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Performance Prediction and Validation: Data, Frameworks, and Considerations

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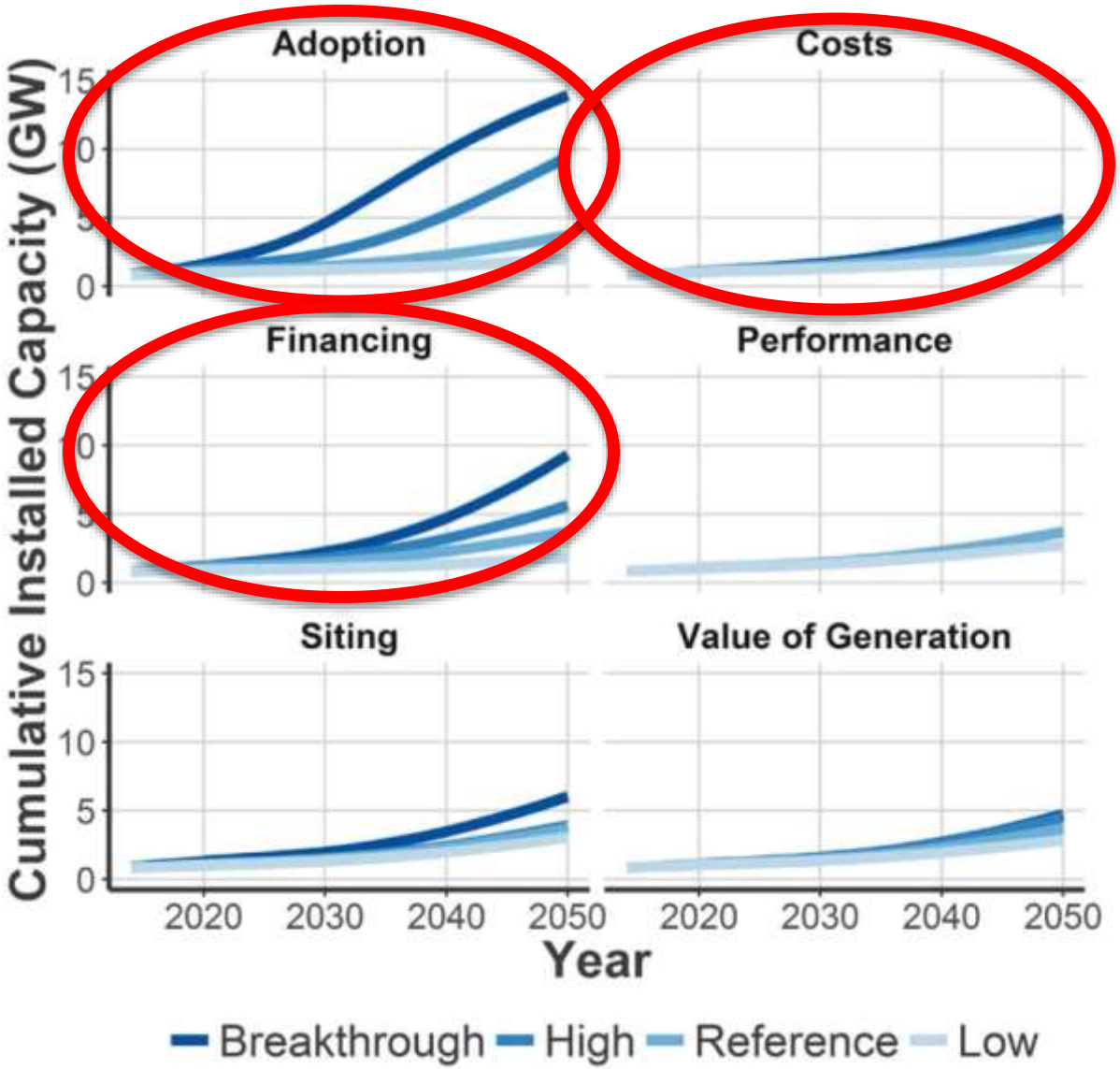
Small Wind Conference 2017 – Minneapolis, MN

