Is Distributed Wind Right for My Local Government Facilities?

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Pacific Northwest National Laboratory

NREL National Renewable Energy Laboratory

Distributed Wind Topics & Resources

The following slides provide an overview of distributed wind technologies, benefits, applications, and considerations so that community leaders can take the first steps to investigate whether distributed wind is right for them.

David Nevala

For more information, please visit the Distributed Wind Resource Hub.

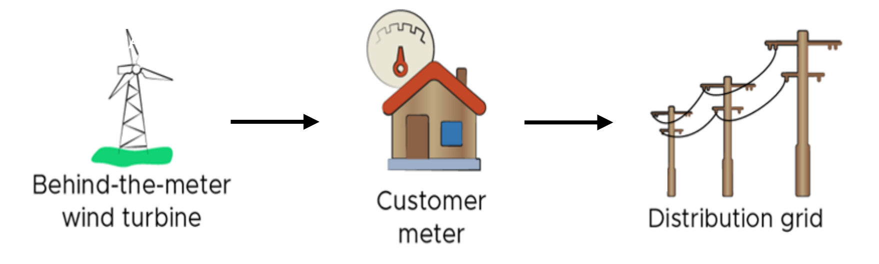
Topics Covered:

- Introduction to distributed wind energy
- Distributed wind benefits and characteristics
- Local government applications of distributed wind
- Sizes and designs of wind turbines
- Is there enough wind in my jurisdiction?
- Siting considerations
- Environmental considerations
- Permitting and zoning
- Construction considerations
- Distributed wind costs and funding opportunities

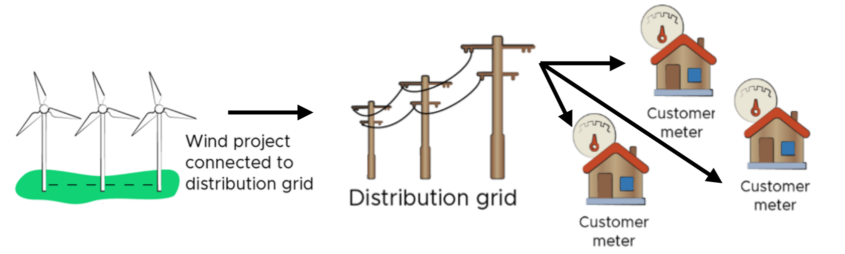
Introduction to Distributed Wind Energy

- **Distributed wind energy** is connected at the distribution level of an electricity delivery system (or in off-grid applications) to serve on-site energy demands or local loads on the same distribution system.

- Most distributed wind projects for local governments are **behind-the-meter** installations for on-site electricity consumption. Excess generation may go back to the grid through net metering or other billing mechanisms.



- Some distributed wind projects for local governments are **front-of-the-meter**, where wind is connected to a distribution grid that serves loads interconnected to it.



- A wind energy **power purchase agreement** is a long-term (several years to decades) contract between the owner of a wind energy project and a customer aiming to offset their energy load (typically a utility, government, or company). Throughout the duration of the contract, the power purchaser buys wind energy at a pre-negotiated price.

- The [American Cities Climate Challenge Procurement Guide] details considerations and steps involved for local governments to procure different types of renewable energy, including on-site projects, community projects, and power purchase agreements.

Distributed Wind Benefits

Local governments use distributed wind energy to:

- Offset retail electricity costs
- Support local loads and grid operations
- Provide energy security and resilience
- Meet renewable energy goals and mandates
- Fix or lower electric costs through long-term power purchase agreements in addition to or as an alternative to net metering

Key benefits of distributed wind energy include:

- Clean energy generation
- Small land-use footprint that enables land co-use
- Support of more reliable and resilient grids by providing backup sources of power during grid outages
- Development of American jobs, economic benefits, and supply chains
- Educational opportunities
- Promotional value – a wind turbine has high visibility and sends the message of commitment to clean energy


The Southeast Wyoming Welcome Center wind turbines are visible from the highway and have educational signs and monitoring displays.

