

Noorvik Wind Resource Report

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Date: September 17, 2010*



Village of Noorvik aerial view; D. Vaught photo

Contents

Summary 2

 Test Site Location 3

Data Recovery 4

Wind Speed 4

 Daily Wind Profile 5

 Probability Distribution Function 6

Wind Shear and Roughness 6

Extreme Winds..... 7

Temperature and Density 7

Wind Direction 7

Turbulence 8

Summary

The wind resource measured at the new Noorvik wind power site, located on the old runway, is difficult to characterize as data recovery from the met tower proved to be sporadic with just six and a half months of data. If projected to a full year, however, a Class 2 (marginal) wind resource is predicted. Unfortunately, the Noorvik airport is not equipped with a NOAA weather observing system (an AWOS or ASOS); hence it is not possible to correlate the met tower recovered data with airport data to predict annual wind energy statistics. Because the winter met tower data appeared promising for met tower development, it is may be advisable to re-erect a met tower at the project site location and obtain a full year data set. If viable, the old runway is ideal for wind power development due to proximity to the power plant and other infrastructure.

Met tower data synopsis

Data dates	August 2, 2008 to May 6, 2009 (6.5 months recovered)
Wind Power Class	Class 2 (marginal), projected from 6.5 months data
Power density mean, 30 meters	170 W/m ² , 6.5 months data
Wind sped mean, 30 meters	4.50 m/s, 6.5 months data
Max. 10-minute wind speed average	24.0 m/s
Maximum wind gust	29.1 m/s (February 2009)
Weibull distribution parameters	K = 1.41, c = 4.83 m/s, 6.5 months data
Wind shear power law exponent	0.237
Roughness class	3.16 (forest)
Turbulence intensity, mean	0.106
IEC 61400-1, 3 rd ed. classification	Not calculated, insufficient data

Community profile

Current Population:	628 (2009 DCCED Certified Population)
Incorporation Type:	2nd Class City
Borough Located In:	Northwest Arctic Borough
Taxes:	Sales: 4% (City), Property: None, Special: 4% Utility Tax (City); 4% Landfill Tax (City)
National Flood Insurance Program Participant:	Yes

Coastal Management District: Northwest Arctic Borough

Test Site Location

The met tower was located at the intersection of the main runway and the cross-wind runway of Noorvik’s old airport. This site was chosen due to its proximity to the Noorvik powerplant and other infrastructure and its ready construction and wintertime access.

Site information

Site number	0002
Latitude/longitude	N 66° 49.829', W 161° 1.848'
Site elevation	15 meters
Datalogger type	NRG Symphonie, 10 minute time step
Tower type	NRG 30-meter tall tower, 102 mm (4 inch) diameter
Anchor type	DB88 duckbill

Google Earth image



Tower sensor information

Channel	Sensor type	Height	Multiplier	Offset	Orientation
1	NRG #40 anemometer	30 m (A)	0.765	0.35	SW
2	NRG #40 anemometer	30 m (B)	0.765	0.35	NE
3	NRG #40 anemometer	20 m	0.765	0.35	SW
7	NRG #200P wind vane	30 m	0.351		NW
9	NRG #110S Temp C	2 m	0.136	-86.383	N

Data Recovery

Unfortunately, data recovery in Noorvik proved to be poor with a datalogger failure on November 20, 2008 that was not corrected until February 6, 2009, after which data was collected (although not temperature) until May 6, 2009. Reportedly, the met tower was removed in October, 2009. Status of data possibly collected from May through October 2009 is not known. Of the data that was collected – approximately 6.5 months worth overall – few icing events were recorded and sensors appeared to function normally. One very significant confusion, however, was that the replacement datalogger in February 2009 did not have the correct site number programmed into it and subsequent data was difficult to manage. Additionally, upon replacement of the datalogger in February, 2009, the temperature sensor now longer functioned and wind direction data no longer matched well with that collected August through November 2009. Reasons for these discrepancies are not known.