April 11, 2017

PR-5000-68426

DWind Analysis: Future Market Potential



Technology Maturity
Diffusion Parameters:
- Innovator
- Imitator

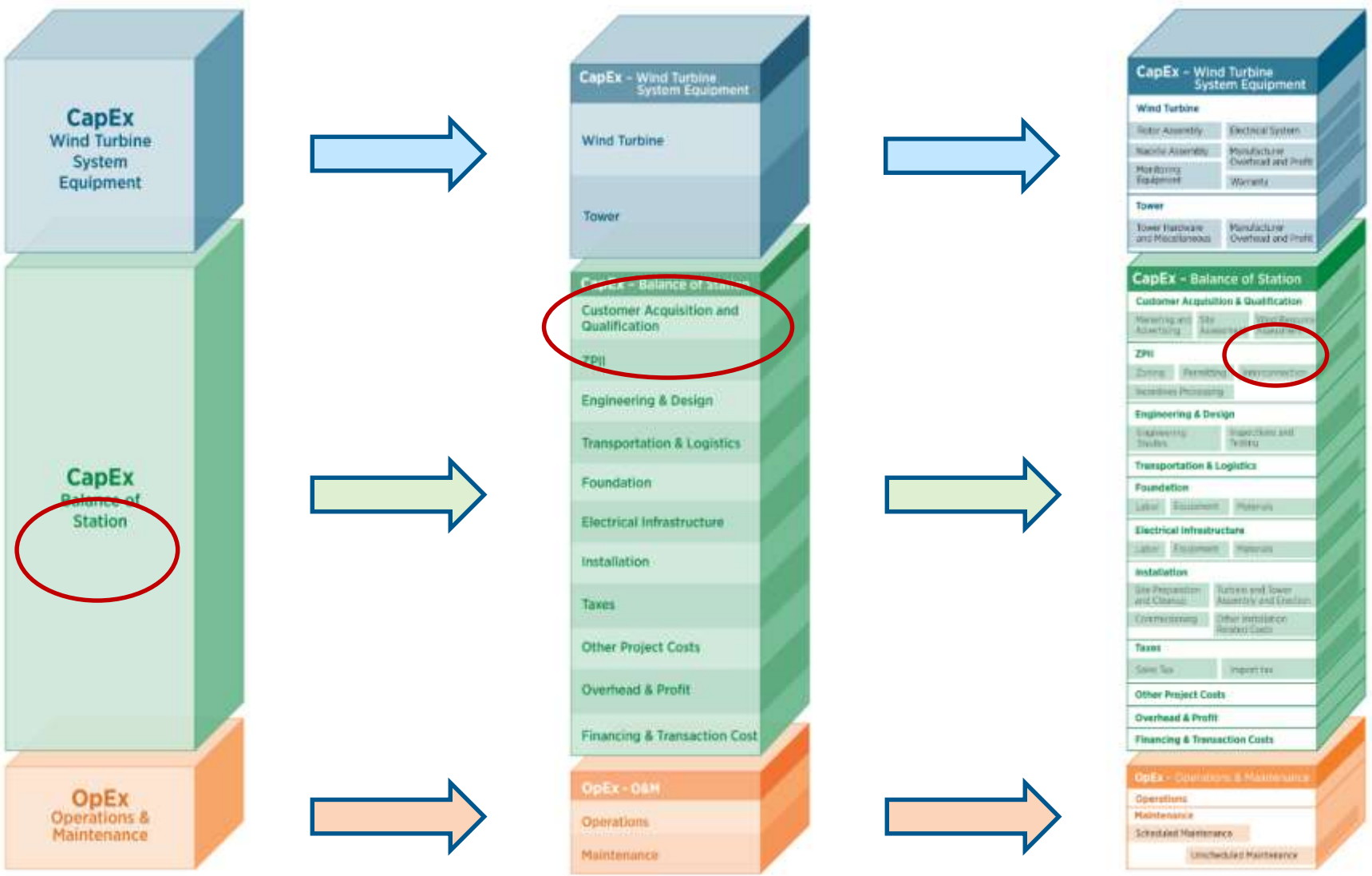
Market Penetration

Project Risk Affects:
- Finance Costs
- Access

Soft Costs Taxonomy

From U.S. Department of Energy. 2017. Assessing the Future of Distributed Wind: Opportunities for Behind-the-Meter Projects. NREL/TP-6A20-67337 National Renewable Energy Laboratory (NREL), Golden, CO (US). https://energy.gov/sites/prod/files/2016/11/f34/assessing-future-distributed-wind.pdf

