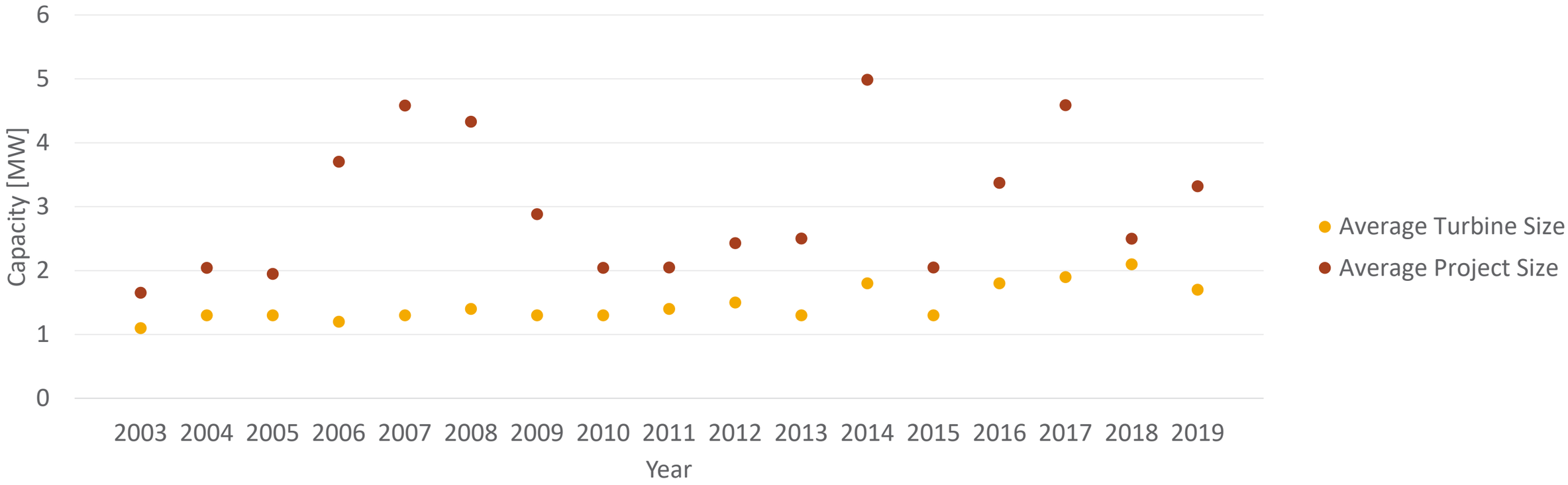

Figure 13: Average size of turbines greater than 100 kW in distributed wind projects and average size of those projects, 2003–2019

U.S. Distributed Wind Turbines: Small Wind

- Annual **small wind** capacity additions continue to decline, driven by a decrease in sales of turbines rated 1 to 100 kW in size.

