



Distributed Wind Resource Assessment Overview

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Agenda

- Background & Motivations
- Current Industry State of the Art
- Key Findings:
 - Challenges
 - Barriers
 - High-Payoff Opportunities.

Wide Range of Capacity Factors

Capacity factor doesn't correlate with turbine size, other factors must be considered.

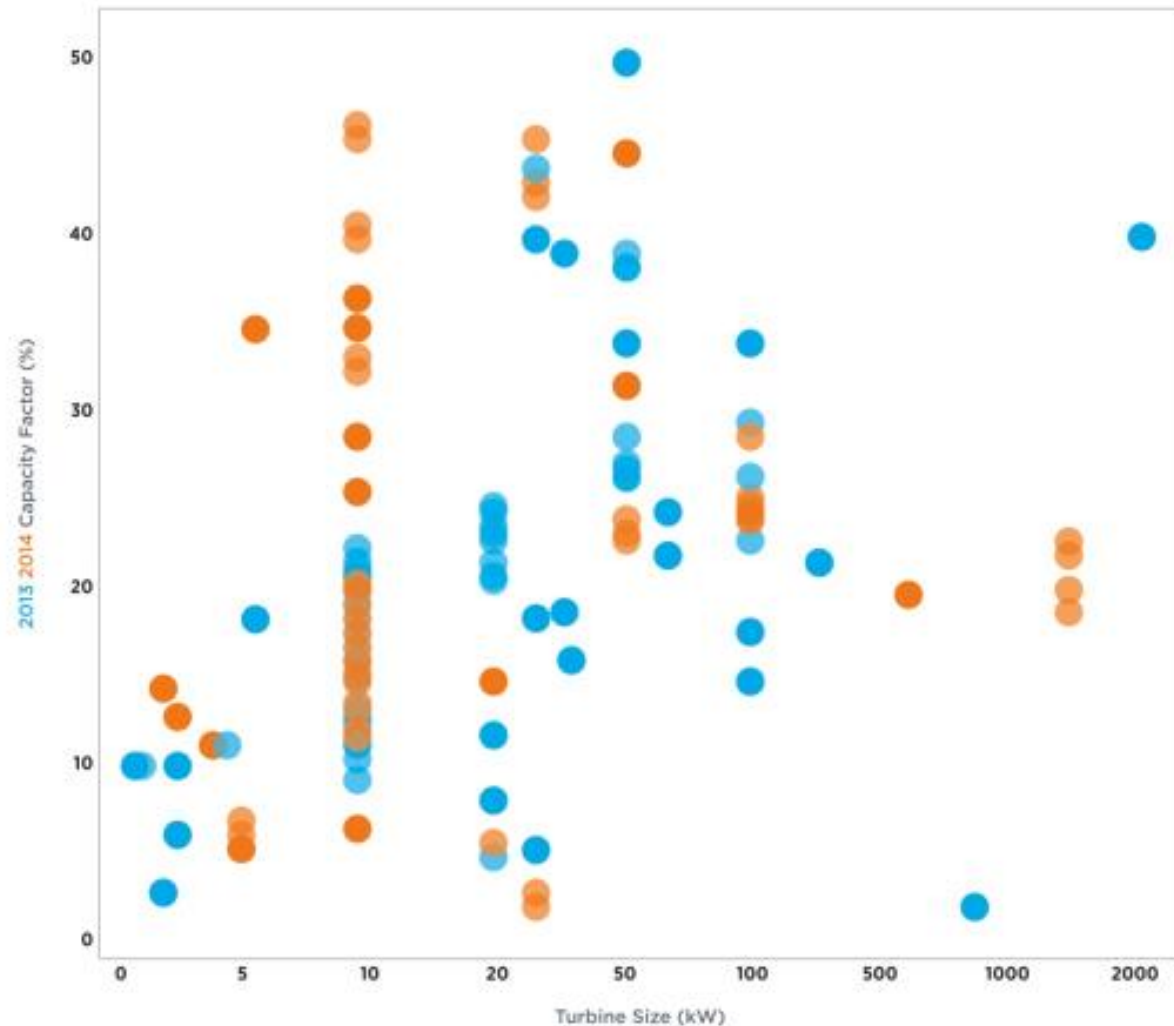


Figure from Alice Orrell, Pacific Northwest National Laboratory
2014 Distributed Wind Market Report

