U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

# Distributed Wind Research Development and Testing T3


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National Renewable Energy Laboratory


Photo Credit: Aegis Renewable Energy; Waitsfield, Vermont

# FY17-FY18 Wind Office Project Organization

"Enabling Wind Energy Options Nationwide"

| Technology Development | Market Acceleration & Deployment |
| --- | --- |
| Atmosphere to Electrons | Stakeholder Engagement, Workforce Development, and Human Use Considerations |
| Offshore Wind | Environmental Research |
| Distributed Wind | Grid Integration |
| Testing Infrastructure | Regulatory and Siting |
| Standards Support and International Engagement | |
| Advanced Components, Reliability, and Manufacturing | |

Analysis and Modeling (cross-cutting)

# Project Overview

## T3: Distributed Wind Research Development and Testing

### Project Summary

- Support innovative R&D and testing of wind technologies designed for distributed energy applications through the Competitiveness Improvement Project request for proposals
- Research, analysis, and stakeholder engagement to develop a fundamental understanding of the installed costs, market potential, and R&D challenges limiting market development

### Project Objective & Impact

- Reduce LCOE via cost reduction and performance improvement
- Increase market share of certified small and medium-scale wind technologies tested to national standards
- Understand the market opportunity for different scales of DW
- Benchmark costs to measure the impact of R&D opportunities
- Understand the challenges with resource assessment leading to performance risk
- Engage installers and project developers to understand their unique challenges and needs

### Project Attributes

**Project Principal Investigator(s)**

Ian Baring-Gould (NREL)
Alice Orrell (PNNL)
Eric Lantz (NREL)
Heidi Tinnesand (NREL)
Robert Preus (NREL)

**DOE Lead**

Patrick Gilman

**Project Partners/Subs**

Wind Advisors Team
eFormative Options
Small Wind Certification Council
Distributed Wind Energy Association
New York State Research and Development Authority

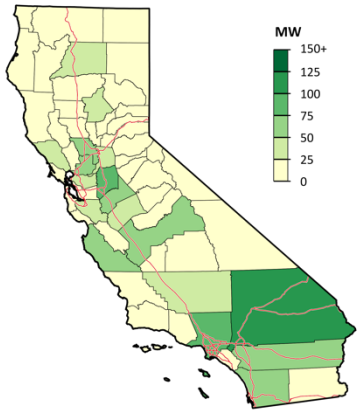
**Project Duration**

October 2016 through September 2018

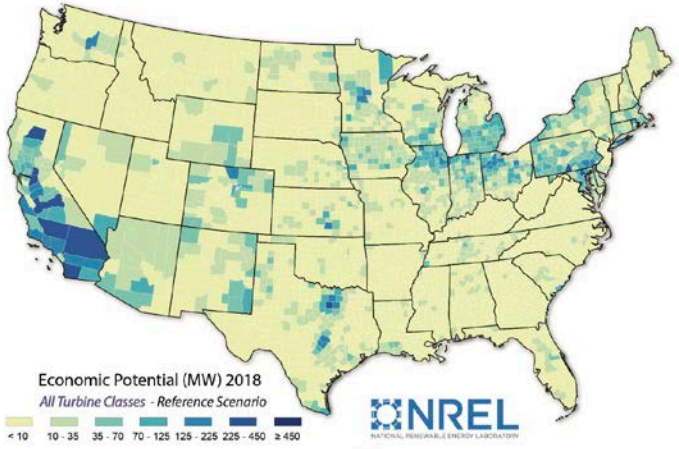
# Technical Merit and Relevance

**Analysis shows that investment in DW R&D could unlock ~30GW of potential by 2030(1). Efforts needed:**

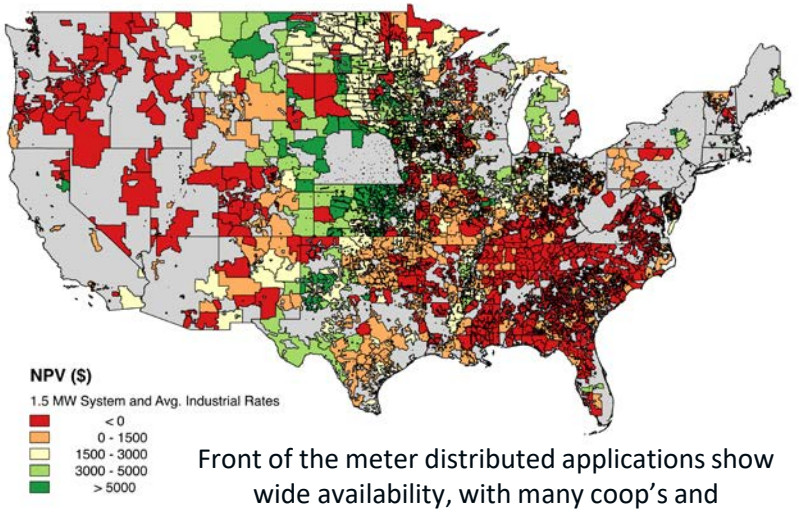
- **Technology cost reduction and performance improvements,**
- Increased adoption rates through expanded market knowledge
- Low-cost capital lead by higher reliability and improved accuracy of performance assessments
- Business cost reductions, allowing lower cost and more reliable project development




DW can compete with solar based on time of use pricing, though policy and continued investment greatly reduces DW development




NREL analysis shows expansive market potential for distributed wind in behind the meter applications




Front of the meter distributed applications show wide availability, with many coop's and municipal power opportunities for cost effective development

(1) Lantz, Sigrin, Gleason, Preus, Baring-Gould. (2016). Assessing the Future of Distributed Wind: Opportunities for Behind-the-Meter Projects. NREL/TP-6A20-67337. Available at: https://www.nrel.gov/docs/fy17osti/67337.pdf.

