Wind Resource Assessment
Practical Guidance for Developing A Successful Wind Project

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What We Do

AWS Truepower partners with developers and investors to advance renewable energy worldwide.

Our services cover the lifecycle of solar and wind projects, from initial site qualification through due diligence, performance assessment, and real-time forecasting.
Company Snapshot

- Independent assessments on over 60,000+ MW
- Project roles in over 80 countries
- Established in 1983; nearly 30 years of industry experience
- Over 100 professional staff
  - Experts in meteorology, spatial analysis, environment, and engineering
Reference

- Measurement practices and standards
- Installation guidelines
- Data validation
- Climate and shear adjustments
- Offshore assessment
- Uncertainty
- Plant design and energy production estimates

Wind Resource Assessment Process

- Site Prospecting
- Monitoring Campaign
- Data Analysis
- Preliminary Reporting
- Wind Resource Modeling
- Energy Production Report
Goal of Resource Assessment: Minimize Uncertainties in Expected Energy Production

Uncertainty in Mean Wind Speed at Hub Height

- Measurement
- Past Climate
- Future Climate
- Shear
- Wind Flow Modeling

Uncertainty Levels:
- High
- Low

Percentage Range:
- 0% to 12%
Site Prospecting: Key Considerations

• Good wind resource
  – Greater than 6 m/s at hub height typically required
  – Estimated from wind maps, weather stations, vegetation, anecdotal information
• Transmission access and available capacity
  – Typically at least 115KV
  – Less than 20 km distance
• Site constructability (moderate slopes, road access)
• Compatible land uses
  – Private farmland, rangeland, grassland preferred
• Favorable market conditions (e.g., Renewable Portfolio Standard)
• Local support
• Few or no environmental and cultural obstacles
• Geographical information systems (GIS) are essential
Online Prospecting Support
Monitoring Campaign Design

• Most monitoring campaigns rely on tall towers (60+ m height)
  – Ground-based sodar and lidar are growing in popularity, but are not the primary instrument in most cases
• Typical tower instrumentation:
  – Two cup anemometers on each of three heights
  – One direction vane at two heights
  – Temperature sensor near ground level
• Additional optional instrumentation:
  – Pressure
  – Temperature change with height ("Delta-T")
  – Vertical wind speed
• Tower number and placement
  – Should be representative of likely turbine locations
  – NOT only in the best sites
• At least one year of data collection
  – Captures seasonal variations
Online Data Management

1. Google maps interface for spatial orientation
2. Projects organized in a navigation panel
3. Online view of mast statistics
4. Sensor summaries and failure flags
5. Sensor plots
6. Raw and QC’d data available for download
7. Monthly reports
Data QC and Validation

- Tall tower wind speed and direction data aren’t necessarily free of problems
- Common data issues:
  - Sensor failures and degradation
  - Sensor icing
  - Tower shadow and secondary effects
  - Influence of turbulence, inflow angle
Icing

• What an anemometer should look like

• What it sometimes really looks like
Assessment of Long-Term Wind Resource Potential

Adjust Measurements to the Long-Term [Measure-Correlate-Predict (MCP)]

- Establish a relationship between the primary on-site mast and a long-term reference site
- Often based on daily mean wind speeds
- Possible reference sites include National Weather Service stations, rawinsonde (upper-air) stations, offshore buoys, and modeled data
Extrapolation to Hub Height

- Characteristic shear measured on the mast
- Consider the observed tower shear and its surroundings
- Use ground-based remote sensing (sodar/lidar), if possible
Wind Flow Modeling

- Extrapolates from a few wind resource measurements to an entire wind farm
- Allows optimization of the plant layout
- Doing it well is essential for accurate energy production estimates
Numerical Weather Prediction (NWP) Models

• Full time-varying 3D physical model of the atmosphere
• Solve the Navier-Stokes equations, including energy balance, surface exchanges, phase transitions, turbulence parameterization...
• Predict the evolution of meteorological variables:
  - Pressure
  - Temperature
  - Wind speed
  - Air density
  - Humidity
  - and more...
NWP Modeling - Hawaiian Islands
NWP Modeling – Mountainous Area

Wind flow at 80-m height
Typical Outputs

- Wind speed map
- Wind resource grid
- Speed/direction distributions
- Used in plant design and analysis programs
Energy Assessment and Project Design

Wind Farm Design and Optimization Software

- **Flexible**: Designed for individuals to large consultancies, beginners to experienced wind engineers.
- **Compatible**: Supports all leading file formats and data types.
- **User-defined**: Architecture patterned after geographical information systems, allows for complex exclusions and setbacks to be designed easily for the most challenging sites.
- **Transparent**: Open source platform. Calculations can be observed and vetted independently, and features can be added or modified by users.
Thank you

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