

Wind Studies Using Sodar Technology

Where is all the wind?

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Wind Energy Production Farms Feasibility Committee

Columbia, SC

Partners



CENTER *for* HYDROGEN RESEARCH



- **CMMC LLC**
- **Deyton's Shipyard Inc.**
- **SecondWind**
- **U. S. Coast Guard**



“Thinking differently”

Fuel	Availability	Energy	Future
Coal	Dispatchable (capacity resource)	Btu/kg	
Nuclear	Dispatchable (capacity resource)	Btu/kg	
Wind	Non-dispatchable Weather dependent	Btu/(m/s) Depending on temp and pressure	Storage = capacity resource, dispatchable

Objective

- **Accelerate acceptance of *Sodar* data as “bankable” for use in obtaining financing of wind farm projects**
 - **Currently accepted technology is expensive to perform offshore due to construction costs.**
 - **Hub height measurements using accepted technology requires FAA permit due to the height of the towers.**

Wind Monitoring

Why?

- **Prospecting**
- **Wind farm design**
- **Project Financing**
- **Operation**
 - **Forecasting**
 - **Maintenance**

What?

- **Wind speed**
- **Wind direction**
- **Turbulence**
- **Temperature**
- **Barometric pressure**

Wind Power

$$Power = 0.5 * \rho * A * U^3$$

ρ = air density

A = area of rotor

U = wind speed

$$4^3 = 64$$

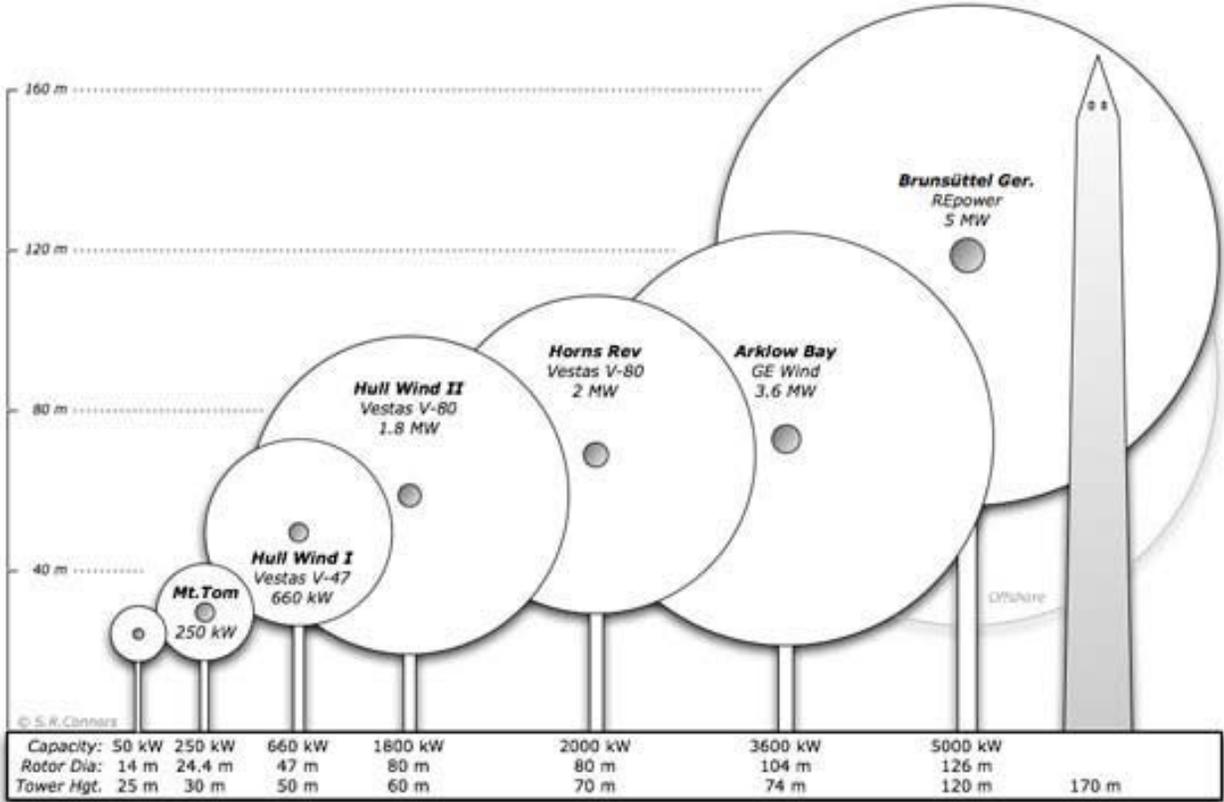
$$6^3 = 216$$

$$8^3 = 512$$

$$10^3 = 1000$$



Not Your Dad's Windmill



Wind Shear

- Surface roughness
- Wind speed increases with height
- Increase varies depending on site conditions
 - Groundcover
 - Topography
- Typical wind turbine has a hub height of 40m – 80m
- Measure wind speed at difference heights

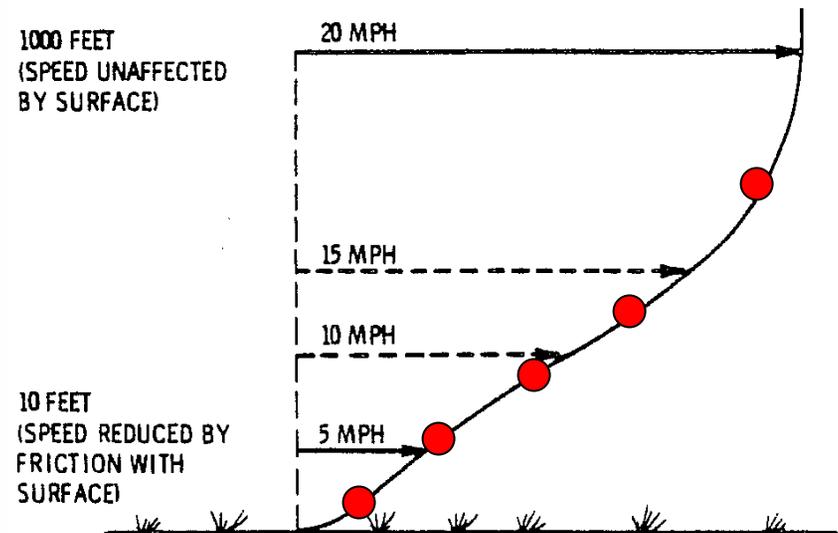
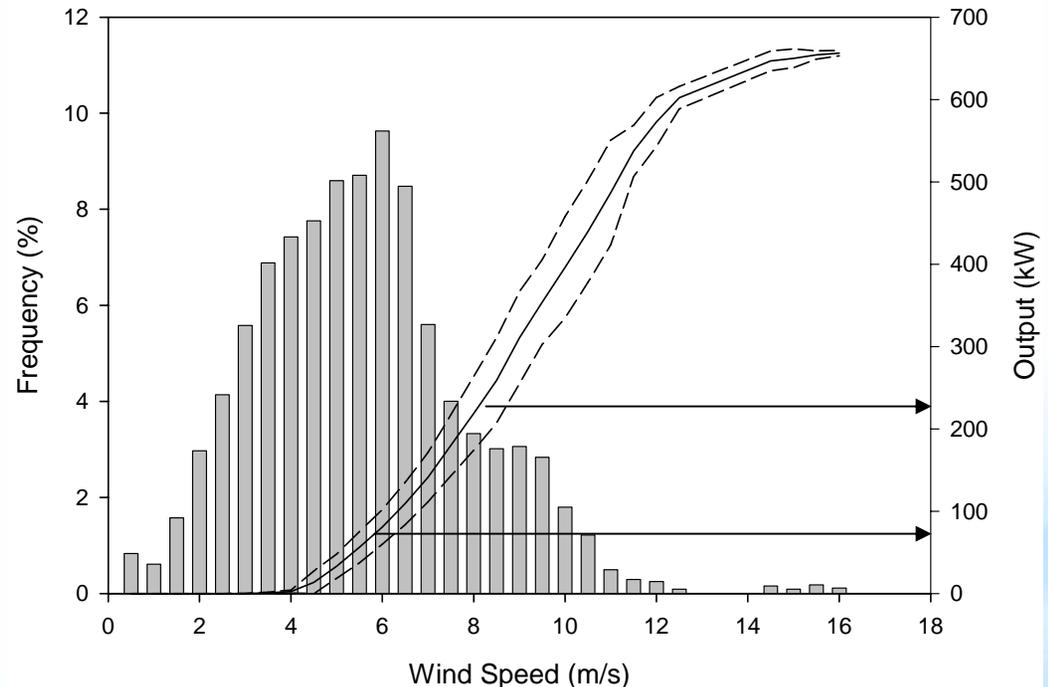