PNNL

Local Government Applications of Distributed Wind

Central Maui Landfill and Recycling Center, Hawaii

Three Bergey Excel 10 wind turbines offset 66-90% of energy consumption, saving the landfill and recycling facility approximately $18,000 annually.

St. Mary's Community Wind Turbine, Alaska

To reduce dependency on expensive diesel, the isolated native community of St. Mary's installed one 900-kW EWT wind turbine to produce 50% of their energy needs.

Local Government Applications of Distributed Wind

Hometown WindPower, Minnesota

Minnesota Municipal Power Agency

In 13 cities throughout Minnesota, 160-kW wind turbines were deployed to provide community power generation and advertise local commitment to the environment and clean energy.

Field’s Point Wastewater Plant, Rhode Island

Mary Murphy

Three 1.5-MW wind turbines were installed to provide power for Narragansett Bay Commission’s Field’s Point Wastewater Treatment Plant.

Local Government Applications of Distributed Wind

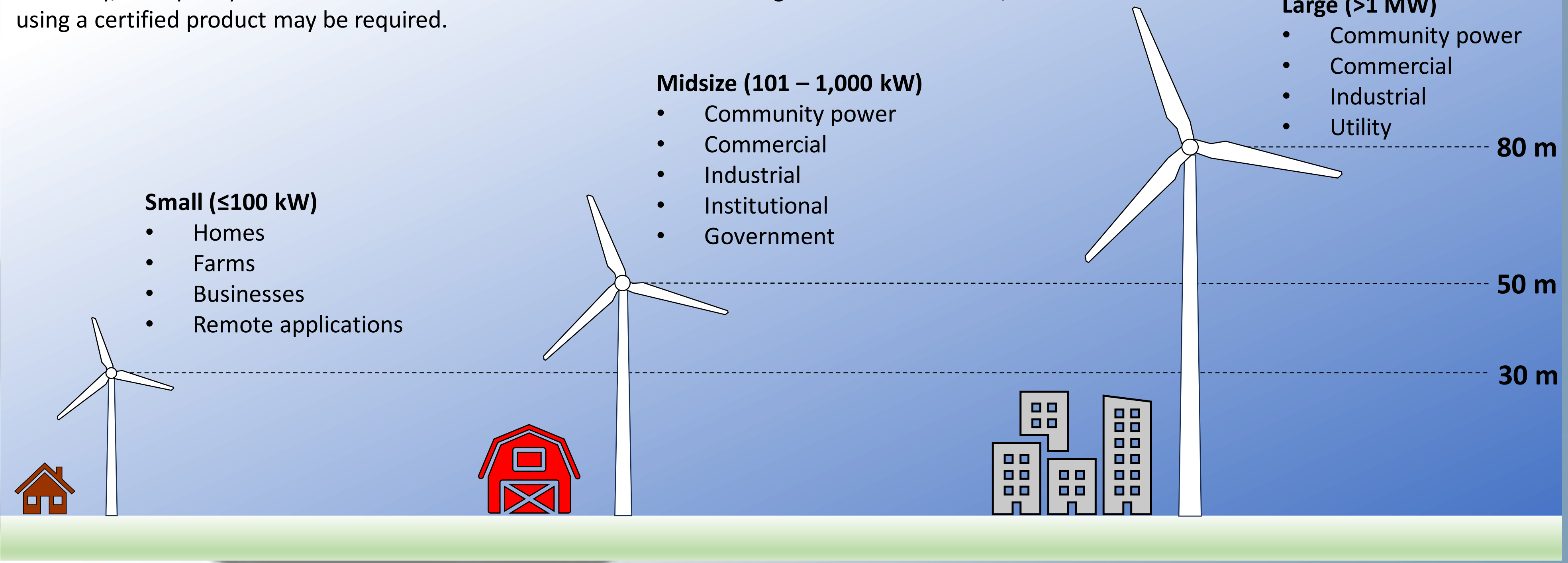
One 1.7-MW wind turbine was installed at the Salinas Valley State Prison to decrease energy costs and to help California meet its goals for reducing greenhouse gas emissions.