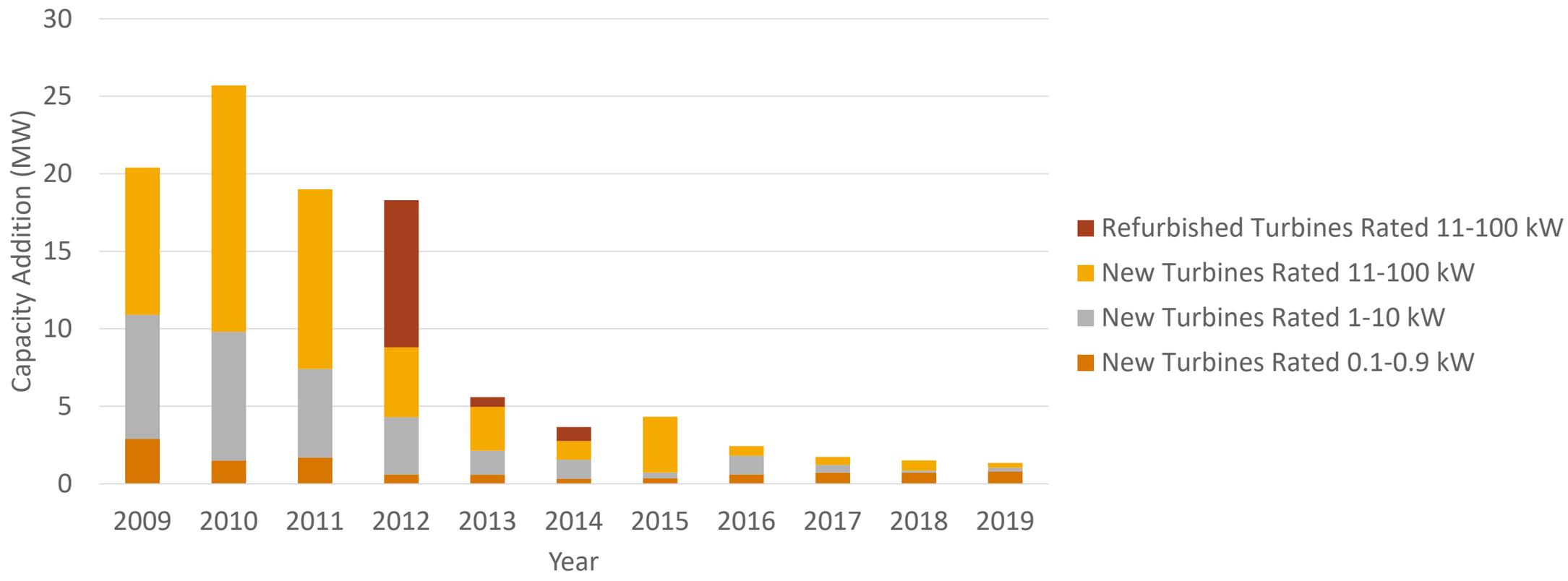

Figure 14: U.S. small wind sales capacity by turbine size, 2009-2019

U.S. Distributed Wind Turbines: Small Wind

- While annual sales capacity for turbines sized **less than 1-kW** has remained relatively steady for the past ten years, it has contributed an increasingly large percentage of total sales capacity for small wind as the sales capacity of turbines sized 1-100 kW has declined.

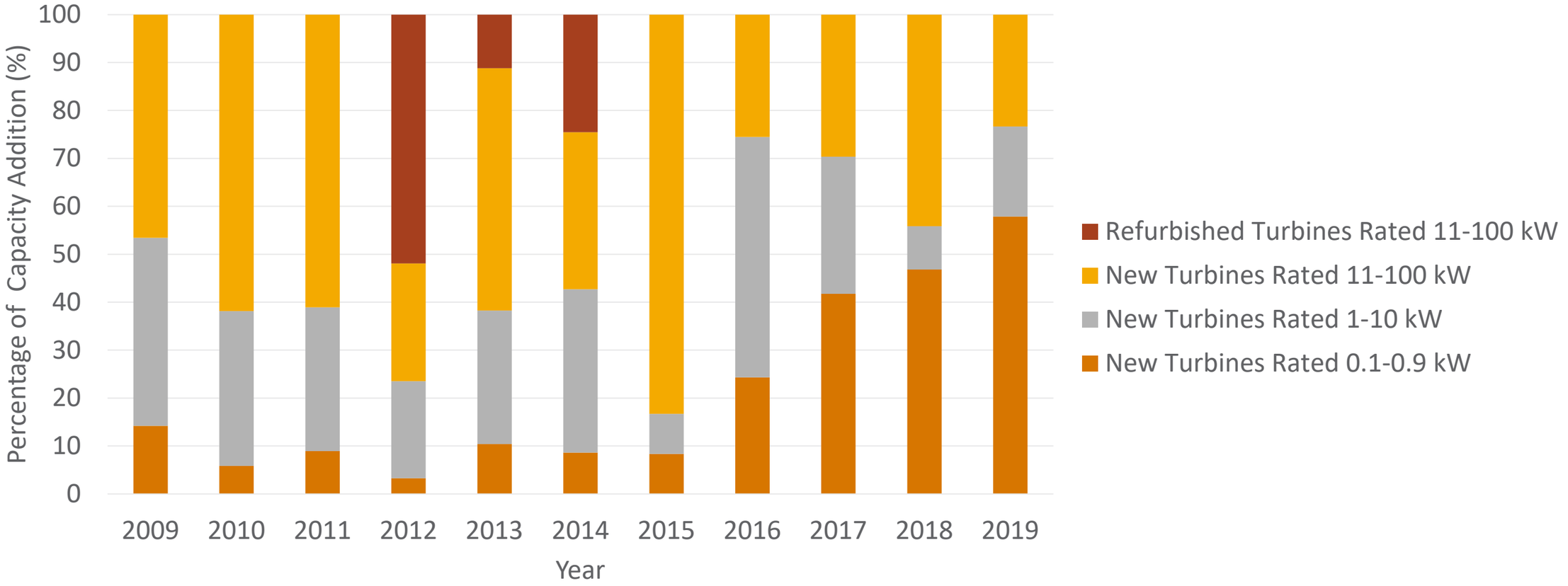

Figure 15: U.S. small wind sales percentage of capacity by turbine size, 2009-2019

Summary

As evidenced by the 2019 data and industry responses collected and analyzed for this summary:

- 2019 distributed wind capacity additions were lower than previous years.
- More customers are becoming interested in microgrid and hybrid solutions that may combine wind, solar photovoltaics, and battery storage.
- Large-scale wind turbines continue to account for most of the distributed wind capacity additions, while small wind sales continue to decline.
- As more, older small wind turbines age, and customers remain committed to wind as their distributed energy resource, reports of retrofits may continue in the future.

A maintenance provider servicing a 20-kW Jacobs 31-20 wind turbine on a farm.
Photo Credit: Roger Dixon / Skylands Renewable Energy LLC

For More Information

- Download the PNNL distributed wind project data set: https://wind.pnnl.gov/dw_download/logon.aspx

- Visit the PNNL photo gallery: https://epe.pnnl.gov/research_areas/distributed_wind/photos2.stm

- Contact primary author:

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