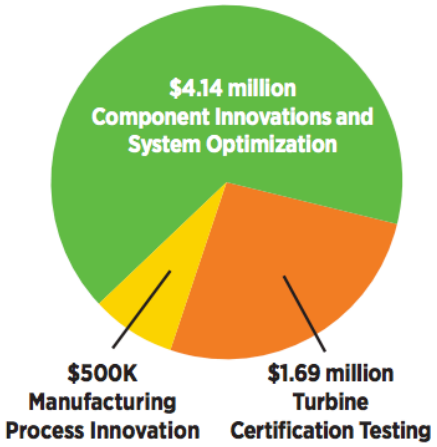
# Approach and Methodology

## Technology cost reduction and performance improvements

### Competitiveness Improvement Project

Supports small businesses who design and manufacture small or medium wind turbine technology through cost-shared subcontracts and technical support awarded via a competitive process under 3 areas of interest.

**28 Subcontracts to 15 companies, totaling $6.3 million of DOE investment while leverage additional $3.5 million of awardee cost share**




Funding breakdown for three CIP research areas

Bergey Windpower (Norman, OK)

Endurance Wind Power (Seattle, WA)

Intergrid (Temple, NH)

Northern Power Systems (Barre, VT)

Pecos Wind Power (Somerville, MA)

Pika Energy (Westbrook, ME)

Primus Windpower (Lakewood, CO)

Rock Concrete (Augusta, KS)

Sonsight (Lawrenceville, GA)

Star Wind Turbines (East Dorset, VT)

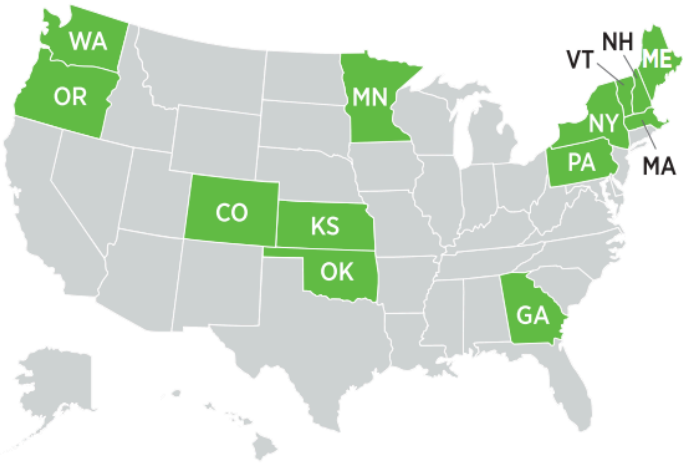
Urban Green Energy (New York City, NY)

Ventera Wind (Duluth, MN)

Wetzel Engineering (Lawrence, KS)

Windurance (Coraopolis, PA)

Xzeres (Portland, OR)



# Accomplishments and Progress

## CIP Highlight: Bergey Windpower Cuts Costs Nearly 50%

**BERGEY EXCEL 10**

- 20-year-old design
- 9.8 kW
- 7-meter rotor diameter
- Pultruded fiberglass blades
- Power control by furling

**Levelized cost of energy: 25¢ per kilowatt-hour**

**BERGEY EXCEL 15**

- 2017 design
- 15.6 kW
- 9.6-meter rotor diameter
- Carbon fiber blades
- Power control by blade stall