Data recovery summary table

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)
Speed 30 m A	m/s	30 m	39,889	28,582	71.7
Speed 30 m B	m/s	30 m	39,889	28,582	71.7
Speed 20 m	m/s	20 m	39,889	28,582	71.7
Direction 30 m	°	30 m	39,889	28,490	71.4
Temperature	°C		39,889	15,769	39.5

Anemometer data recovery

Year	Month	Possible Records	30 m A		30 m B		20 m	
			Valid Records	Recovery Rate (%)	Valid Records	Recovery Rate (%)	Valid Records	Recovery Rate (%)
2008	Aug	4,237	4,237	100.0	4,237	100.0	4,237	100.0
2008	Sep	4,320	4,320	100.0	4,320	100.0	4,320	100.0
2008	Oct	4,464	4,464	100.0	4,464	100.0	4,464	100.0
2008	Nov	4,320	2,748	63.6	2,748	63.6	2,748	63.6
2008	Dec	4,464	0	0.0	0	0.0	0	0.0
2009	Jan	4,464	0	0.0	0	0.0	0	0.0
2009	Feb	4,032	3,225	80.0	3,225	80.0	3,225	80.0
2009	Mar	4,464	4,464	100.0	4,464	100.0	4,464	100.0
2009	Apr	4,320	4,320	100.0	4,320	100.0	4,320	100.0
2009	May	804	804	100.0	804	100.0	804	100.0
All data		39,889	28,582	71.7	28,582	71.7	28,582	71.7

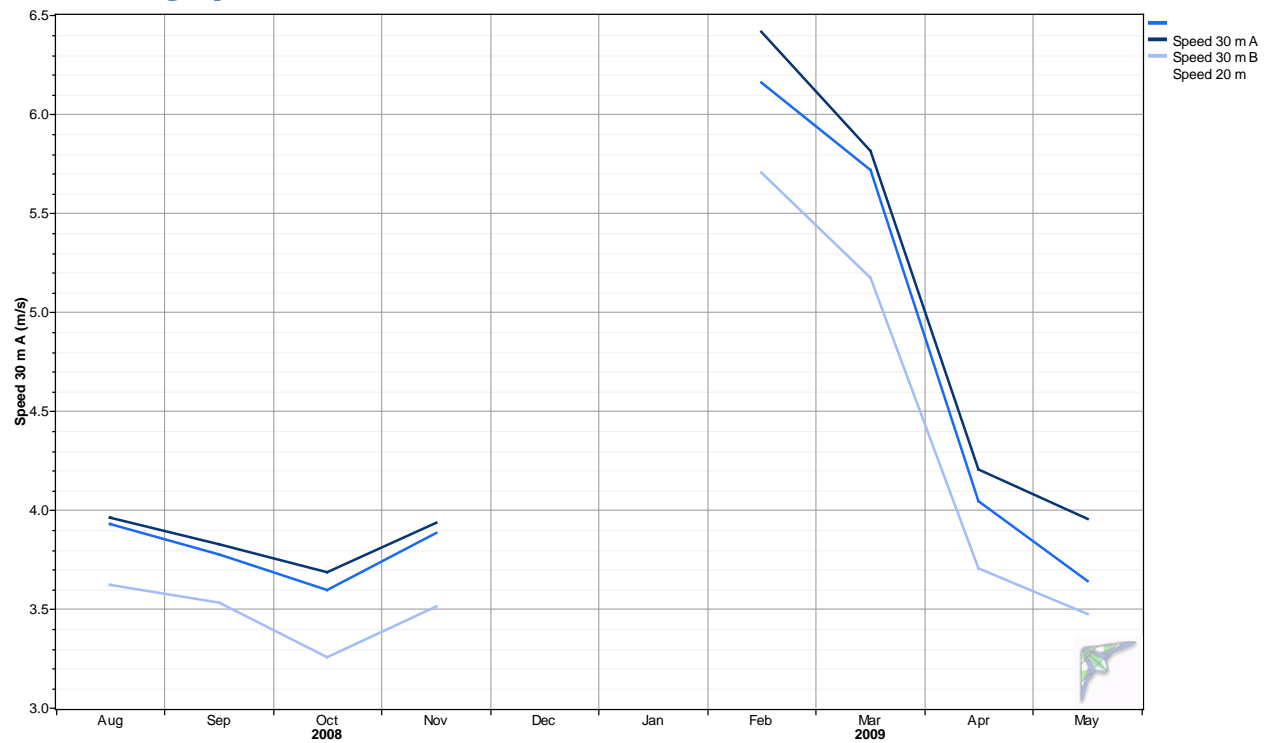
Wind Speed

Wind data collected from the met tower was not sufficient to adequately characterize the site or predict the annual wind resource. Of data that was collected, late winter winds in Noorvik were stronger than late summer/autumn winds.

