NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Distributed Wind Diffusion Model Overview

SOLAR 2014 Conference

Robert Preus, Easan Drury, Ben Sigrin, and Michael Gleason

San Francisco, California

July 8, 2014

NREL/PR-5000-62341

Data Presented Are Samples Only

- This presentation includes sample graphs and tables and all data included are for purposes of illustrating input or output data type.
- The Distributed Wind Market Diffusion Model has not been confirmed to produce reliable data and not all examples are from the same model input set.

Purpose/Background

- **Simulate distributed wind (DW) generator demand through 2050; simulates customer purchase decision**
- **Explore market impacts of:**
  - DW installed cost changes
  - DW generator performance changes
  - DW energy policy and incentive changes
  - Changes to electricity rates and rate structure
  - Changes in financing options
  - Other factors.

Modeling Distributed Wind Diffusion

Basic model representation approach is to:

(1) Simulate the DW energy generation profiles for a range of turbine sizes and heights (12 sizes from 2.5 to 3,000 kW)

(2) Characterize the electricity load and on-site wind power potential for multiple market segments (residential, commercial, and industrial)

(3) Represent siting exclusions and limitations by location for each market segment

(4) Calculate the distributed wind economics for each market segment and location

(5) Calculate DW power diffusion based on wind economics and historical DW deployment.

Modeling Distributed Wind Diffusion

Distributed wind turbine size and hub height matrix

Turbine Rated Power (kW)	h1 (m)	h2 (m)	h3 (m)	h4 (m)
2.5	30			
5	30	40		
10	30	40	50	
20	30	40	50	
50	30	40	50	
100		40	50	
250			50	
500			50	80
750			50	80
1000				80
1500				80
3000				80

- We will add a 20-m hub height option for 2.5-kW turbines
- Other height options will be considered and balanced against the added computation required.