FIGURE 2. Effect of Surface Friction on Low-Level Wind

$$\frac{U(z_2)}{U(z_1)} = \frac{\ln(z_2/z_0)}{\ln(z_1/z_0)}$$

Power Curve

- Wind speed histogram
- 660 kW wind turbine
 - Power generation begins at 4 m/s
 - 33% increase in wind speed, 6 – 8, results in a 300% increase in power output



Measuring Wind Speed

- **Anemometer, wind vane**
 - **Requires tower**
 - >200ft needs FAA permit
 - **Multiple heights**
 - Wind shear
 - **Multiple sensors**
 - Shadowing
 - Require maintenance
 - **Cup**
 - Rotation speed correlated to wind speed
 - **Data recorder**



Measuring Wind Speed

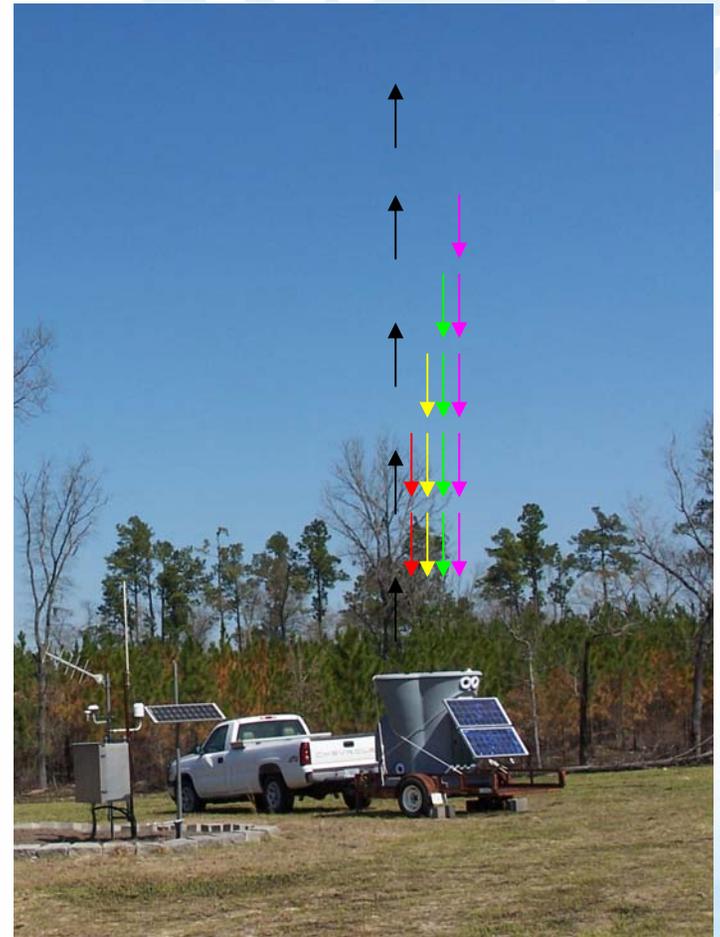
■ Sodar

- Sound detection and ranging
- “Chirp” of sound emitted from a phased array of transceivers
- Reflected sound collected by transceivers array
 - Different air densities at different heights
- Data analyzed to determine wind speed and direction (horizontal and vertical) at 11 different heights, up to 200m