Anemometer data summary

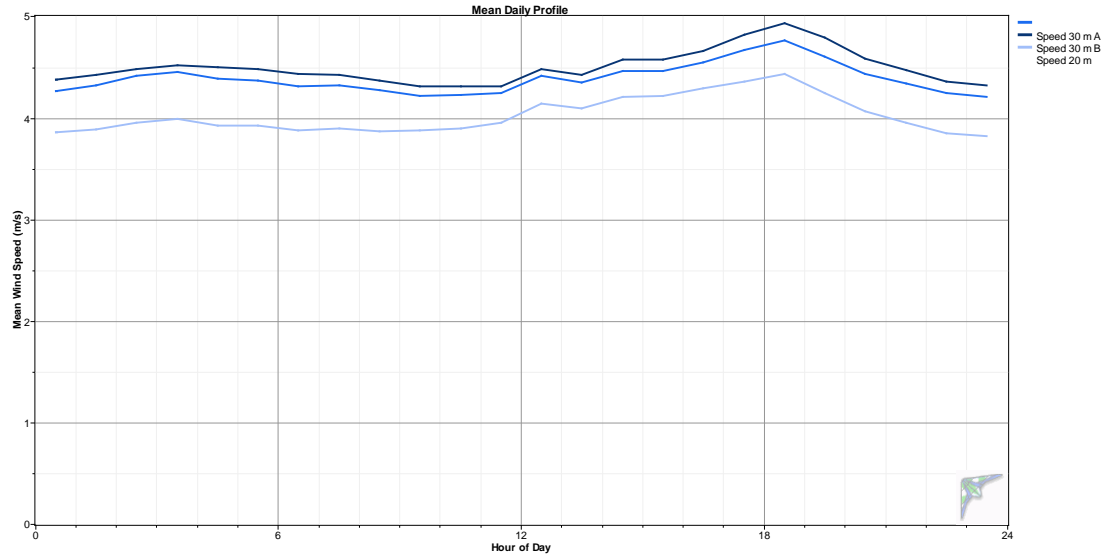
Variable	Speed 30 m A	Speed 30 m B	Speed 20 m
Measurement height (m)	30	30	20
Mean wind speed (m/s)	4.39	4.50	4.03
Max 10-min avg wind speed (m/s)	23.8	24	22.2
Max gust wind speed (m/s)	29.4	29.1	28.3
Weibull k	1.41	1.44	1.43
Weibull c (m/s)	4.83	4.96	4.44
Mean power density (W/m ²)	165	170	125
Mean energy content (kWh/m ² /yr)	1,441	1,488	1,093
Energy pattern factor	3.14	3.01	3.08
1-hr autocorrelation coefficient	0.925	0.918	0.922
Diurnal pattern strength	0.027	0.032	0.049
Hour of peak wind speed	19	19	17