Wind Resource Data

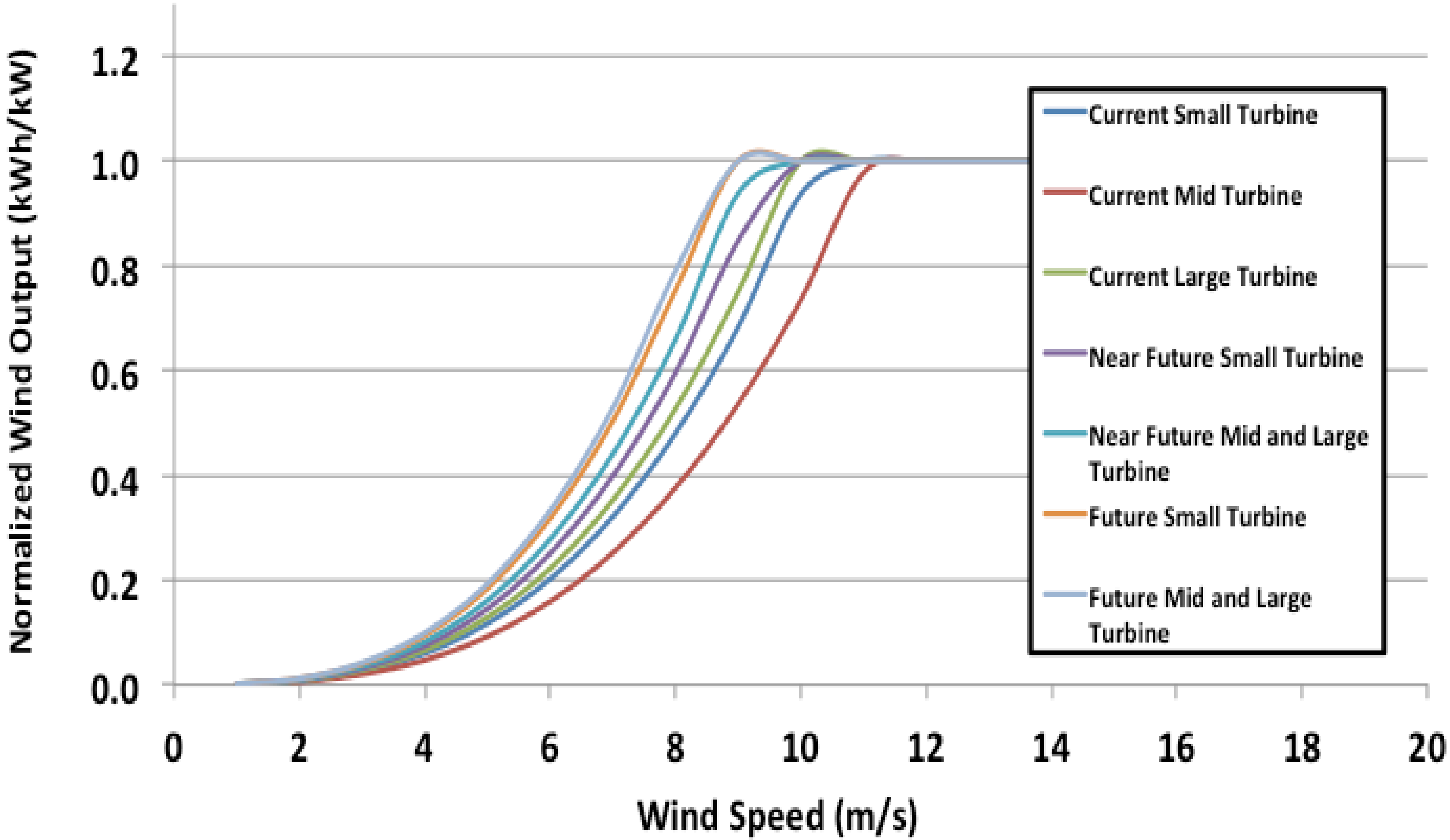
- NREL recently received a data set from AWS Truepower with 80-, 50-, and 30-meter data for the United States including Alaska and Hawaii.
- The model will be modified to calculate shear values from the 50- and 30-meter data to produce wind speed estimates at 40 and 20 meters.