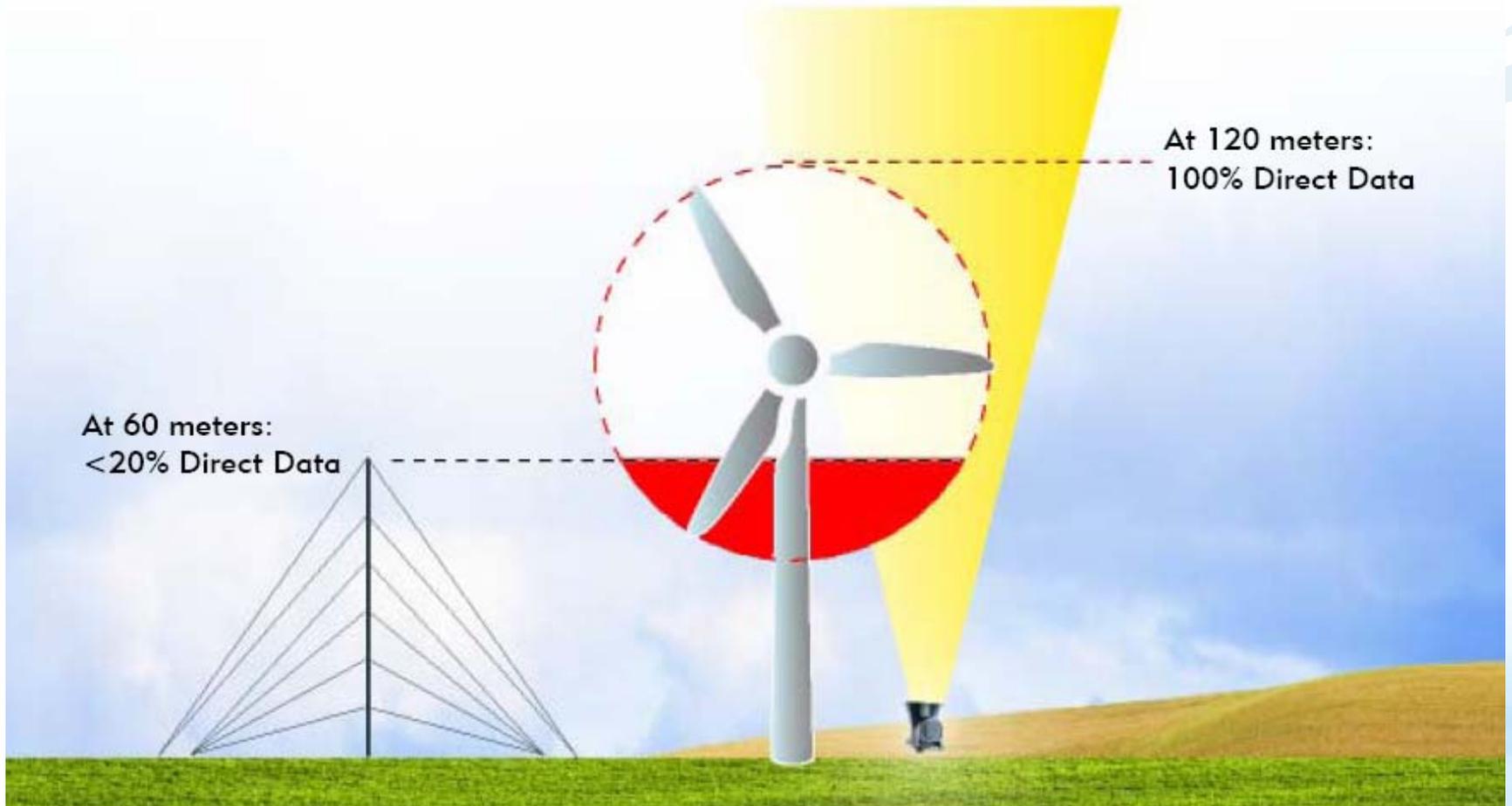


Sodar

- **Triton by SecondWind**
 - Low power consumption
 - Operates in adverse weather conditions
 - Robust online data analysis package
 - Small (6'x6'x4') and portable
 - Rugged
 - Designed for wind power assessments