Diversity of DW Industry Stakeholders

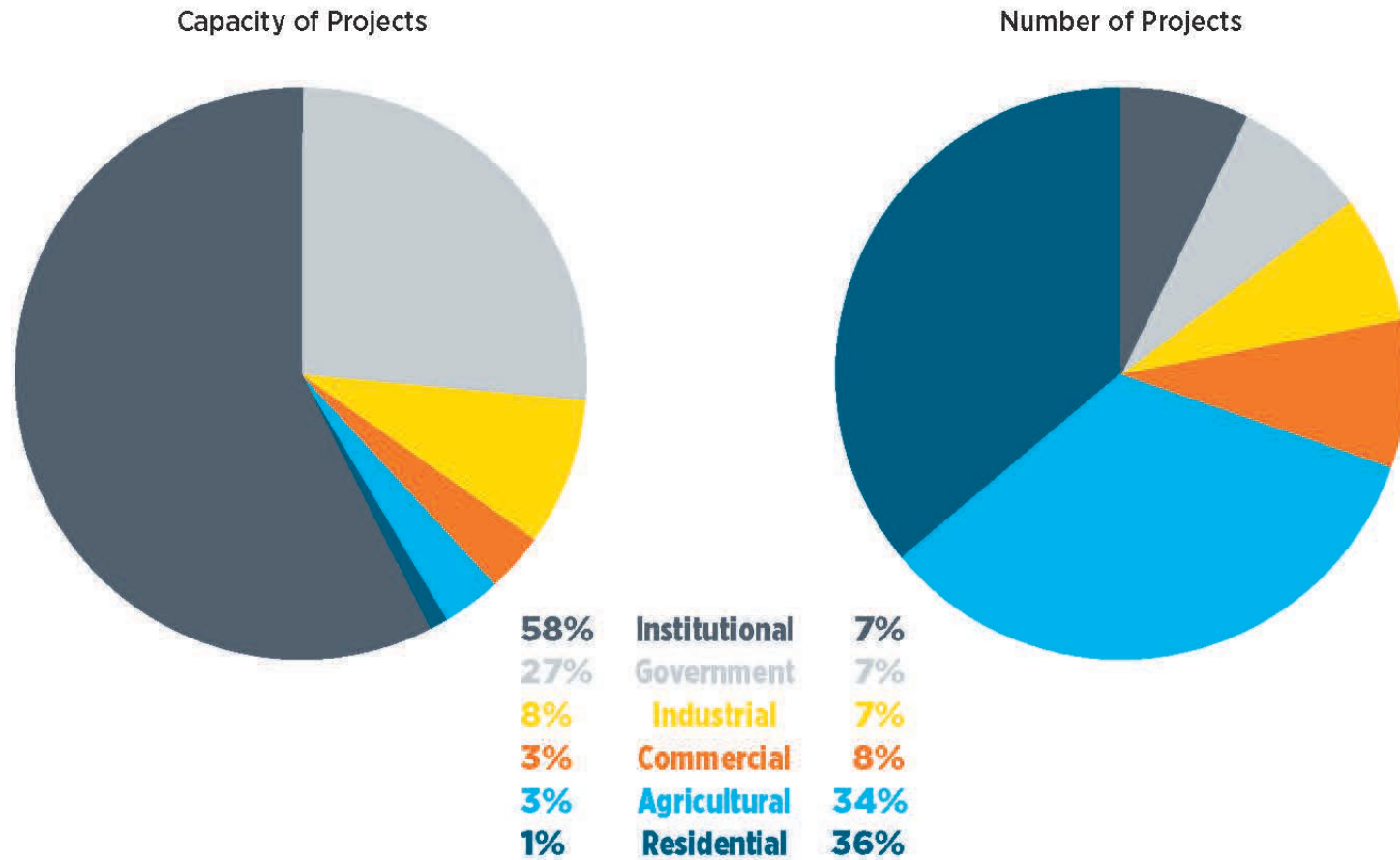


Figure from Alice Orrell, Pacific Northwest National Laboratory
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Resource Assessment Big Picture

Improper siting means sub-optimal performance and reliability.