**Levelized cost of energy: 13¢ per kilowatt-hour**

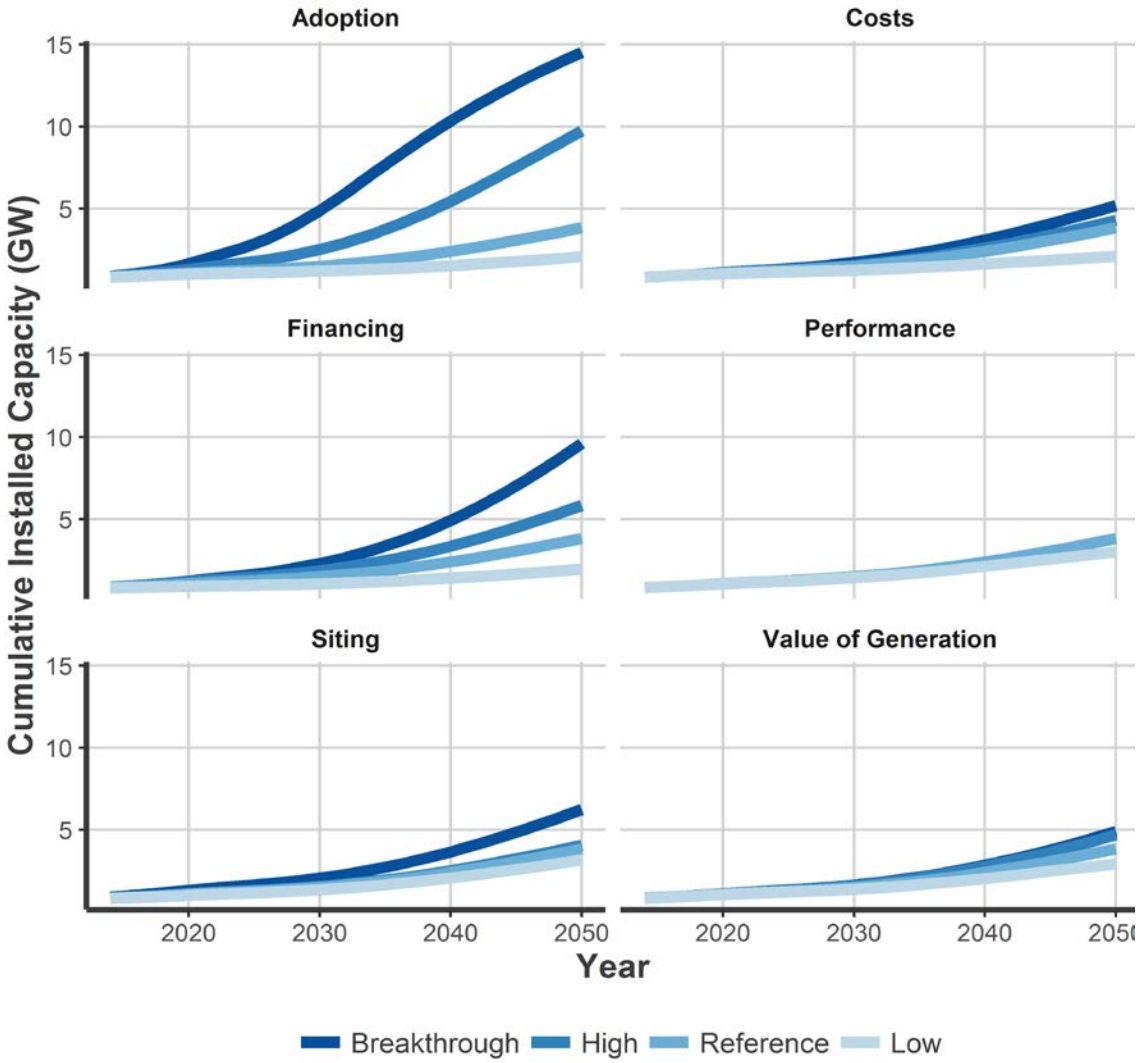
**Next-generation, low wind speed technology yields near 50% reduction in levelized cost of energy, making this small wind turbine cost-competitive with solar (photovoltaics)**

# Approach and Methodology

**Cost reduction and performance improvement alone not enough**, additional drivers include:

- Adoption
- Financing
- Siting
- Value of generation

Laboratory efforts focused on better understanding sensitivities of additional drivers and approaches for addressing them.

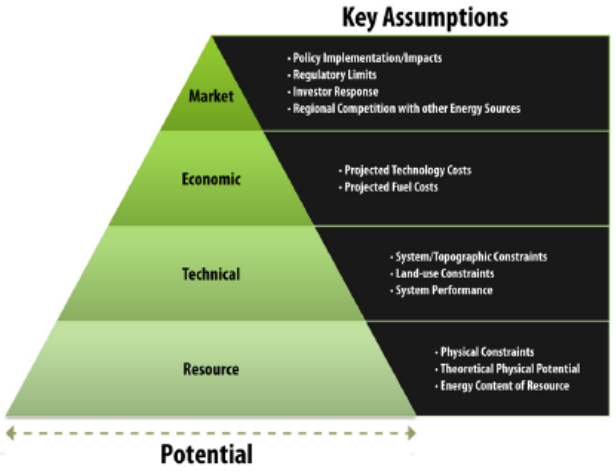



Impact of different levers on DW market opportunity from the NREL DW futures Study

# Approach and Methodology

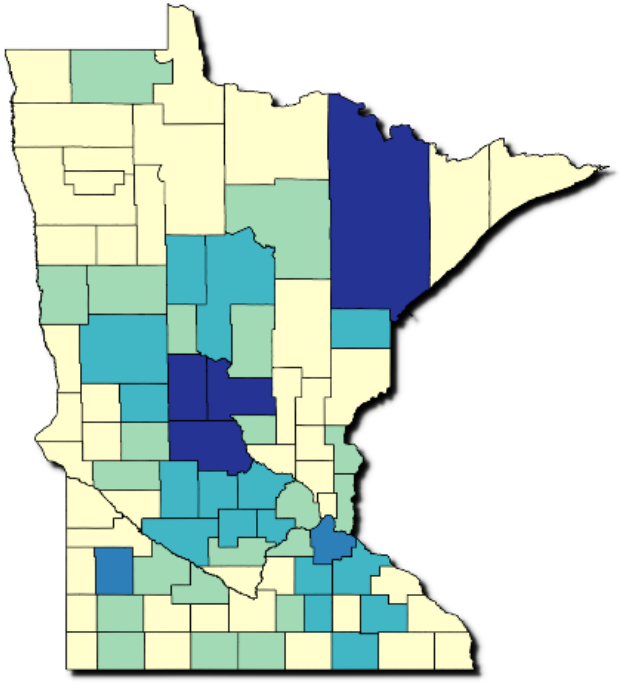
Building off similar efforts for distributed solar, NREL developed and uses geo-spatial modeling tools to understand the market potential for DW in both behind and in front of the applications.

