Wind Data Collection Best Practices

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Before starting, ponder…

What am I trying to accomplish with a wind study?

What data do I need?

How much data is necessary?

What questions must I answer with the data?

Process

Review — Review existing information
- Airport weather stations, previous projects, upper air data

Anticipate — Anticipate the project (e.g., kW of installed capacity)

Select — Select met tower site(s)

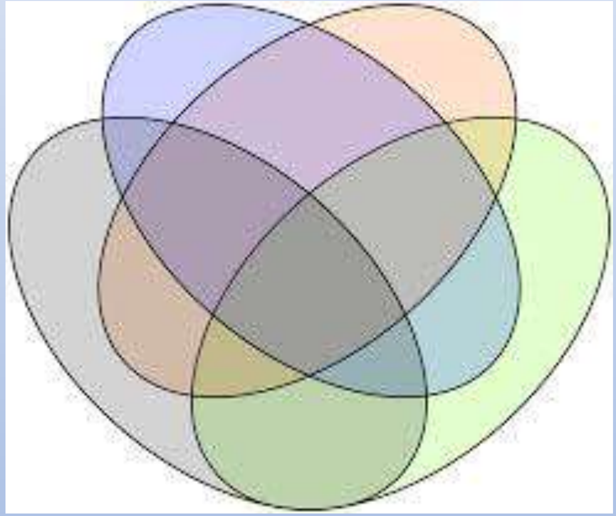
Obtain — Obtain permission for met tower (FAA, landowner)

Install — Install met tower(s); collect 1 year plus of “bankable” data
- Anticipate modeling use

Process continued

Analyze	Analyze wind data
Calculate	Calculate wind power class •1 (poor) to 7 (superb)
Classify	Classify the site per IEC 61400-1, 2nd and 3rd editions
Evaluate	Evaluate wind turbine options
Estimate	Estimate turbine annual energy production (AEP)

Site Selection



- Wind resource (high but not too high)
- Power distribution infrastructure, existing
- Road access
- Geotechnical conditions
- Landownership
- Airspace restrictions (FAA)
- Space for multi-turbine array
- Environmental, historical, wildlife considerations
- Icing potential
- Visual, noise, shadow flicker

Install Met Tower(s)

Think ahead; consider hub height of prospective turbines

Order 34 to 60 meter (115 to 195 ft.), tubular kit-type

Hire experienced installer

Document the installation!

- Use a standard documentation sheet to not forget anything

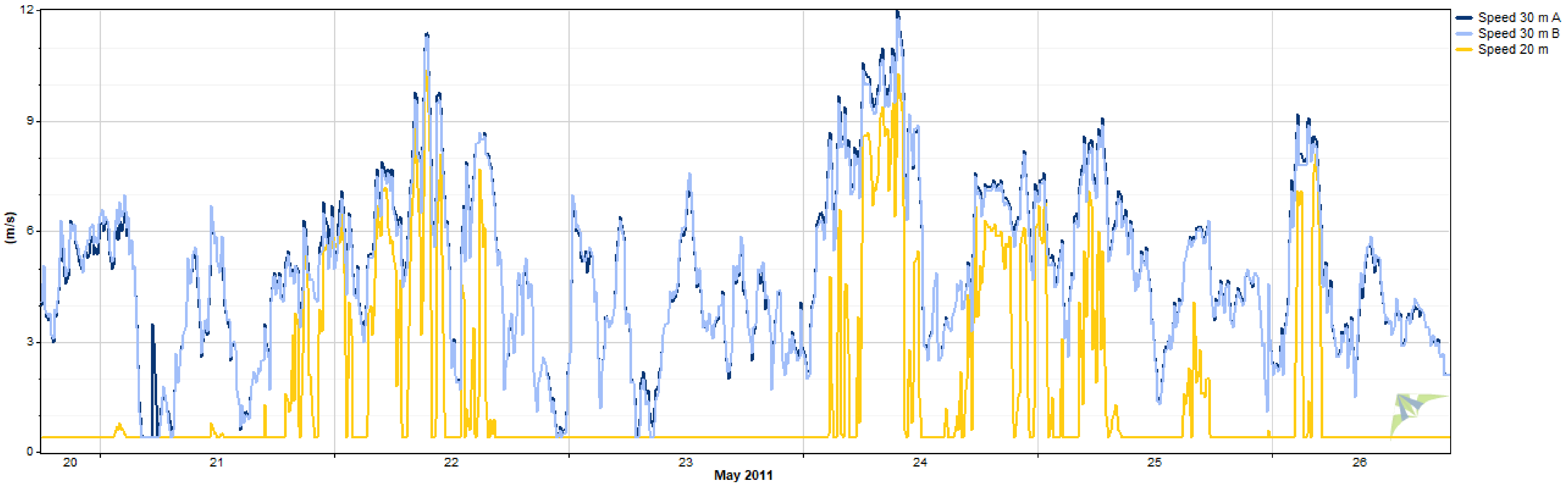
Photograph the installation!