Even the best designs may fail in the wrong environments.



Photo from Rinspeed, Inc.

DWRA Background

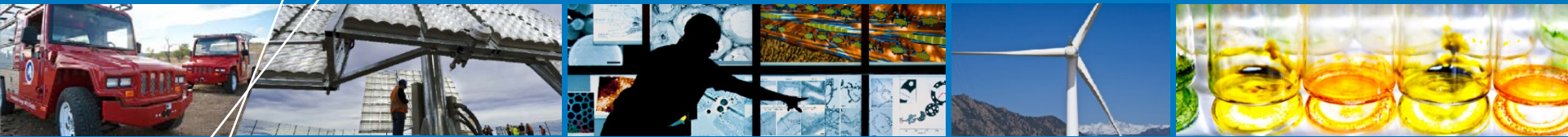
Wind resource characterization and assessment identified through the 2014 DOE RFI as one of the **top four Distributed Wind Portfolio R&D focus areas**.

Subsequent actions:

- Workshop developed with the help of an industry-based advisory board to obtain information in the following focus areas:
 - Current industry state of the art
 - Challenges and barriers
 - High-payoff opportunities.
- Follow-on survey completed fall 2015
- Report published spring 2016.

Workshop Details

- DWT Wind Resource Assessment Stakeholder Workshop held June 18-19, 2015, in Stevens Point, WI
- Total attendees: 30
- Sectors represented:
 - Turbine OEMs
 - State energy programs
 - Non-profits
 - Consultancies
 - Site assessors
 - Developers.
- Key companies/perspectives
 - Endurance, Bergey, Primus
 - One Energy
 - NWSEED, Alaska Energy Authority, Minnesota Energy Office
 - Wind Advisors Team, Sagrillo Light & Power
 - Small Wind Certification Council.



State of the Industry

DWRA State of the Industry

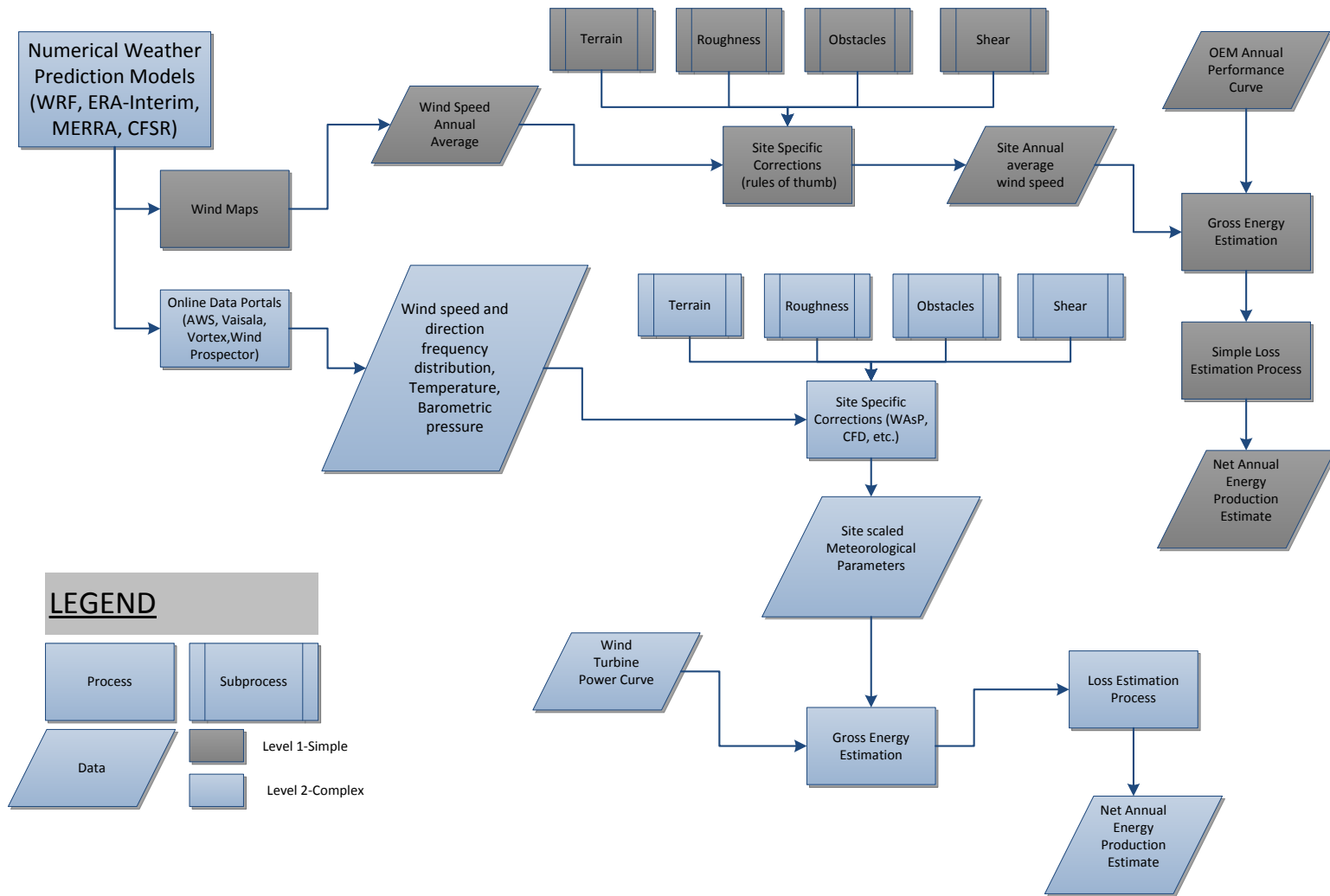
Two main approaches:

- Model based (majority of assessments)
- Instrumentation based (500 kW+).

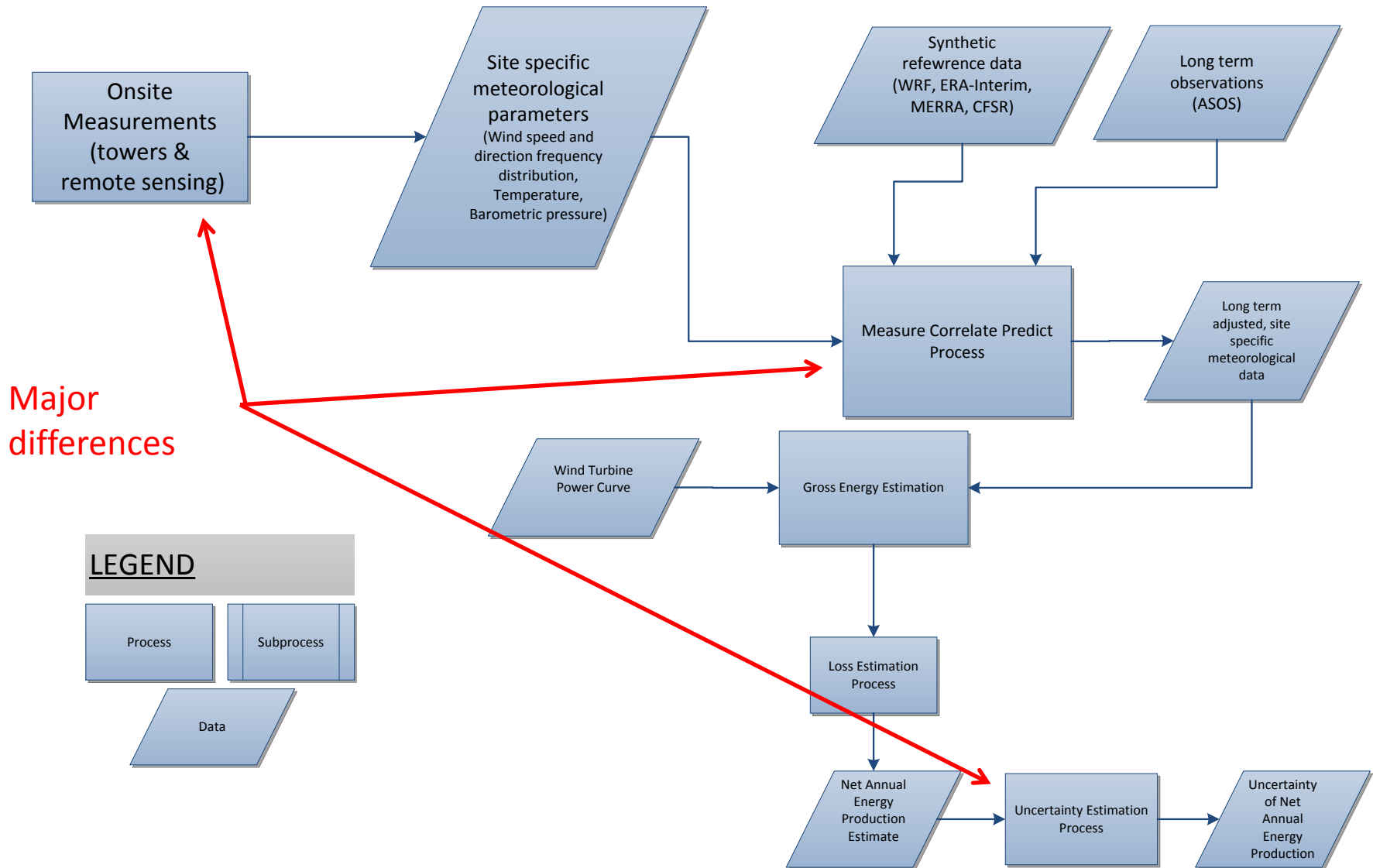
Key findings:

- Measurements are important and valuable; however, instrumentation is cost and time prohibitive.
- Validation and feedback for models are lacking.
- A wide range of stakeholders and economics drives variability in:
 - Processes
 - Precision/accuracy
 - Budget/time.

DWRA Model-Based Approach



DWRA Instrumentation-Based Approach



Resource Assessment Drivers

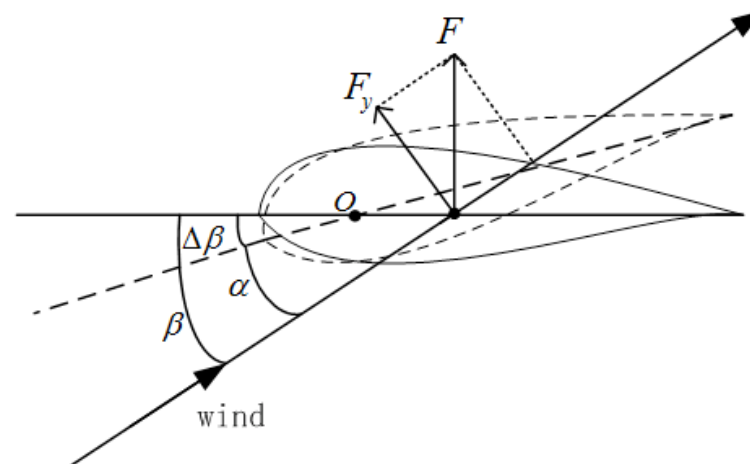
What matters?

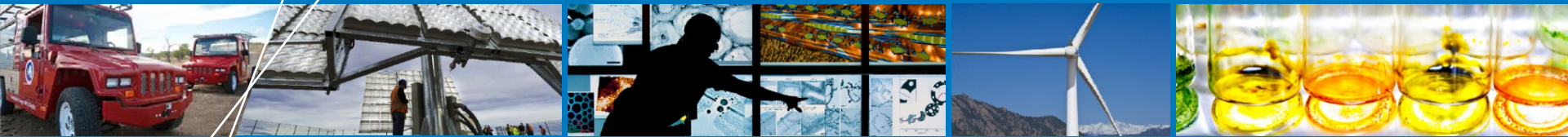
- Power production
- Turbine loading*
- Grid integration*
- Risk quantification.*

* Largely infeasible in current DWRA processes



Photo by Warren Gretz, NREL 00001





Key Findings

DWRA Challenges Identified by Industry

Tier 1:

- Data access
- Validation and benchmarking
- Industry education and outreach.