Time series graph



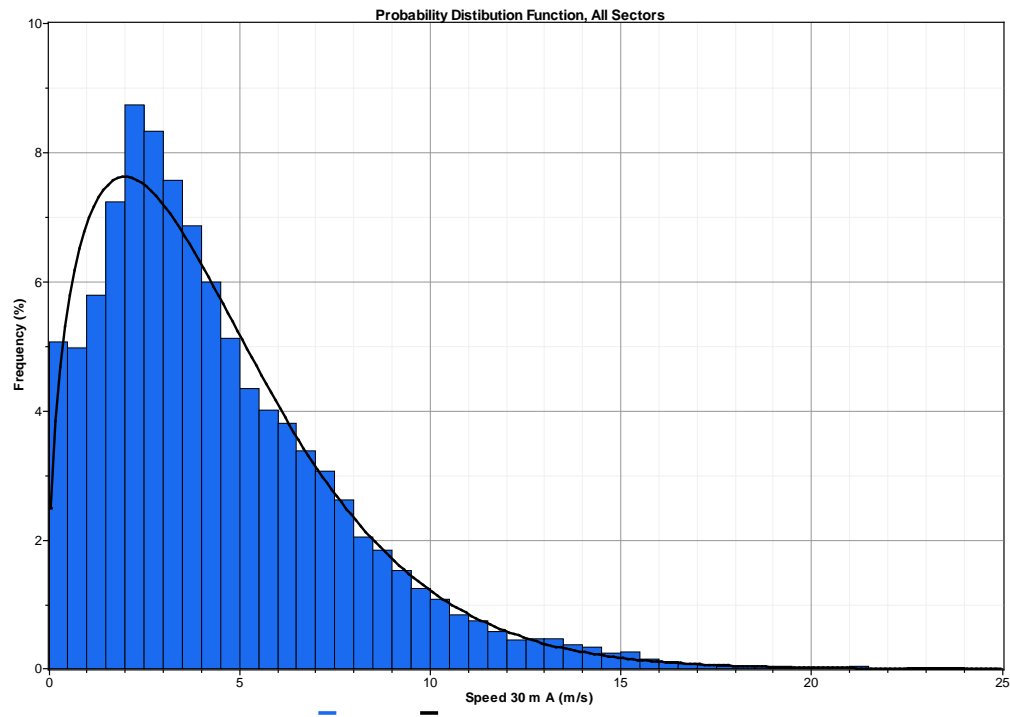
Daily Wind Profile

The average daily wind profile in Noorvik indicates lowest wind speeds during the mid-morning hours and highest wind speeds during early evening.



Probability Distribution Function

The probability distribution function (PDF), or histogram, of the 30 meter A wind speeds indicates wind speed “bins” oriented toward the lower speeds compared to a normal wind power shape curve of $k=2.0$, otherwise known as the Rayleigh distribution.

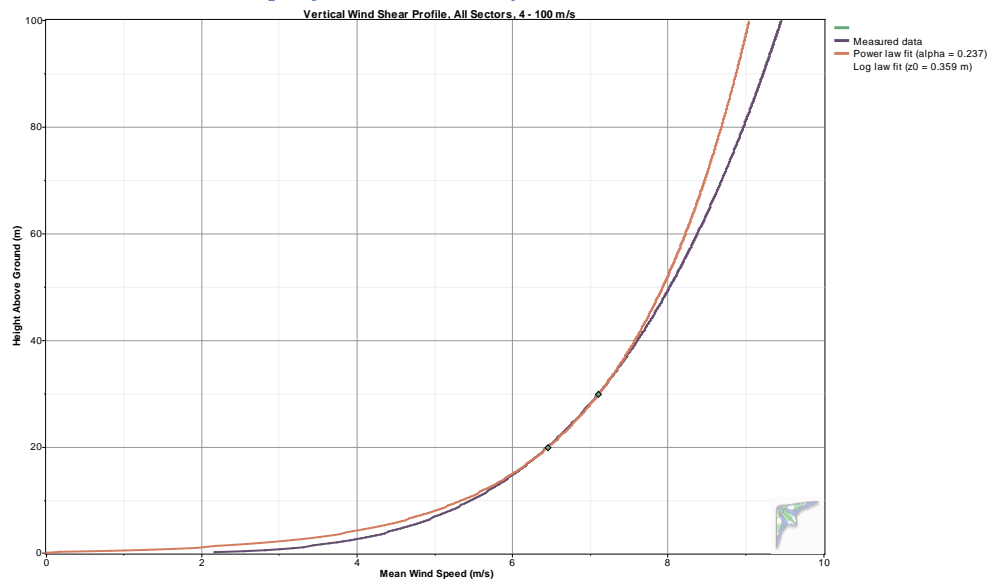


Wind Shear and Roughness

A wind shear power law exponent of 0.237 indicates fairly wind shear at the test site; hence wind turbine construction at a high hub height would be a desirable option. Related to wind shear, a calculated surface roughness of 0.403 meters (the height above ground level where wind velocity would

be zero) indicates very rough terrain (roughness description: forest) surrounding the met tower. Undoubtedly this is related to the heavy willow brush in the vicinity of Noorvik's old runway.