Performance

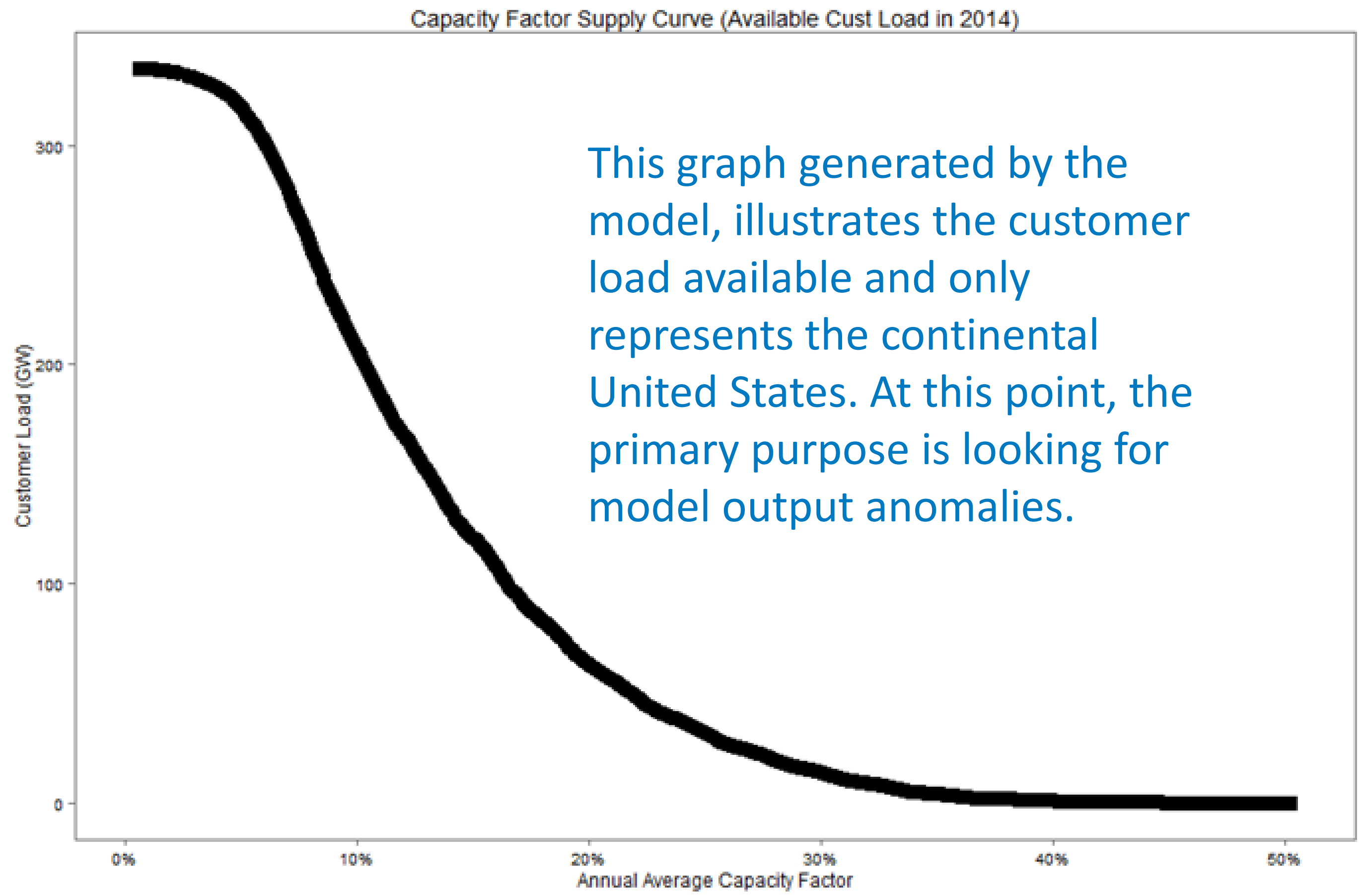
- Turbine performance (kWh/kW_{rating} /year) is modeled on a unit basis using generic power curves derived from a variety of current turbines.
- The family of generic curves was created assuming an array of values for turbine efficiency and specific swept area (m^2/kW_{rating}).
- Improvements in wind turbine performance are modeled by using a combination of increased area and efficiency.