Tier 2:

- Atmospheric model input data
- Measure-Correlate-Predict (MCP)
- Downscaling methods
- Standardization.

Tier 3:

- Site suitability assessment
- Low-cost instrumentation.

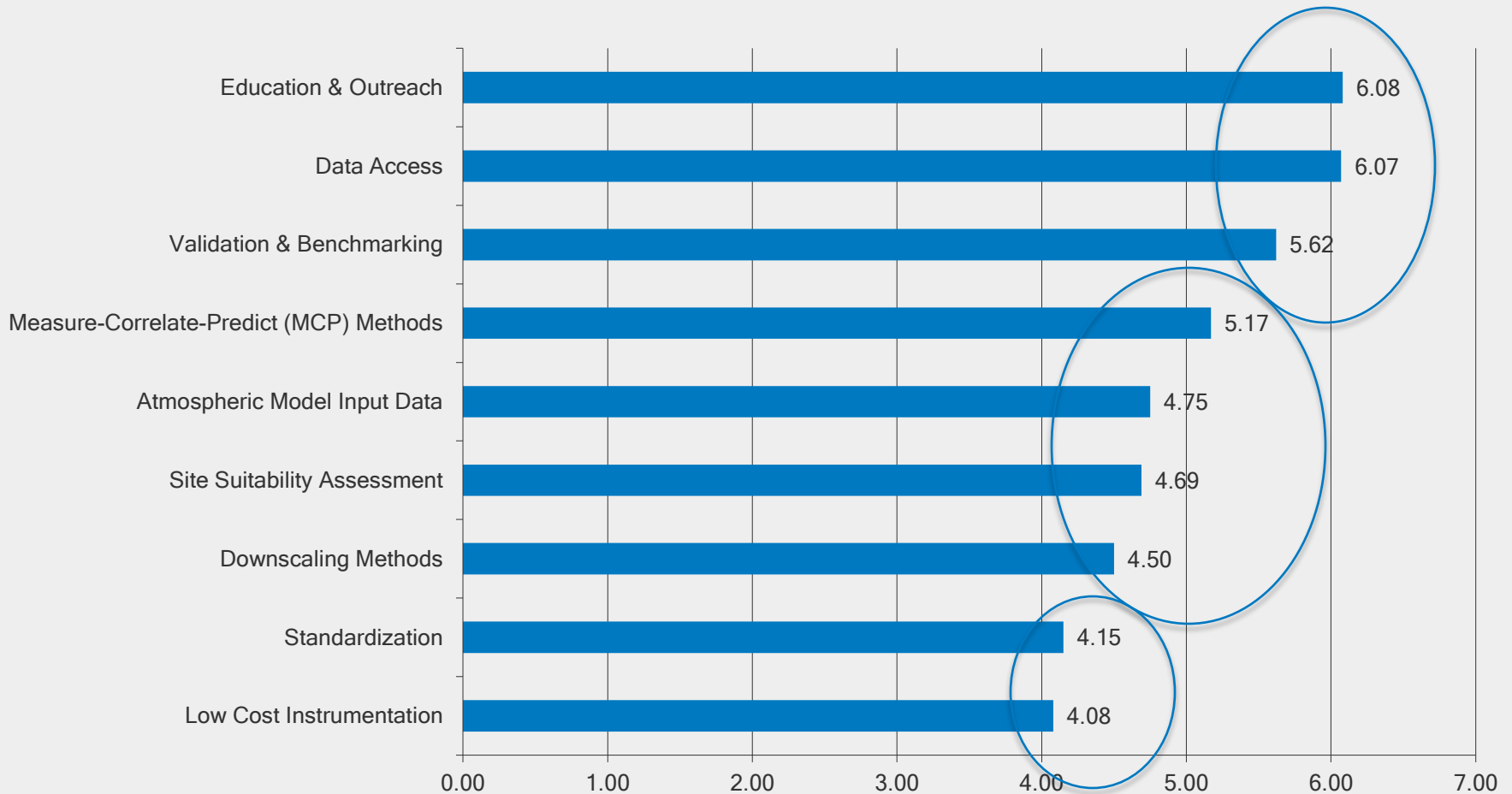
NREL researchers asked industry members to rank priorities according to various perspectives:

- According to the industry
- According to their individual needs
- According to the government's role.