- Use a guideline to obtain all needed shots

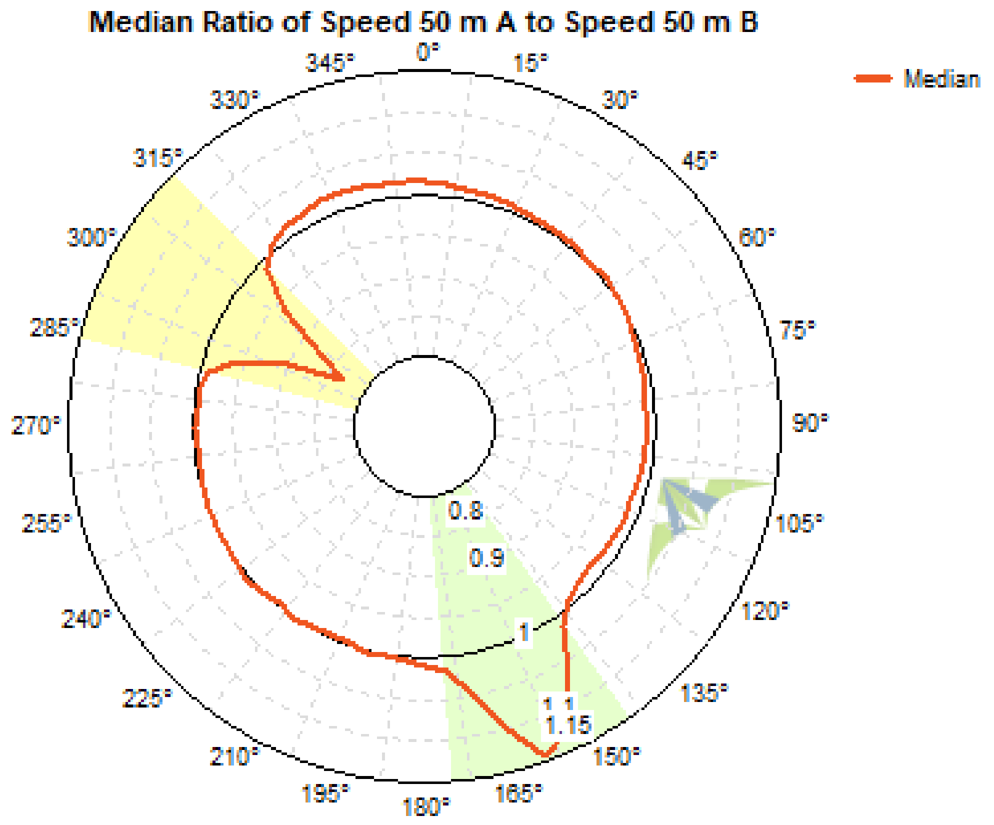
50 Meter Met Tower

Analyze the Wind Data

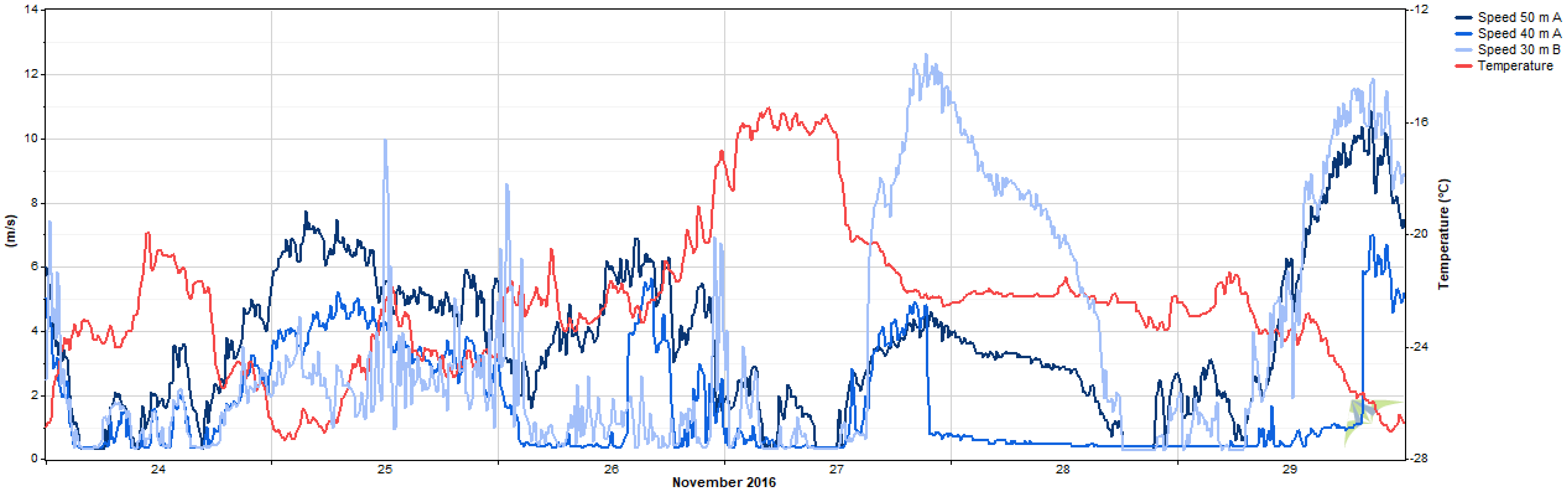
- Quality control; filter out:
  - Bad data (broken sensors, spurious signals, etc.)
  - Tower shadow
  - Icing events
- Create a clean data file
  - Conservative synthesis to create more representative data set compared to raw and filtered data
- Assess:
  - Turbulence
  - Extreme wind
  - Cold temperatures
  - Shear coefficient (speed change with height)
  - Statistical analyses (long-term correction, probability of exceedance)


12
9
6
3
0
(m/s)
20
21
22
23
24
25
26
May 2011
Speed 30 m A
Speed 30 m B
Speed 20 m