A 10-kW wind turbine was recently repowered to 15-kW to provide even more energy to the Amagansett Fire Department on Long Island.

Sizes and Designs of Wind Turbines

Distributed wind projects owned by local governments can incorporate **small (≤100 kW), midsize (101 – 1,000 kW), or large (>1 MW)** wind turbines, depending on their energy needs. Horizontal axis wind turbines with three blades are the dominant configuration in the wind energy marketplace.

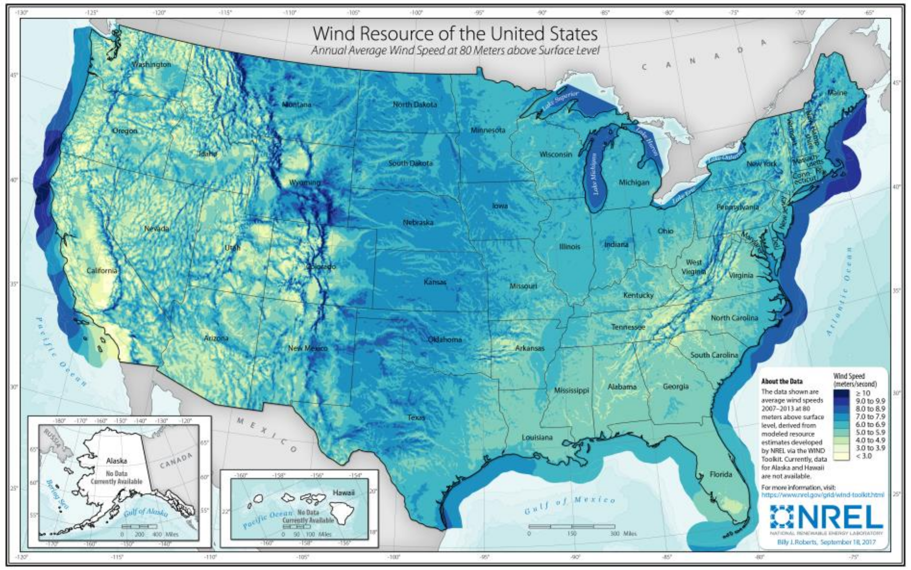
Choosing a [certified wind turbine] is recommended, as certification provides consumer protection and allows turbine manufacturers to demonstrate that the turbine model meets performance, durability, and quality standards. In order to access tax credits for installing a small wind turbine, using a certified product may be required.



Is There Enough Wind in My Jurisdiction?

Rule of thumb minimum annual average wind speed for wind energy project feasibility

Height above ground	Minimum annual average wind speed	Typical turbine sizes associated with this hub height
30 m	4.0 m/s	Small (≤100 kW)
80 m	6.5 m/s	Large (>1 MW)



To assess the wind energy potential at your site:

Begin with initial evaluations of your wind resource using:

- Wind resource maps, including the Wind Exchange maps
- Publicly or commercially available tools, such as the System Advisor Model
- Technical assistance, like through DOE's Energy Improvements in Rural or Remote Areas program
- Nearby meteorological data

Discuss with neighboring communities that already have distributed wind energy deployed in their districts

Consult with wind energy installers/developers to refine wind energy expectations after initial evaluations

Deploying on-site measurements, such as a meteorological tower, lidar, or sodar, during the predevelopment phase may be needed to refine energy expectations