Note: Many of the challenges overlap and can potentially be addressed synergistically.

Industry Survey: Impact to DW Industry

Rank of Interest, based on potential impact to the distributed wind industry



Challenges & Barriers

- Accuracy of current approaches wildly inconsistent or unknown
- Little verification of existing tools/rules of thumb
- Few standards for processes and documentation
- Limited funding or processes to understand errors or improve assessment process – limited feedback loop
- Lack of publically available and low-cost data/tools
- Industry relies heavily on personal experience; limited training and educational opportunities
- Poor understanding of the cost/benefit of different fidelities of WRA (on-site data collection, model selection)
- Limited feedback between OEMs and site assessors – lack of an ability to do more detailed site optimization
- Total WRA costs (dollars and effort) must be tiered to reflect project size and volume.

Challenges & Barriers: In Summary

- Accuracy of current approaches wildly inconsistent or unknown
- Little verification of existing tools/rules of thumb
- Limited **VALIDATION, STANDARDS, and FUNDING** to understand the **ACCURACY** and **IMPACT** of myriad WRA methods and approaches
- Lack of publically available and low-cost data/tools
- Industry relies heavily on personal experience; limited
- Limited **ORGANIZED OPPORTUNITIES** for resource assessment **KNOWLEDGE SHARING** and **TRAINING**.
- Limited feedback between OEMs and site assessors – lack of an ability to do more detailed site optimization
- Total WRA costs (dollars and effort) must be tiered to reflect project size and volume.

Impact of Solutions

All three Tier 1 challenges would have a major effect on performance estimation with low or moderate effort required.

	Improvement Opportunity	Cost of Assessment	Consumer or End User Confidence	Performance Estimation	Improving Characterization of Site Suitability	Level of Effort Required
Tier 1	Data Access	Major	Minor	Major	Major	Moderate
	Validation & Benchmarking	Minor	Major	Major	Minor	Moderate
	Education & Outreach	Major	Major	Major	Major	Low
Tier 2	Atmospheric Model Input Data	Major	Minor	Major	Minor	Low/Moderate
	Measure-Correlate-Predict (MCP)	Minor	Minor	Major	Major	Low
	Downscaling Methods	Minor	Minor	Major	Major	Moderate /High
	Standardization	Minor	Major	Moderate	Moderate	Low
Tier 3	Site Suitability Assessment	Minor	Major	Major	Major	Moderate /High
	Low-Cost Instrumentation	Minor	Major	Major	Major	High

Potential Actions: Tier 1

<p>Data Access:</p> <ul style="list-style-type: none">• Expand the availability of data accessible by the public<ul style="list-style-type: none">○ Site to aggregate datasets (Wind Prospector)<ul style="list-style-type: none">▪ Wind maps▪ Anemometer loan programs.	<p>Moderate effort</p> <p>Major impact on:</p> <ul style="list-style-type: none">• Cost of assessment• Performance estimation• Site suitability analysis.
<p>Validation and Benchmarking:</p> <ul style="list-style-type: none">• Develop long-term performance monitoring approaches• Implement a model validation process.	<p>Moderate effort</p> <p>Major impact on:</p> <ul style="list-style-type: none">• Consumer confidence• Performance estimation.
<p>Industry Education and Outreach:</p> <ul style="list-style-type: none">• Develop a content-sharing platform• Aggregate key distributed and utility wind resource assessment best practices• Organize annual or bi-annual DWRA workshops.	<p>Low effort</p> <p>Major impact on:</p> <ul style="list-style-type: none">• Cost of assessment• Consumer confidence• Performance estimation• Site suitability analysis.

Resources & Next Steps

Resources

- Workshop proceedings published on OpenEI.org
[http://en.openei.org/wiki/Distributed Wind Resource Assessment Workshop](http://en.openei.org/wiki/Distributed_Wind_Resource_Assessment_Workshop)
- Report published on NREL's Publications page
- <http://www.nrel.gov/docs/fy16osti/66419.pdf>

Next Steps

- R&D on Tier 1 activities
 - Plan depends on budgets.

Thank you!

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