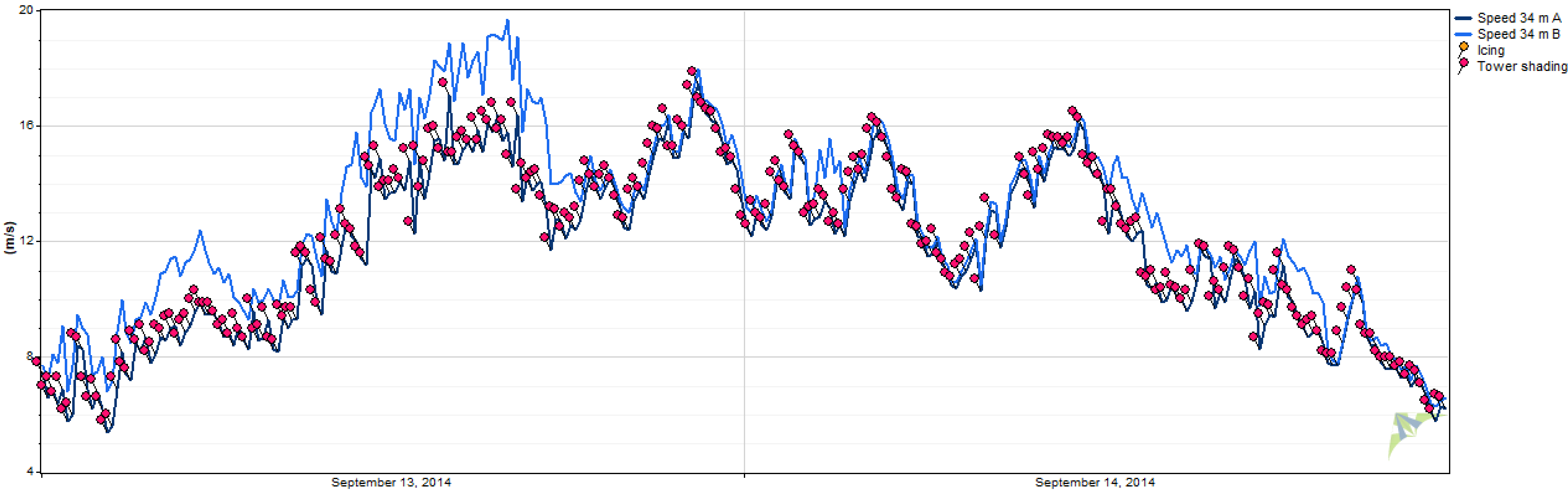
Bad Data



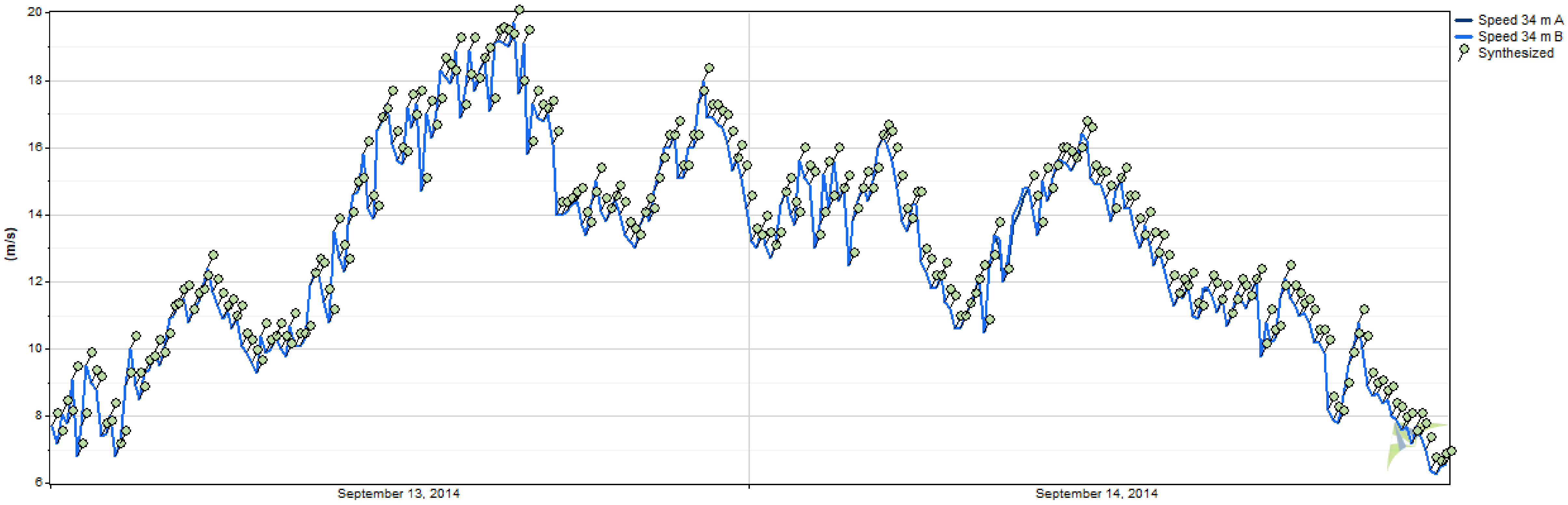
Tower Shadow (of paired anemometers)



Icing (rime ice)