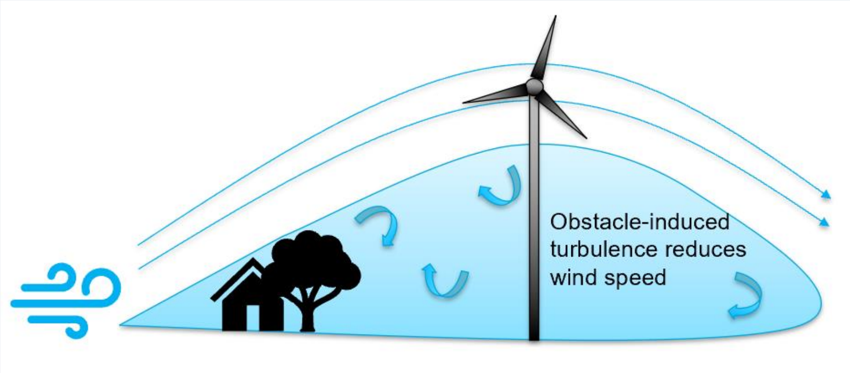
Siting Considerations

Wind energy installers and developers will assist with designing appropriate wind turbine configurations. Through the permitting process (slide 12), local ordinances will provide guidelines on height limits and setbacks from structures and property lines. For educational purposes, some siting considerations include:

- For small-scale distributed wind energy technologies (≤100 kW), a minimum of **1 acre** is typically required to allow for setbacks from neighbors and property lines (to mitigate human environment impacts such as noise, shadow flicker, and ice throw) and from obstacles that could cause turbulence (buildings, trees).

- The lower blade tip of the turbine rotor is recommended to be at least 10 m higher than any obstacles within a 150 m radius.

- Installations involving multiple turbines are typically recommended to be spaced **8-10 rotor diameters in the prevailing wind direction** and 3-5 rotor diameters in the perpendicular direction.



Environmental Considerations

Siting is important to minimize impacts to birds, bats, and other migratory species

- Impacts to animals are primarily through collision and habitat disruption
- Studies have concluded that wildlife impacts are relatively low, especially for smaller projects


Potential impacts at large wind farms will be different than for distributed wind energy projects
Getty Images

Strategies to mitigate wildlife and habitat impacts from wind energy:

- Use the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines to assess potential wildlife impacts prior to project development
- Site turbines away from known concentrations of birds and bats, such as wetlands and caves where bats hibernate


Edgar Figueiredo, Adobe Stock

Permitting and Zoning

Permitting

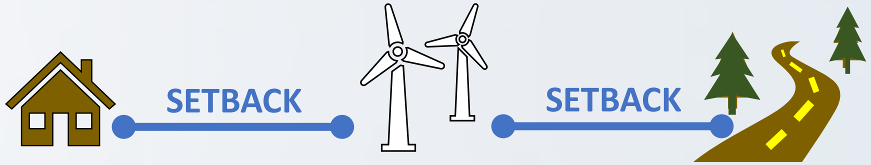
- Permitting refers to obtaining all the permission documents that must be applied for to construct and operate a wind turbine
- Permits can be required by federal, state, and/or local laws and regulations
    - Federal example: Federal Aviation Administration (FAA) Determination of No Hazard to Air Navigation
    - State example: State natural resources office
    - Local example: County or city building permit
- Most small wind turbines will only require local permitting, while larger turbines will require state and federal permitting

For more information on permitting and zoning, visit the Department of Energy WINDExchange

Zoning

- Zoning laws or ordinances dictate how a parcel of land can be used and what operations or activities are allowed on that land
- Local entities (planning commissions, zoning boards, city councils) typically regulate zoning through zoning ordinances
- Local zoning ordinances can have height and setback requirements

Permitting and zoning laws may need to be updated to accommodate distributed wind in your jurisdiction.