Performance

Large improvements are expected

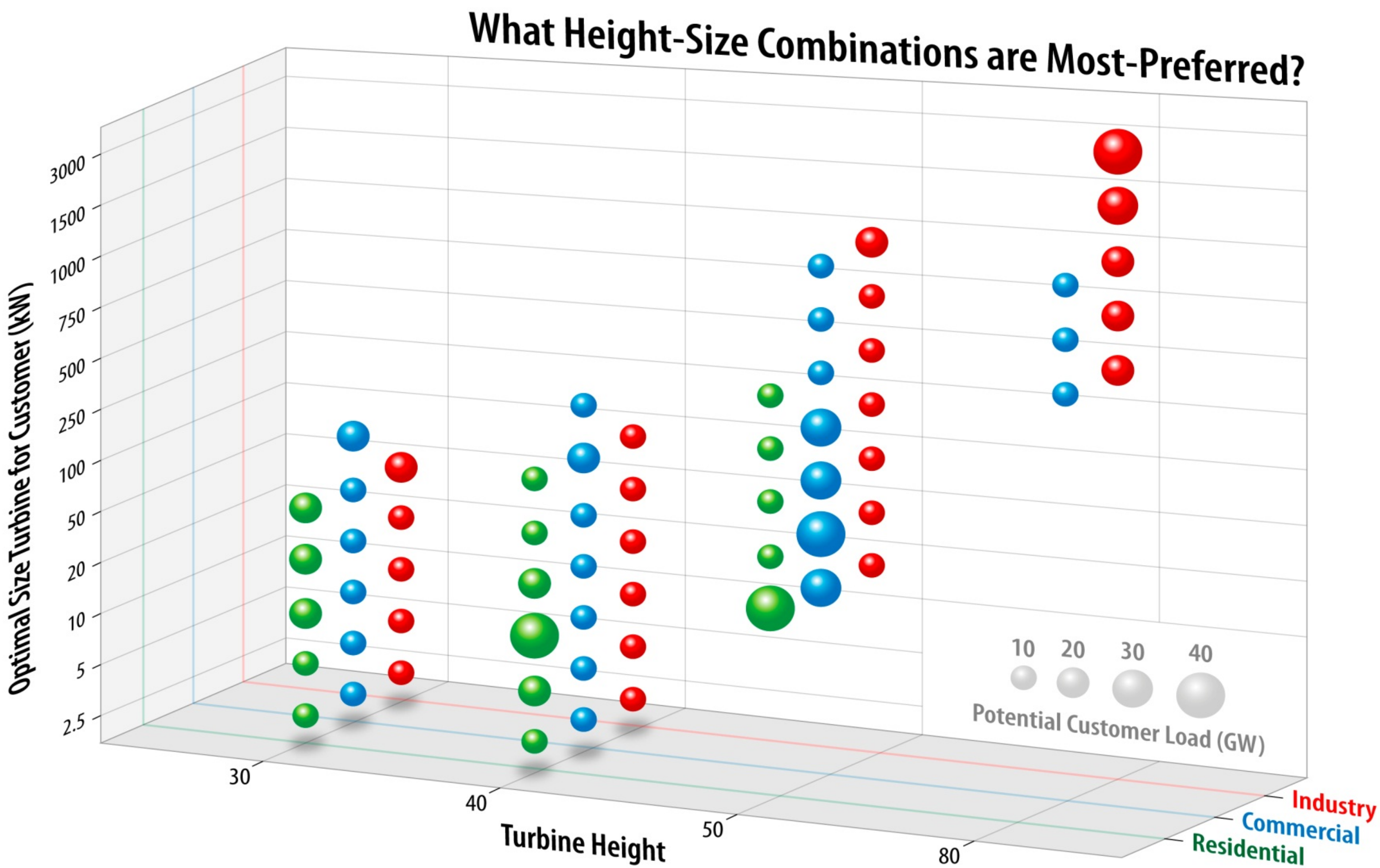


Performance – Capacity Factor Supply Curve



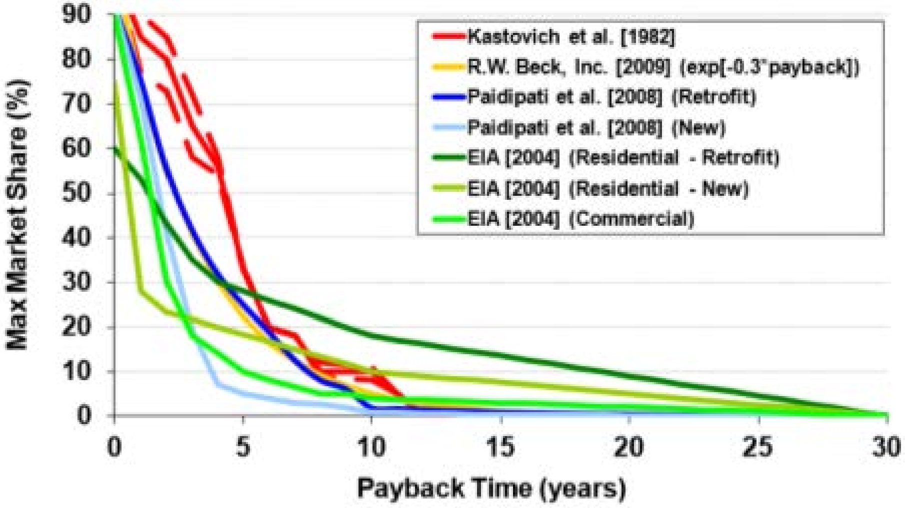
This graph represents the total load that could be supplied by distributed wind if built out to include all on-site load that has a capacity factor (CF) above the labeled value (i.e., at CF > 15% 100 GW). A similar graph with future power curves would show more available capacity.