Vertical wind shear profile, wind > 4 m/s



Extreme Winds

Insufficient data was collected to predict extreme wind probability for the site. It is likely though, considering the low average and maximum winds recorded during the 6.5 months of data recovery, that the site classifies as International Electrotechnical Commission (IEC) 61400-1, 3rd edition (2005), Class III, the lowest defined and most common.

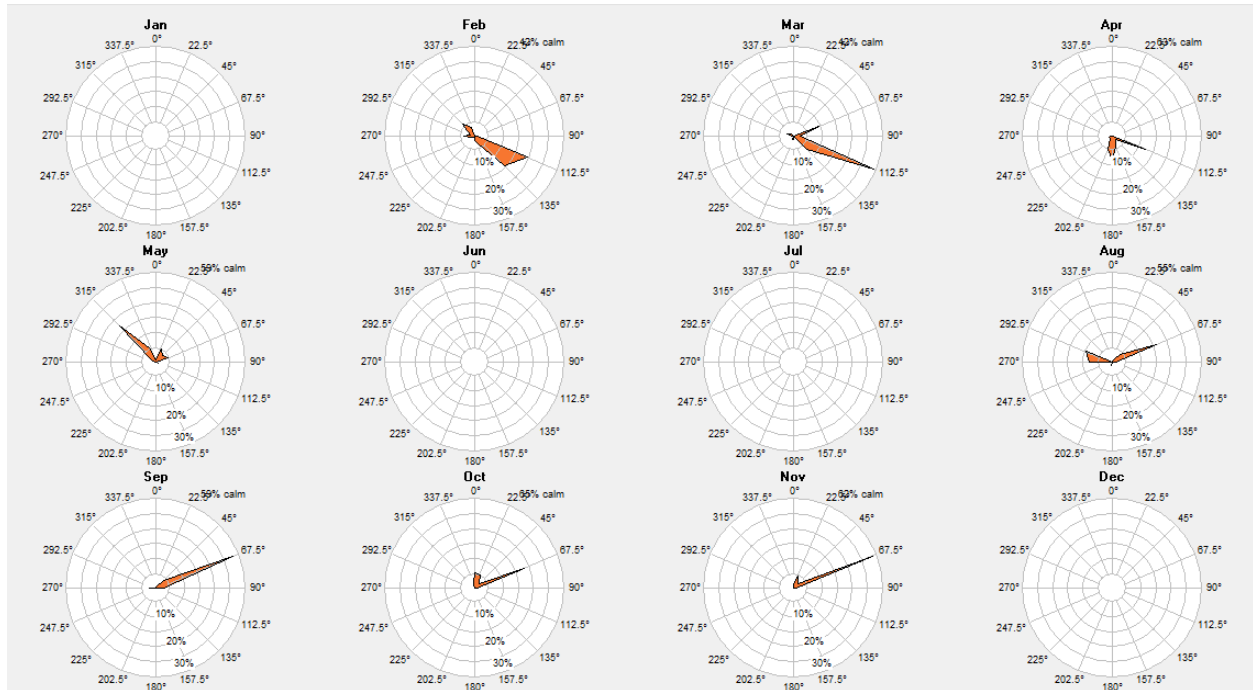
Temperature and Density

Only 3.5 months of temperature data were collected from the met tower as the temperature sensor following datalogger replacement in February 2009 was inoperative. Without airport weather station data, it is not possible at this point to precisely characterize temperature and air density in Noorvik, although given Noorvik's proximity to Selawik and Kotzebue, either location could be considered a reasonably good substitute this data.

Wind Direction

Measured wind direction information from the met tower is suspiciously inconsistent from the first data collection period, August to November 2008, and the second period, February to May 2009. For that reason and given the fact that this met tower study is not comprehensive enough to adequately characterize the wind power potential of the site, summary wind direction is not presented here, although below are monthly wind frequency roses measured during the study.

Monthly wind frequency roses



Turbulence

Turbulence intensity at the Noorvik test site, for the time period measured, is within acceptable standards for wind power development with an IEC 61400-1, 3rd edition (2005), classification of turbulence category C, which is the lowest defined. Mean turbulence intensity at 15 m/s is 0.106.

Turbulence intensity, all wind sectors