Flag Tower Shadow

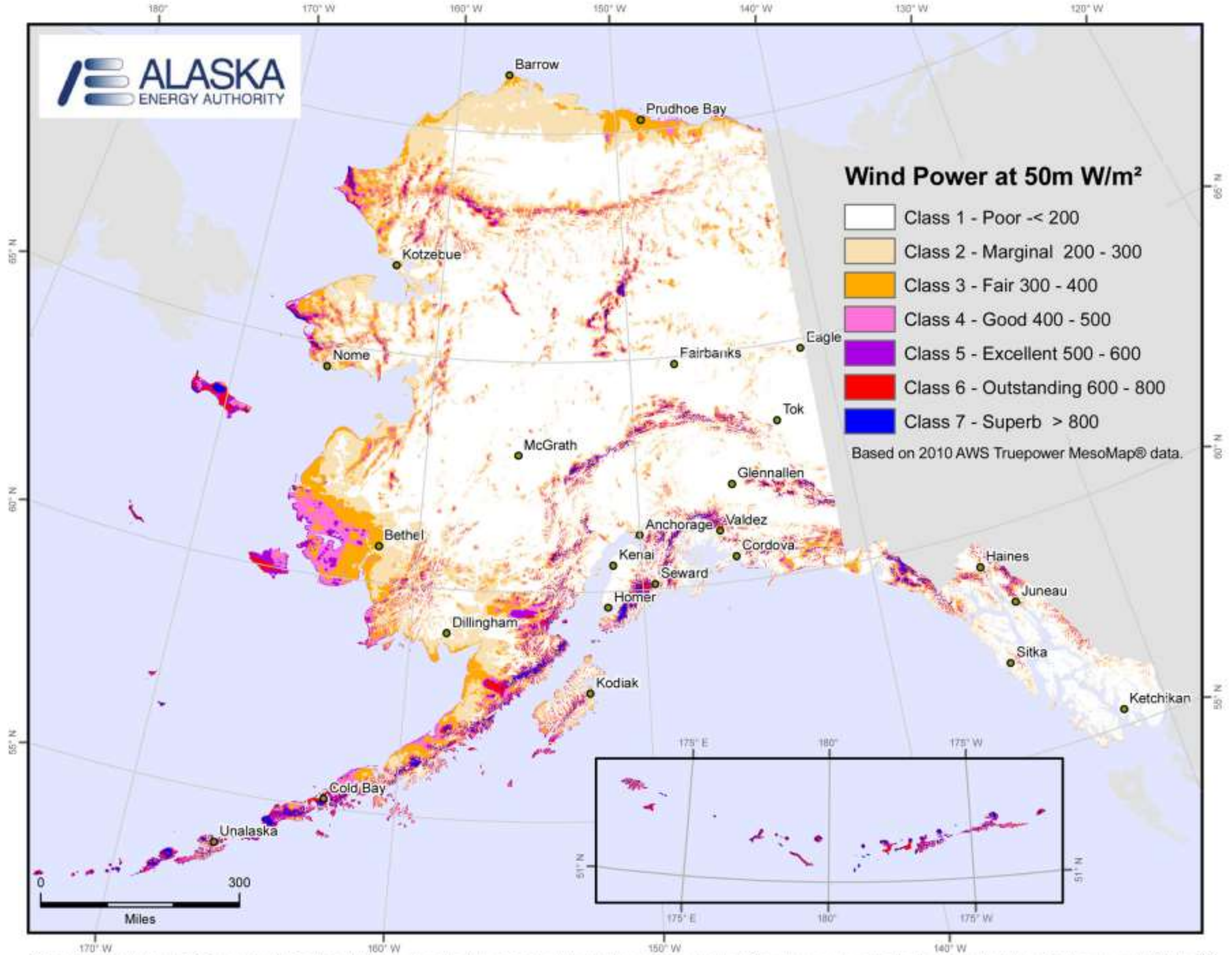


Data Synthesis of Filtered Data

Wind Power Class

- Developed by U.S. DOE, National Renewable Energy Laboratory
- Intuitive classification separates lower value from higher value sites
- Comparison only counts for “Rayleigh” wind speed distribution
- Based on wind power density ($\frac{P}{A} = \frac{1}{2}\rho U^3$)
  - Class 1 (poor)
  - Class 2 (marginal)
  - Class 3 (fair)
  - Class 4 (good)
  - Class 5 (excellent)
  - Class 6 (outstanding)
  - Class 7 (superb)