Swept Area Coverage



Triton Data - Skyserve



Home > Site Data

Standard Data Extended Data Operational Data Analysis Configuration

Site: Triton 149
Time: 3/31/2009 17:30:00 UTC

Latitude: 33.33333
Longitude: -81.59157
Elevation: 318.16ft

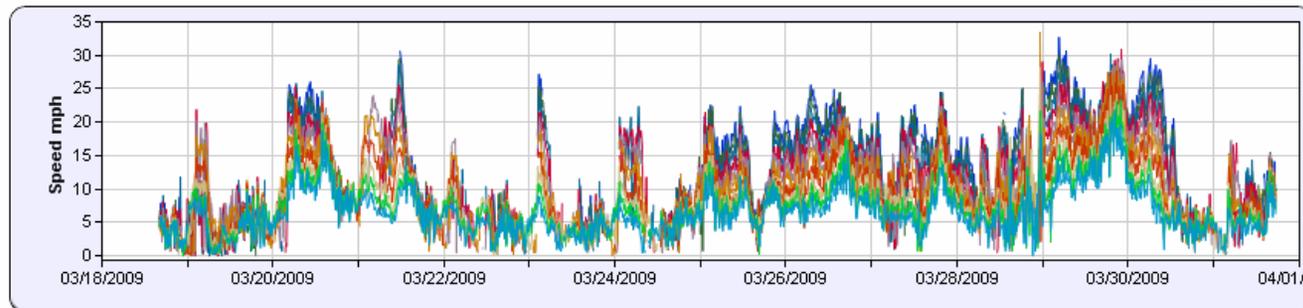
Humidity: 53%

Q > 85%			
Height	Wind Speed	Wind Direction	Avg. Wind Speed
656ft	9.9 mph	179°[SSE]	16.5mph
590ft	9.8 mph	178°[SSE]	14.9mph
524ft	9.7 mph	177°[SSE]	13.2mph
459ft	8 mph	178°[SSE]	12.2mph
393ft	8.2 mph	167°[SSE]	11.3mph
328ft	9.6 mph	173°[SSE]	10.4mph
262ft	9.2 mph	168°[SSE]	9.4mph
196ft	7.1 mph	171°[SSE]	8.2mph
164ft	6.9 mph	180°[S]	7.4mph
131ft	6.1 mph	178°[SSE]	6.5mph

Start:
End:
Time selections are in UTC, mm/dd/yyyy
Other:

▾

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Sodar Testing

- Coastal
- Offshore
- Validate with Met tower



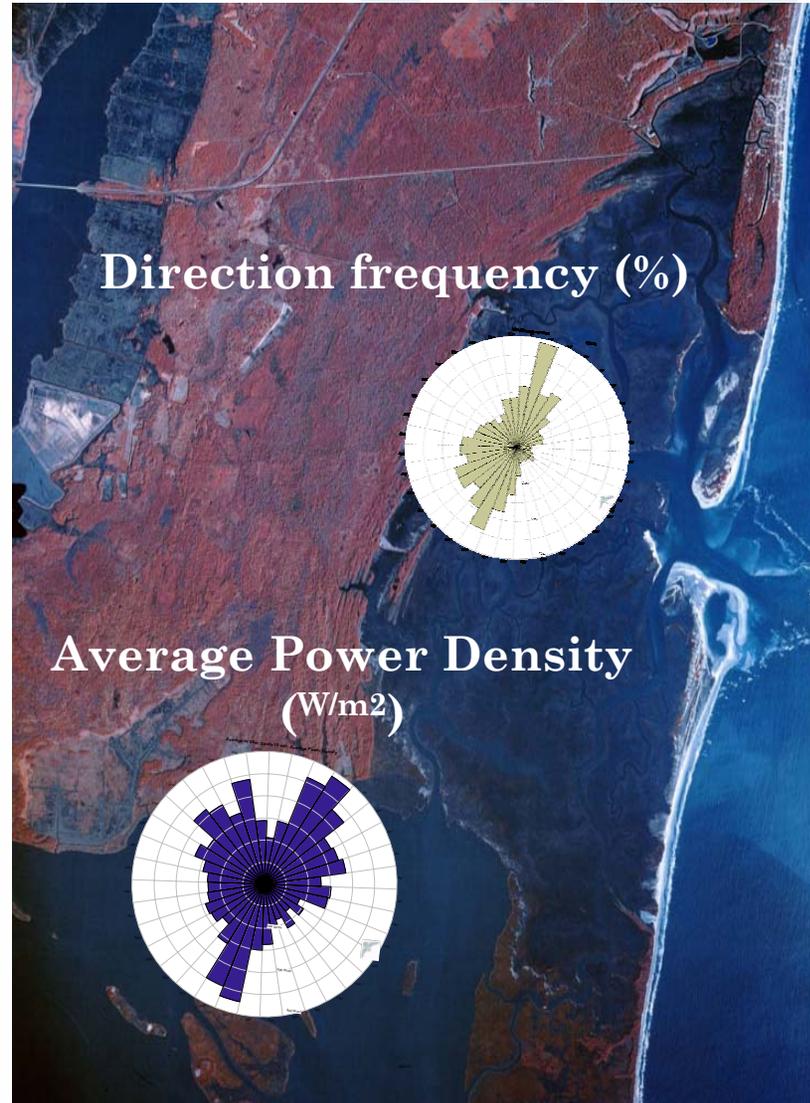
Sodar Testing

- **Locations**



Met Tower

- Preliminary Data

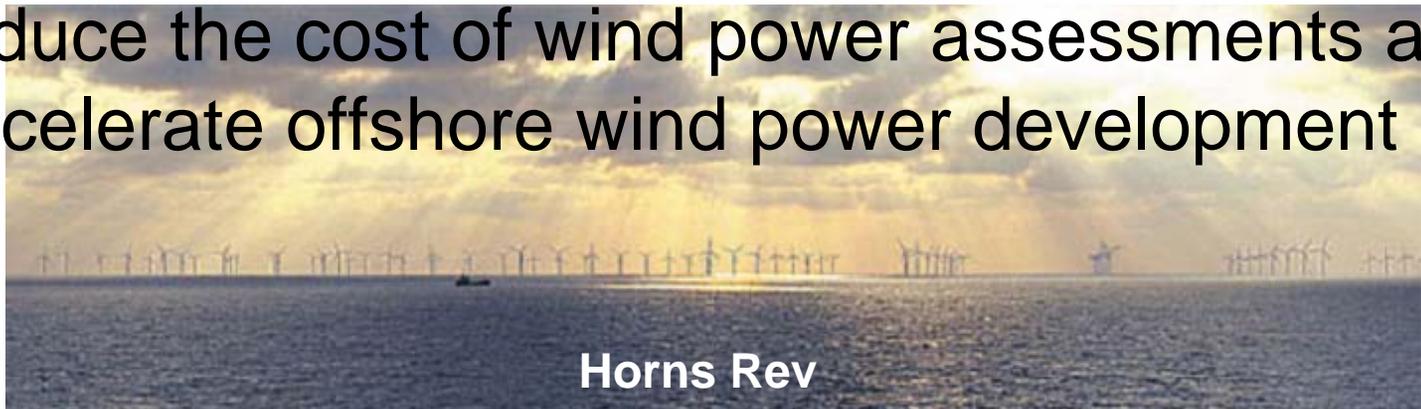


Where Are We?

- **Sodar purchased and received**
- **Operational check performed at SRNL**
- **Mount on trailer for transport to coast**
- **Begin testing at Goat Island, 5/14/09**
- **Begin testing on USCG platform, 5/14/10**

Summary

- Wind power varies with the cube of wind speed
- ***Distribution*** of wind speed must be measured at a potential wind farm site
- Offshore met towers are expensive and are not typically built to the height of the wind turbine
- Acceptance of Sodar data as “bankable” will reduce the cost of wind power assessments and accelerate offshore wind power development



Horns Rev