- Using extensive public and private GIS data sets
- Screen down from resource to market potential
- Consider various cost reduction scenarios for 4 different market breakouts
- Extensive industry consultation

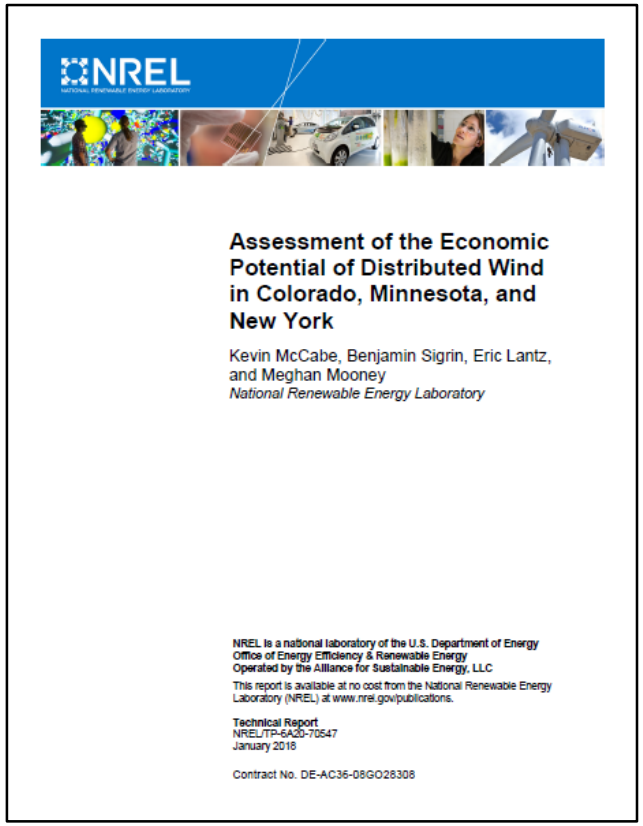



# Accomplishments and Progress

**Distributed wind technology and market assessments:** Expanded and more detailed analysis of behind the meter potential published and front of the meter market potential analysis initiated, improving industry and WETO market understanding.




Assessment of Development Potential in Minnesota


NREL

Assessment of the Economic Potential of Distributed Wind in Colorado, Minnesota, and New York

Kevin McCabe, Benjamin Sigrin, Eric Lantz, and Meghan Mooney
*National Renewable Energy Laboratory*

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

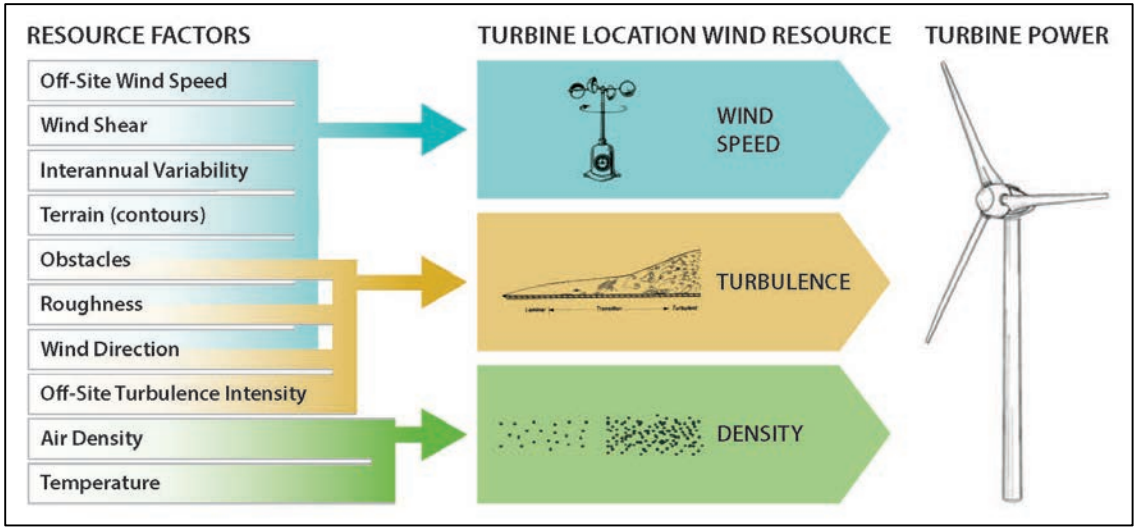
Technical Report
NREL/TP-6A20-70547
January 2018