P	Power	W
A	Area	m^2
ρ	Density	kg/m^3
U	Wind speed	m/s



This map was created based on AWS Truepower MesoMap® system and historical weather data. Although it is believed to represent an accurage overal picture of the wind energy resource estimates at any location should be confirmed by measurement. October, 2010

IEC classification

- International Electrotechnical Commission
  - Switzerland-based standards organization
- For wind power, section 61400-1
  - 2nd edition, 1998
  - 3rd edition, 2003
- Wind turbines are classified by IEC 61400-1
  - Not by NREL wind power class!

IEC 61400-1, 3rd edition

- Classifications: extreme wind and turbulence
  - V_{ref} (50-year event, probable maximum 10-min average wind speed predicted by a Gumbel distribution)
  - I_{ref} ($I = {}^{\sigma_i}/_{U_i}$)

Wind Turbine Class		I	II	III	S
V_{ref}	m/s	50	42.5	37.5	Values specified by the designer
A	I_{ref}(-)	0.16			
B	I_{ref}(-)	0.14			
C	I_{ref}(-)	0.12			

V	Velocity (wind speed)	m/s
I	Turbulence Intensity	(-)
σ	Standard deviation	m/s
U	Wind speed	m/s

Wind Turbine Options for Alaska

- Home-scale (typically off-grid users)
  - 1 to 10 kW nameplate capacity
- Village-scale (village/hub community projects)
  - 25 to 1,000 kW capacity
- Utility-scale (Railbelt projects, except Kodiak)
  - 1,500 kW and larger capacity

Village-scale: Northern Power Systems (new)

- Based in Barre, Vermont, USA
- NPS 100C-21 (Class IIA), 21 m rotor, 100 kW
- NPS 100C-24 (Class IIIA), 24 m rotor, 95 kW
- Arctic model to -40°C (std. model to -20°C/-4°F)
- Monopole tower, upwind
- Direct-drive synchronous generator, no gearbox
- Hub heights: 30 and 37 meters (98 and 121 ft.)

Village-scale: XANT (new)

- Based in Brussels, Belgium
- XANT M-21 (Class IA), 21 m rotor, 100kW
- XANT M-24 (Class IIIA), 24 m rotor, 95 kW
- Arctic package available
- Direct-drive synchronous generator, no gearbox
- Monopole and tilt-up, guyed towers; downwind
- Hub heights
  - Monopole: 23, 31, and 37 meters
  - Tilt-up, guyed: 31 and 55 meters

Village-scale: EWT (new)

- Based in Amersfoort, The Netherlands
- DW 52-900 (Class IIA), 52 m rotor, 900kW
- DW 54-900 (Class IIIA), 54 m rotor, 900 kW
- DW 61-900 and 61-1000 (Class IIIA, 2nd and 3rd edition of IEC 61400-1 respectively)
- Arctic package available
- Direct-drive synchronous generator, no gearbox
- Monopole; upwind
- Hub heights
    - Monopole: 35, 50, 75 meters (new model 46 and 69 meters)

More Wind Turbine Options

- Windmatic
  - Originally built in Denmark
  - New 1979 to 1988
  - 17 to 24 meter rotor options
- Vestas
  - Leading Danish wind turbine manufacturer
  - New turbines utility-scale
  - <1,000 kW used models available
  - Remanufactured in California
- EOCycle
  - 20 and 25 kW models
  - New; Montreal, Quebec, Canada

For an Economic Analysis

- Identify suitable wind turbine per IEC 61400-1
- Select hub (and hence tip) height
  - Obtain FAA determination of no hazard
- Calculate Annual Energy Production (AEP)
  - Adjust for cold air density
  - *Conservatively* estimate AEP losses
    - Icing
    - Electrical
    - Array (wake interference)
    - Maintenance
    - Curtailment
- Combine with electrical and thermal load data to create a system model

Wind Data Take-aways

Need	Need high quality “bankable” data for project confidence and financing flexibility
Want	Want largest rotor diameter possible to maximize energy production and project economic value.