Balance of Station – Customer Qualification - Resource Assessment



From U.S. Department of Energy. 2017. The Distributed Wind Cost Taxonomy. NREL/TP-5000-67992. National Renewable Energy Laboratory (NREL), Golden, CO (US). http://www.nrel.gov/docs/fy17osti/67992.pdf

Background

2015 challenges identified by industry:

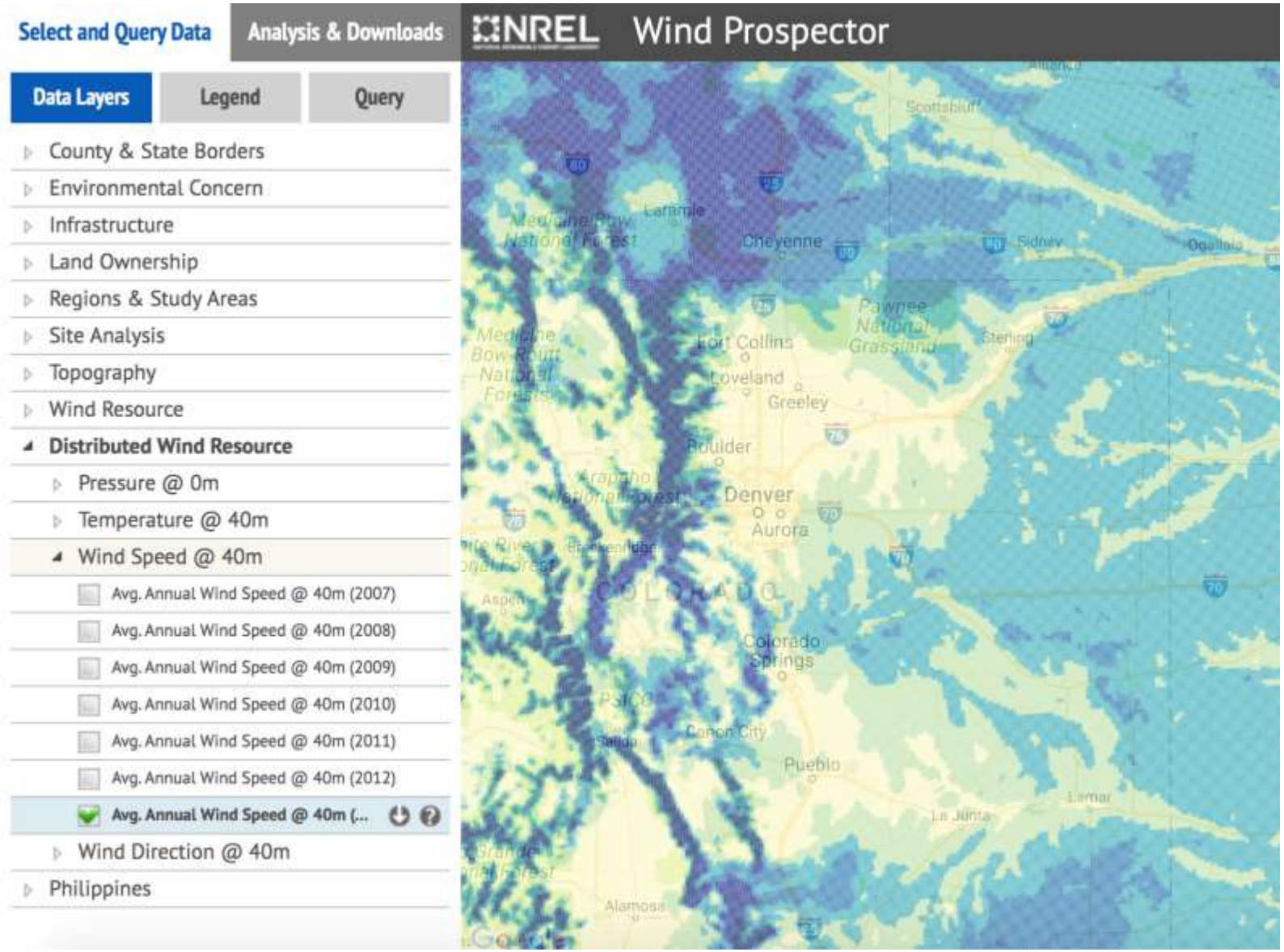
- Lack of data
- Lack of validation for current methods.