Contract No. DE-AC36-08GO28308

# Approach and Methodology

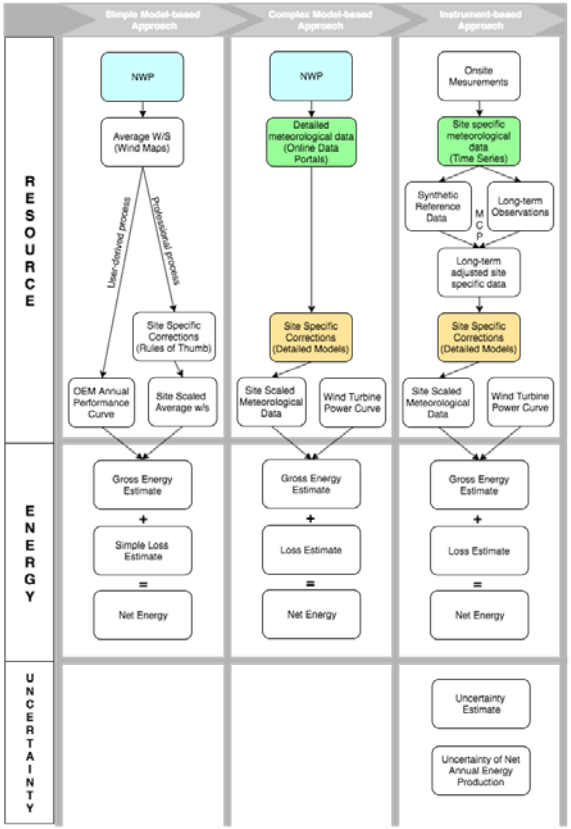
Working to understand resource assessment and turbine performance for DW technology, allowing expanded industry knowledge and preparing for additional research

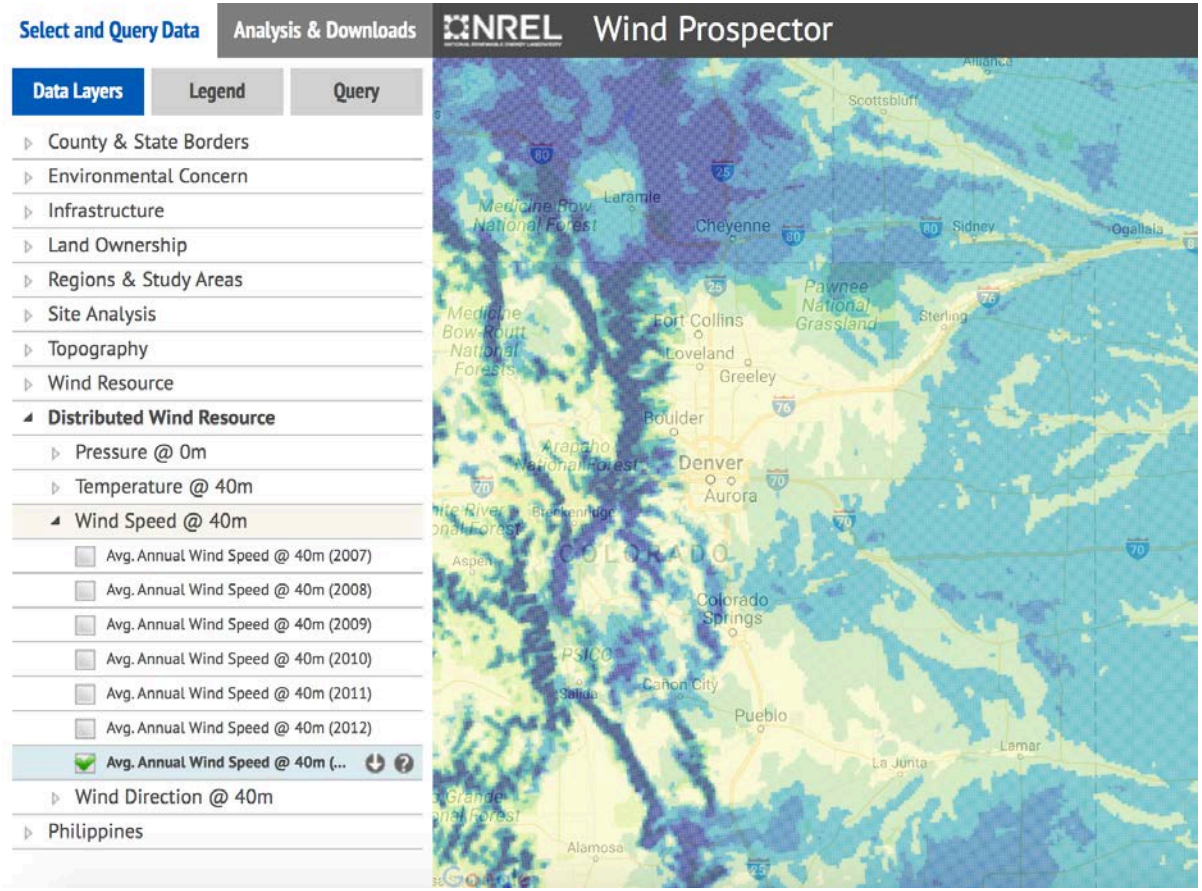
- Document and communicate current practice with turbines in the built environment
- Support for International Energy Agency Wind Task 27 - Small Wind Turbines in High Turbulent Sites
- Working with industry to understand and document the approaches for performance predication
- Development of new data tools to support DW market (Wind Prospector)
- Using turbine modeling tools to update rules of thumb and better understand the impacts of different resource parameters (turbulence, vertical component)



# Accomplishments and Progress

**Distributed resource assessment:** Efforts to better understand the key elements of wind resource assessment over the wide array of DW deployments have been undertaken which will lead to a greater ability to develop tools to better model site specific resource availability.