Construction Considerations

Site preparation and civil work for a turbine installation may include:

- Installing temporary office trailers, site access roads, crane pads, crane lay-down areas, turning radii, and other civil infrastructure
- Implementing security and access controls to prevent damage or theft of equipment, prevent unauthorized entry to the site, and to protect wildlife from site exposure
- Having stormwater pollution control
- Locating all existing underground utilities before excavation

Construction may require:

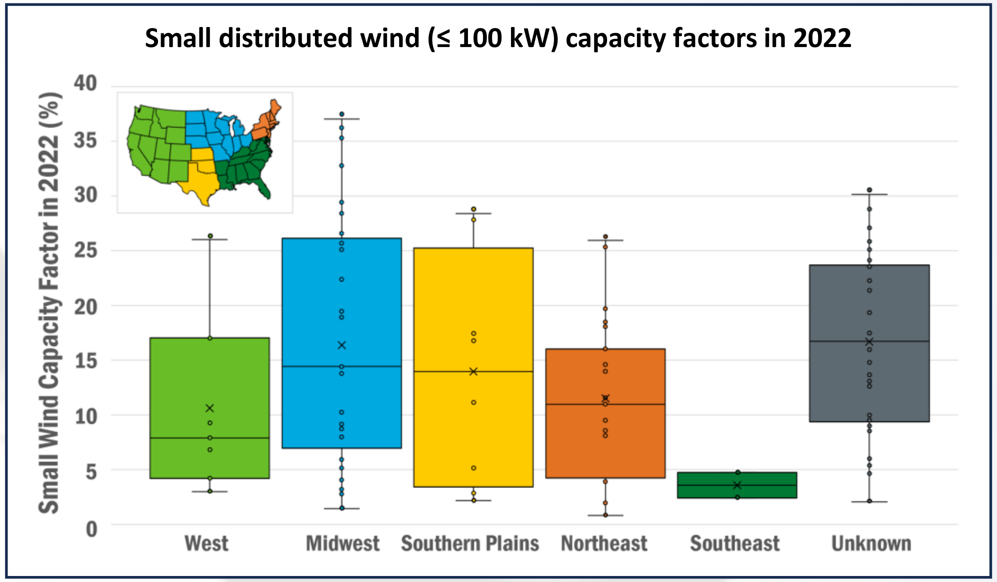
- Heavy equipment such as a crane, boom truck and/or skid steer
- Wait time for a concrete foundation to set

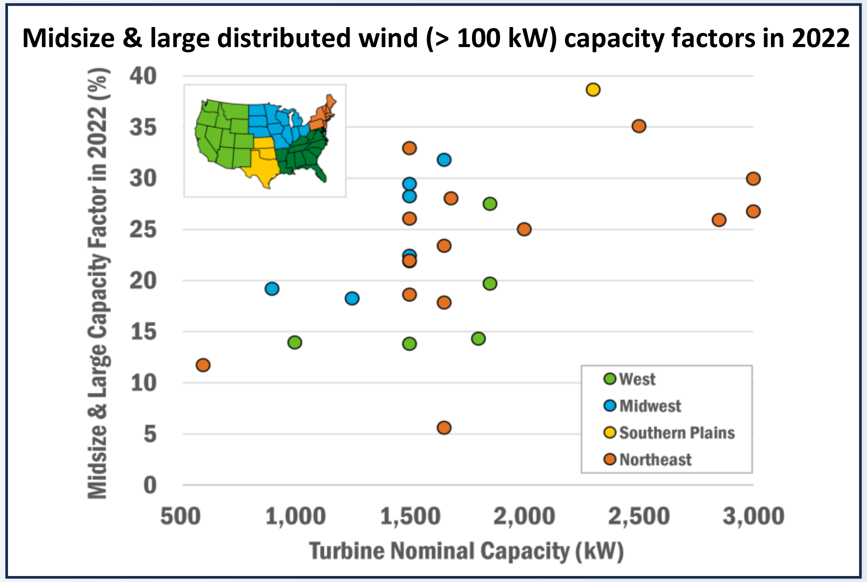
Skylands Renewable Energy LLC

Distributed Wind Performance

- A wind project's **capacity factor** measures how often a power generator is running at maximum power. A power generator with a capacity factor of 100% means that it is producing power all the time.
- Higher capacity factors correspond to higher wind project performance, but they are not expected to approach 100%. Many factors influence a wind project's capacity factor, including the available wind resource and the amount of downtime for planned or unplanned maintenance.
- On average, distributed wind projects using small wind turbines tend to have capacity factors of 10%-20%, while projects using larger turbines tend to have capacity factors of 20%-30%.