2017 progress toward addressing challenges:

- Wind Prospector
- Framework to facilitate evaluation of the accuracy of any resource assessment toolset.

Data: Wind Prospector

Data: Wind Prospector Development



WIND Toolkit

- Developed by NREL in 2012
- 7 year (2007-2013) time series
- 2 km x 2 km grid
- Based on ERA Interim Boundary conditions and weather resource and forecasting
- Spatially and temporally consistent
- Open source
- Reproducible, extendable horizontally, and, in time, fully documented
- Physical and statistical interpretations of data possible
- Validated on- and offshore at a dozen sites; more rigorous validation by September 2017.

AWS Data Licensed at NREL

- Developed by AWS Truepower
- 14 years: 1997-2010 statistics and TMY (no time series)
- 200-m gridded data
- Based on National Centers for Environmental Prediction/National Center for Atmospheric Research boundary conditions, the Mesoscale Atmospheric Simulation System, and microscale simulations
- Proprietary statistical data set; details not available
- Validation with ~200 sites, mostly surface (10 m?).

Model Validation

Prediction Variability

Case Study #3 from Site Assessment Guidelines (Olsen and Preus 2016): Hempstead Project

Performance Estimates:	Mean wind speed at 37 m (m/s)	Assumed net losses	Weibull k	Weibull a (m/s)	Annual Energy Production (MWh/yr)
Wind Project Installer	5.13	0.08	2.0	5.79	134
Manufacturer	6.14	0.07	2.4	6.92	209
NYSERDA Small Wind Explorer (two 50-kW WTG)	6.22	0.20	n/a	n/a	168-216
MERRA Data with Windographer (21/24m rotor)	6.26	0.08	2.3	7.07	235/267

MERRA Hourly Mean Wind Speed 21-m Rotor	March 27, 2012 to March 26, 2013: with an adjustment for Hurricane Sandy and the car accident	210 MWh/yr **165 MWh/yr**
MERRA Hourly Mean Wind Speed 24-m Rotor	March 27, 2012 to March 26, 2013: with an adjustment for Hurricane Sandy and the car accident	237 MWh/yr **189 MWh/yr**
Per Manufacturer Data, Energy Production	March 27, 2012 to March 26, 2013 Note: Turbine off-line for 57 days during this time	**186 MWh/yr**