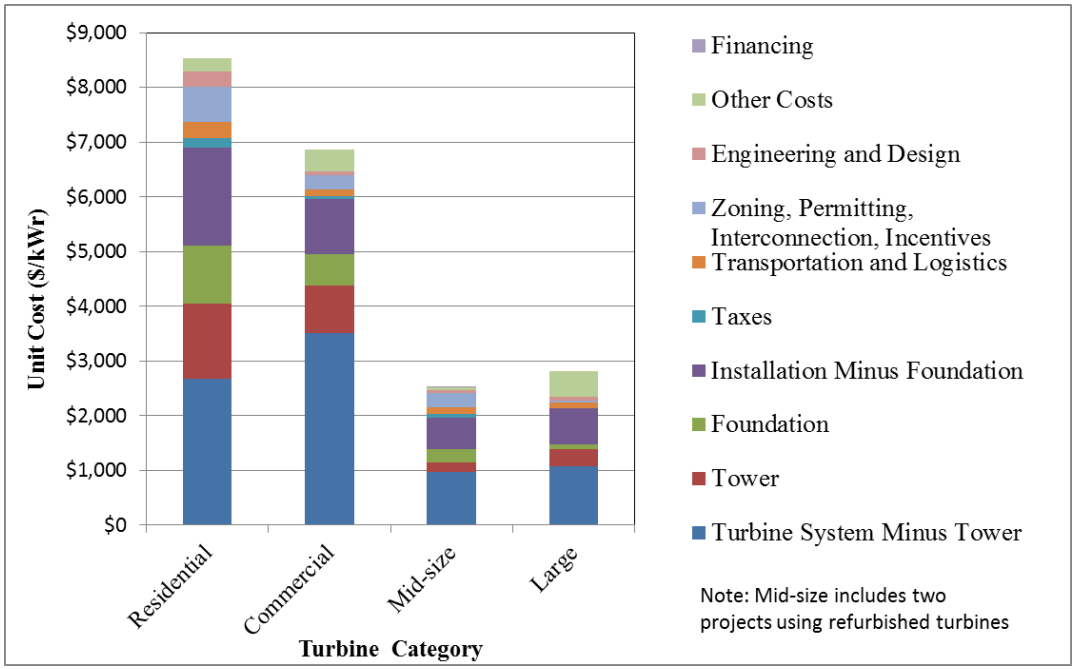


# Approach and Methodology

**Building off of the DW Market Report, develop a better understanding of the development costs and DW, benchmarking those costs and identifying cost reduction opportunities.**

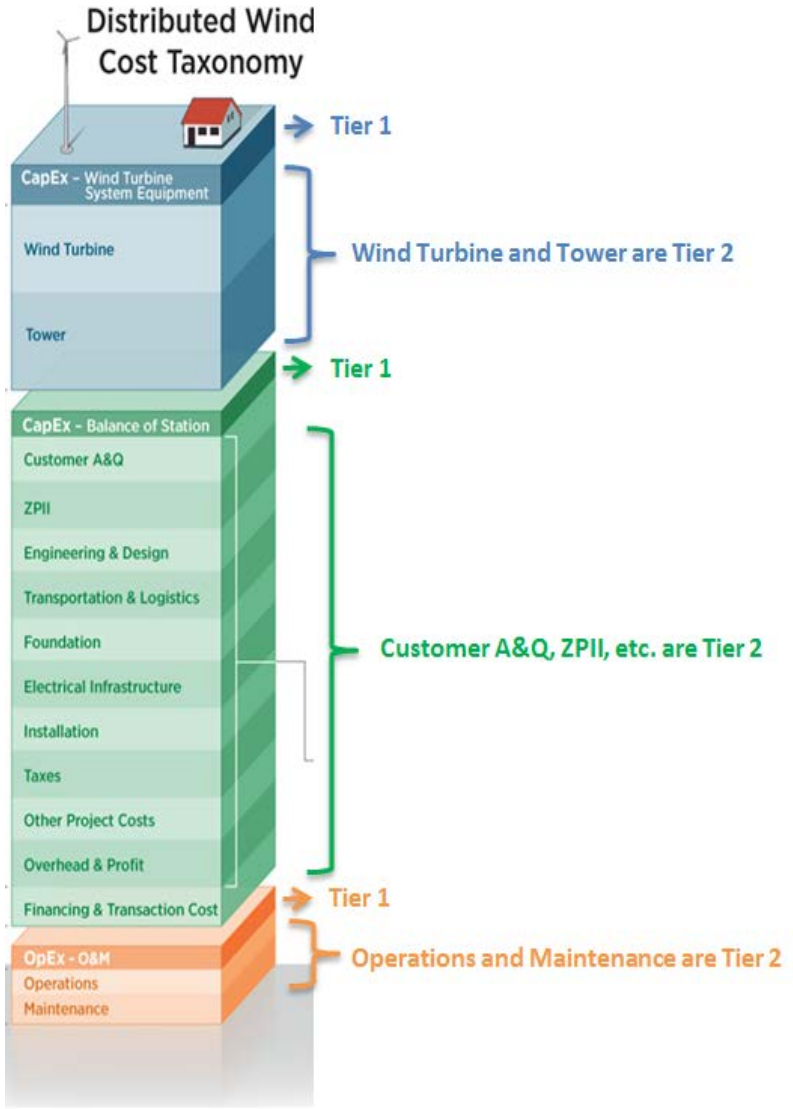
- Supporting expanded engagement with DW developers through the formation of the DW Installers Collaborative.
- Extensive engagement and interviews with developers to better understand costs, leading to the development of a cost taxonomy
- Benchmarking of installation costs, leading to detailed technical report on cost reductions options
- Engaging with key market actors, training workshops for federal energy managers and a workshop with energy cooperatives