The Distributed Wind Market Report: 2023 Edition reported the highest small wind (≤ 100 kW) capacity factors in the Midwest and Southern Plains (left) and the highest midsize and large (> 100 kW) capacity factors in the Midwest, Southern Plains, and Northeast (right).





Distributed Wind Costs

Installation

- Installation costs include the turbine equipment, installation, foundation, electrical labor, transportation, taxes, zoning, permitting, inspection, interconnection, design and engineering, financing, and overhead.
- Average installation costs for turbines ≤ 100 kW are $4,000-$8,000/kW.
- Average installation costs for turbines > 100 kW are $2,000-$3,000/kW.

Operations & Maintenance

- Operation costs include land lease payments, operations contracts, insurance, and property taxes.
- Maintenance costs include preventative maintenance, repairs, and maintenance contracts.
- A reasonable O&M budget estimate is $30-$40 per kW per year.

Decommissioning

- The expected life of a wind turbine is 20-30 years, and they can be repowered or decommissioned (removed).
- Decommissioning costs are variable depending on degree of removal (for example, whether the foundation was left or removed and backfilled with clean dirt).
- Average decommission costs for turbines > 100 kW range from $67,000-$195,000 depending on salvage opportunities. Decommission costs are expected to be lower for smaller turbines (≤ 100 kW).

Levelized Cost of Energy

- Levelized cost of energy (LCOE) represents the present value of all anticipated project costs (installation and operations & maintenance) divided by the project's anticipated lifetime energy production.
- LCOE allows for comparison of different energy technologies of unequal lifespans, sizes, and initial capital costs, but doesn't account for value streams such as meeting renewable energy targets or increasing land co-use that promotes additional revenue.

Estimated LCOE for distributed wind turbines from the 2022 Cost of Wind Energy Review

Wind Turbine	Residential	Commercial	Large
Turbine Capacity	20 kW	100 kW	1.5 MW
Estimated LCOE	23.5 ¢/kWh*	16.3 ¢/kWh*	7.8 ¢/kWh*

** Estimated LCOE values do not account for distributed wind incentives (slide 17)*

- Whether or not a distributed wind project's LCOE is cost competitive with retail electricity rates depends on the location of the site, as retail rates vary greatly across the United States. In 2022, the average U.S. electricity retail price was 12.4 ¢/kWh.
- Average state electricity retail prices ranged from 8.2 ¢/kWh (Wyoming) to 39.7 ¢/kWh (Hawaii).

Distributed Wind Funding Opportunities

[Advancing the Growth of the U.S. Wind Industry: Federal Incentives, Funding, and Partnership Opportunities]

- Federal opportunities

[Database of State Incentives for Renewables and Efficiency]

- State and local funding opportunities
- Search by zip code, technology type (“Wind (All)” or “Wind (Small)”), and eligible sector (“Local Government”)

[Funding Clearinghouse]

- Funding opportunities are reviewed and updated weekly using publicly available information
- Sort on “small wind” or “wind” as Eligible Recipient

[U.S. Department of Agriculture Rural Energy for America Program]

- Funding opportunities for cooperatives
- Funding opportunities for electric utilities (including Tribal or governmental electric utilities) that provide service to rural consumers (must operate independently of direct government control)

[Energy Community Tax Credit Bonus Map]

- Geographic Information System (GIS) map that provides preliminary data about communities eligible for bonus credit in the forthcoming Clean Electricity Investment Tax Credit

** Note: Some of the above funding resources are specific to wind energy but not distributed wind.*

Acknowledgments and Resources

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Distributed Wind Energy Resource Hub

For more information on distributed wind energy:

- **Technology**
- **Funding opportunities**
- **Technical assistance opportunities**
- **Models, tools, and toolkits**
- **Publications**

Visit the Distributed Wind Energy Resource Hub!