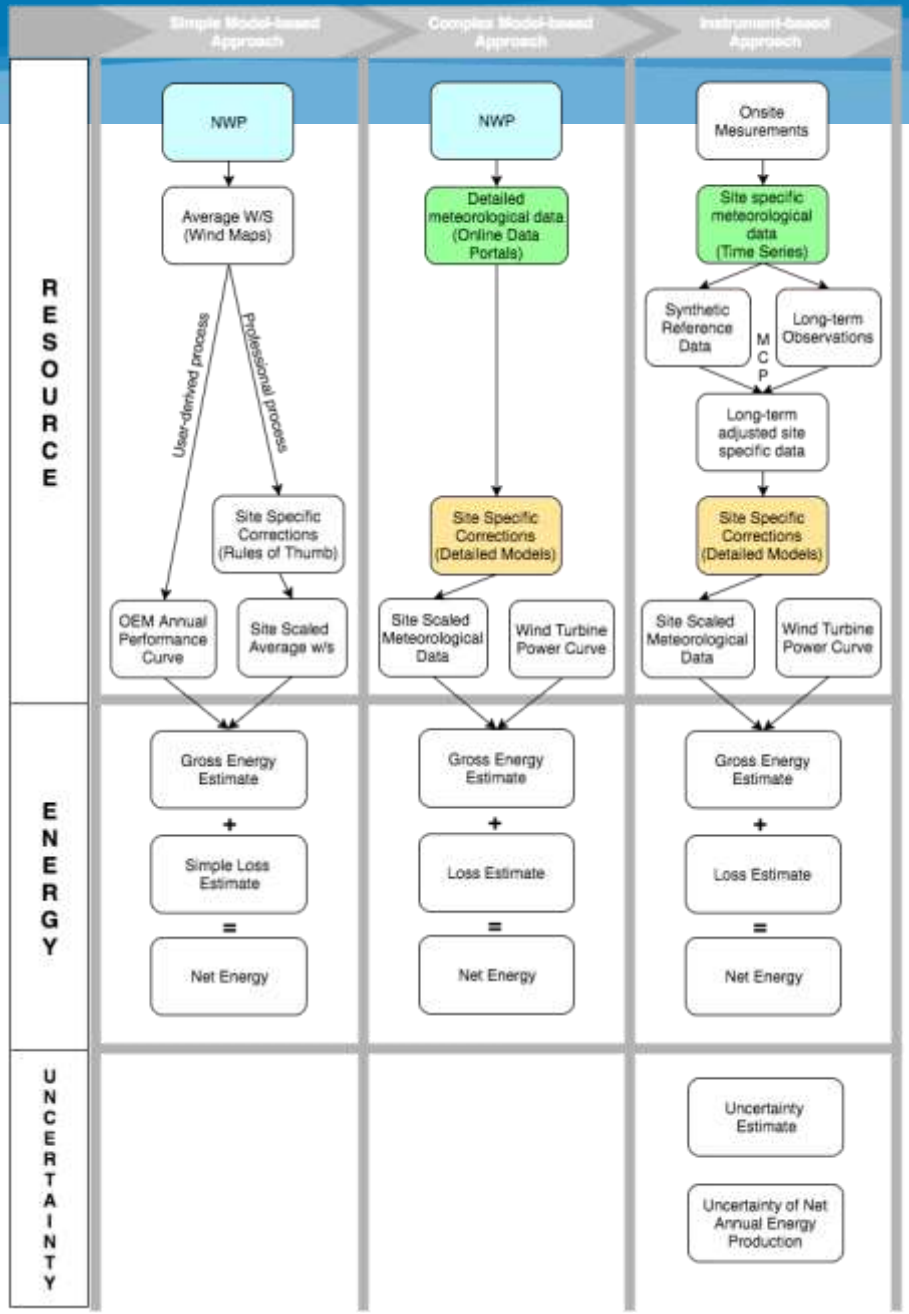
Summary of Approaches

Residential:
up to 20 kW

Commercial:
> 20 kW to 100 kW

Mid-size:
> 100 kW up to 1 MW

Large:
> 1 MW
(in a distributed application)



Framework Methodology

Part 1: Define resource assessment process

- Key parameters
  - Ramp of complexity
- Rules of thumb
- Loss and uncertainty factors.

Part 2: Define operational assessment parameters

- What needs to be measured
- How is it measured: monitoring and reporting.

Part 3: Determine validation approach.

Potential Next Steps

1. Quantify the impact of various input parameters
2. Evaluate rules of thumb
3. Validate the accuracy of current methods
4. Curate lessons learned into improved models and best practices.

Thank you!

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