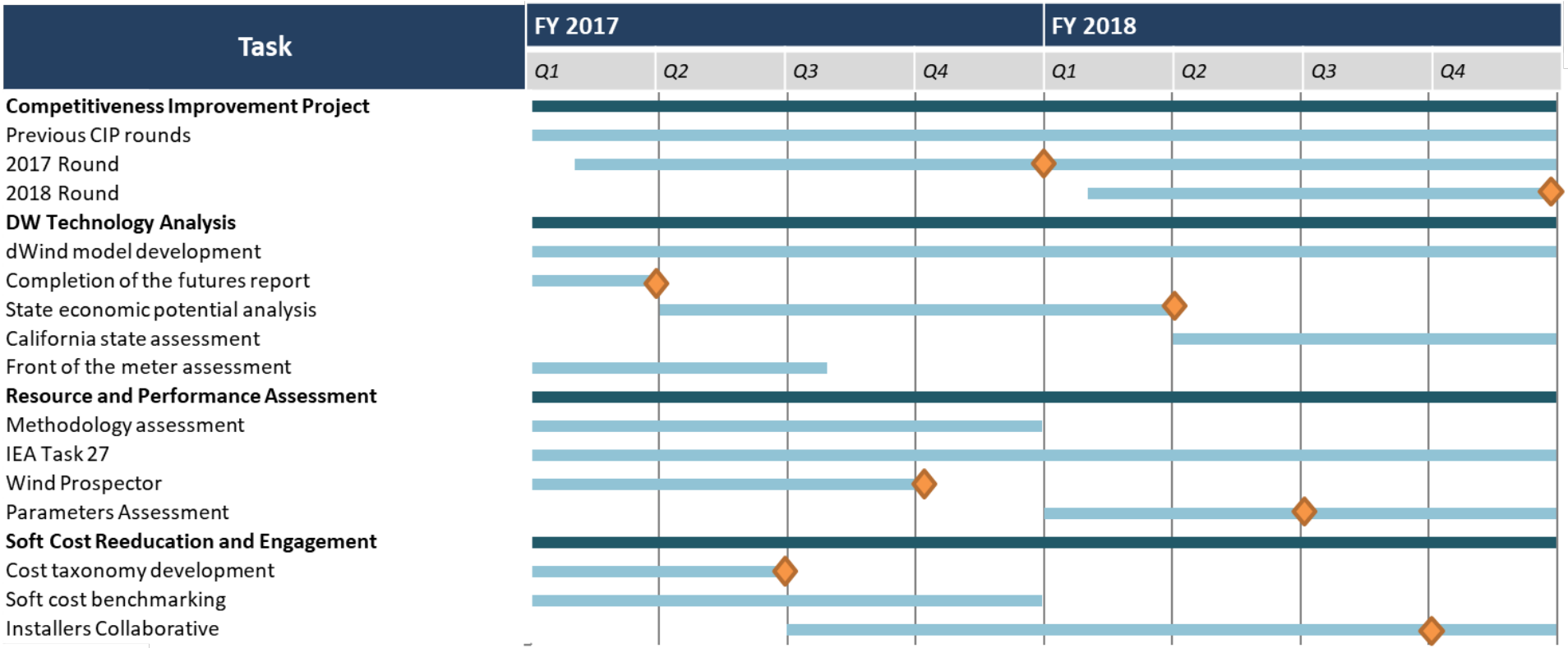
# Accomplishments and Progress

**Distributed wind cost taxonomy development:** The development and publication of a full cost taxonomy allows a better understanding and articulation of system costs, allowing focused efforts to reduce both hard and soft costs, a key feature of future industry success.