Optimum Turbine Size/Hub-Height Combination



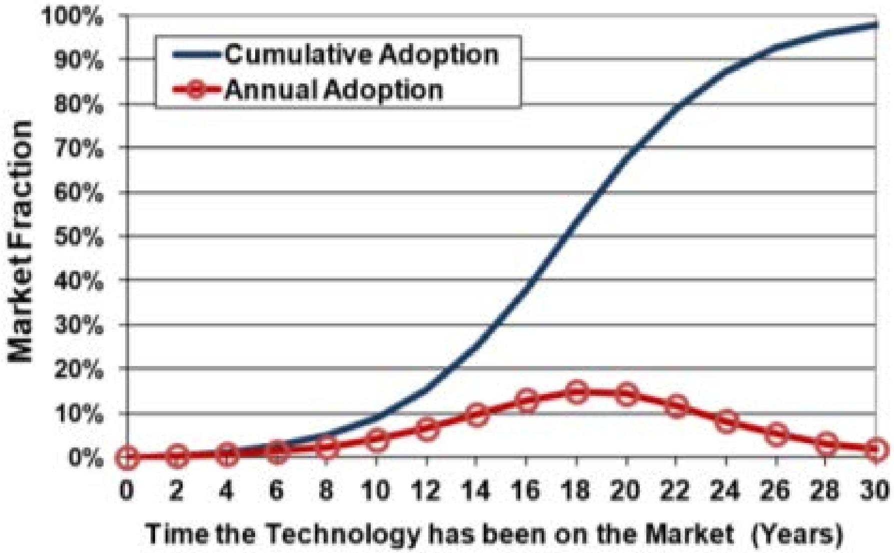
Likely need to add height restraints to get more realistic results for small wind

Diffusion – Past Work



Maximum market share as a function of payback time from referenced studies. NREL is currently adding new relationships based on a survey of 790 photovoltaic owners.

Typical annual and cumulative adoption rates simulated using the Bass Diffusion model



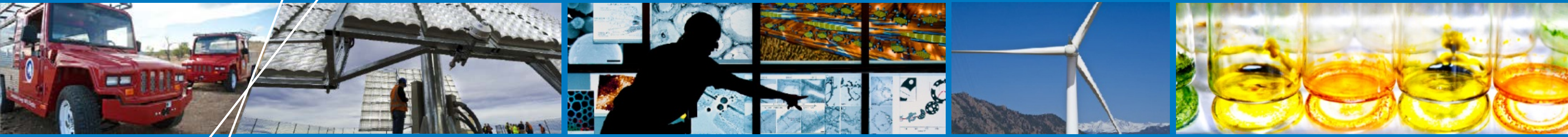
Development Before Simulating Market Trends

Next steps include:

- Importing improved wind data set from AWS Truepower
  - Covers Alaska and Hawaii
  - 30-m wind speed data set and 20-m calculation
- Improving representation of end-use electricity demand, rates, and rate structure
- Analyzing potential performance and cost improvements for small wind
- Reviewing if the model is over-predicting the tall tower selection
- Reviewing the exclusions parameter settings
- Adding leasing to financing options.

What Questions the Model Can Address

- What is the potential market size for distributed wind with current economic conditions?
- How large can the DW market grow with a range of performance and cost improvements?
- How much can reducing soft costs and other barriers improve the market?
- How much impact will incentives have and which ones are most effective?
- What is the impact of more attractive financing options?



Robert Preus

Robert.preus@nrel.gov