**Distributed Wind Installers Collaborative:** Expanding beyond traditional engagement with turbine manufactures, the development of an network of installers has allowed better communication across this limited community while identifying specific areas of expanded engagement, such as the development of DW case studies and dialog with electrical cooperatives,



# Accomplishments and Progress



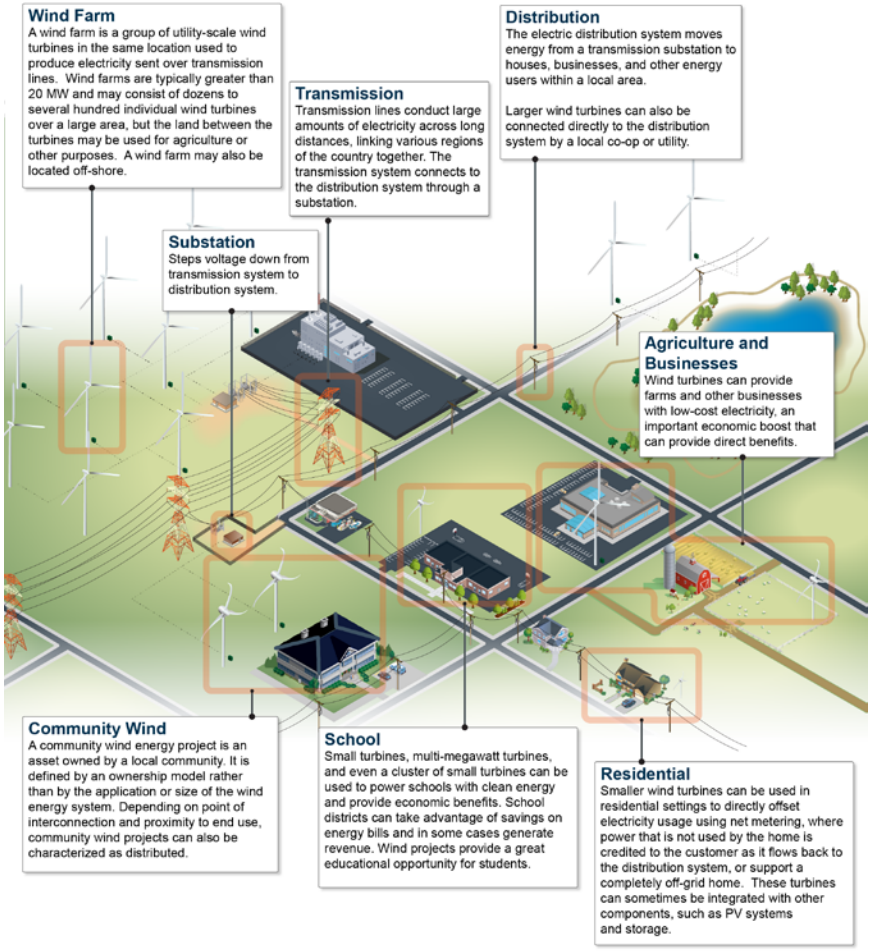

All milestones met, although some were delayed due to process and staffing issues

Go / No-Go milestones were more process oriented, relation to analysis decisions

# Communication, Coordination, and Commercialization

Work closely with DWEA, AWEA and other industry partners directly and through advisory boards to disseminate the results of research efforts.

- Produce multiple technical and market reports, providing valuable information to industry and stakeholder
- Presentations at numerous events including DWEA, WINDPOWER, Small Wind Conference
- Conduct webinars and other direct outreach events, such as informational workshops to expand industry engagement
- Initiated new IEA Wind Task 41 - Enabling Wind to Contribute to a Distributed Energy Future
- Updated web content



# Upcoming Project Activities

**Competitiveness Improvement Project (CIP):** Annual competitive solicitation concentrating on turbine testing, advanced manufacturing, and component and whole system innovation for small and medium-size wind turbine technology.

**Tools Assessing Performance (TAP):** Modeling and application development to greatly increase the accuracy and reduce the cost and risks of distributed wind site assessment, project development, and performance.

**Strategic and Technical Engagement:** Reduce technical, economic, and market barriers through strategic and technical stakeholder engagement, including:

- **Analysis and Modeling:** Collects and analyzes the critical data to support and inform identification of potential markets and cost reduction opportunities.
- **Federal DW Education:** Providing educational resources and training to federal energy decision makers about the appropriate use and integration of DW technologies
- **DW Standards Assessment:** An assessment of domestic (AWEA SWT) and International (International Electrotechnical Commission 61400-2) certification standards for DW followed, if appropriate, by the completion of research or analysis to support the justification of any proposed standard modification
- **International Collaboration:** Implementation and operation of a new IEA Wind effort Enabling Wind to Contribute to a Distributed Energy Future
- **Market Information:** Annual development of the Distributed Wind Market Report

# Upcoming Project Activities

**Microgrids, Infrastructure Resilience and Advanced Controls Launchpad (MIRACL):** Integrate modern distributed wind equipment into national lab testing capabilities, develop secure standardized controls and interfaces to seamlessly integrate with other distributed energy resources in microgrid applications, and increase DW capabilities to provide grid services.

**Defense and Disaster Deployable Wind Turbine (D3T):** Develop wind turbine design requirements for operational applications such as military and disaster relief and assess commercially available technology and technology development opportunities against operational design requirements.