Nanortalik
A preliminary analysis of the wind measurements - rev 1

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Introduction

A 50 m met mast has been measuring the wind speed at Nanortalik Heliport for two years. The measuring project at Nanortalik is a part of the Vest-Norden project. The Vest-Norden project aims to introduce renewable energy sources in combination with hydrogen for energy storage for distant settlements. The mast has been operative since July 1st 2007. This note will summarize the measurements per August 2nd 2009, two years of measurements. The site will be referred to as *6101 Nanortalik.*

Sensors

The mast is equipped with the sensors listed in Table 1. The different anemometers have different characteristics regarding precision. The measurements by the Risø P2546A sensor are given an uncertainty of less than 1%. The measuring range is 0.3-70 m/s. The NRG #40 has an accuracy of 0.1m/s within the range 5-25m/s. The measuring range is from 0.35 m/s. 6101 Nanortalik is equipped with heated sensors that can be valuable in case of icing episodes which can stop or slow down the unheated anemometers. However the precision of the heated anemometer is lower then for the others. The uncertainty of the NRG Icefree III is 4-5%. The measuring range starts at 1 m/s for this anemometer. The icefree anemometer is not calibrated, but an offset value can be calculated by comparing the icefree anemometer to the other anemometers for a period without icing.

Table 1 Sensors mounted at 6101 Nanortalik

Parameter	Type	Height [m]
Wind Speed	NRG #40	48.8
Wind Speed	NRG #40	30.0
Wind Speed	NRG #40	10.0
Wind Speed	Risø P2546A	48.8
Wind Speed	NRG Icefree III	47.5
Wind Direction	NRG Icefree III	47.2
Wind Direction	NRG #200P	41.4
Temperature	NRG 110S	

A picture of the mast is shown in Figure 1. The sensors are mounted on booms with a distance of 2150 mm from the mast-centre. This is done to minimize the influence of the mast itself on the measurements. The top boom is mounted 1500 mm from the mast centre. The sensors are also mounted 640 mm higher than the boom itself to minimize the influence of the boom on the measurements. The predominant wind directions have to some degree been analysed upfront of the installation of the mast so that any influence from the mast, boom and lightning rod on the measurements will be at the sectors with the least frequent winds. Although these precautions have been made to minimize external influence on the measurements it can not be totally avoided. All sensors except those at the top of the mast will be influenced by the mast itself for certain wind directions.

The logger has been set up to transfer all data on a daily basis. The data is sent by email by a telephone modem included in the logger. The data returned are 10 minute averages, maximum value, minimum value and standard deviation.

Figure 1 the 50m met mast 6101 Nanortalik

Summary of measurements

The data coverage is good for the measurement period. Icing events has been found for a total of 105 hours during the measuring period. Icing is not found to be a problem at this site. Table *2* shows the annual mean wind speed for the different sensors. The icefree sensor gives a higher value that the other sensors at this height. The data from the ice free sensors need to be calibrated toward one of the other sensors (on-site calibration) in order to use the data for further analysis. This is a common methodology used for the data from the ice free anemometer. Since icing on the instruments is a minor problem at this site it is only consider the data from the unheated anemometers, excluding the hours where icing is identified, for better precision. The two anemometers at 48.8 meters differ by 0.2 m/s. The annual mean for the Risø anemometer is found to be 6.3 m/s, while for the NRG anemometer it is 6.1 m/s. The NRG anemometer at 30m also gives 6.1 m/s as the annual mean; one would expect the mean value to be higher at 50m than at 30m. It is likely that the annual mean found for the NRG anemometer at 48.8m height is somewhat lower then the actual value. The value of 6.3 m/s for the Risø anemometer is a more significant estimate of the annual mean wind speed at 48.8m height than the NRG sensor.

The annual mean wind speed for the Risø anemometer after one year of measurements was 6.4 m/s. After two years of measurements the annual mean wind speed has decreased to 6.3 m/s, which is around 1.6 %. The annual wind speed has also decreased with around 0.1 m/s for the other sensors.

For all instruments the 99 percentile value is less than 21 m/s. A wind speed of 25 m/s is a typical cut-out wind speed for turbines. For higher values than the cut-out wind speed there will be no power production. The maximum measured value is higher than 25m/s, but as the 99 percentile is lower than 25 m/s, the power production losses due to high wind speed will be quite low. However the maximum measured wind speed has increased with around 3 m/s after two years of measurements.

Table 2 Annual mean wind speed, 99 percentile value and maximum measured value for July 1 2007 – June 30 2009

Sensor	annual mean wind speed	99 percentile	maximum
NRG #40 – 48.8 m	6.1 m/s	19.4 m/s	29.3 m/s
NRG #40 – 30.0 m	6.1 m/s	18.7 m/s	28.3 m/s
NRG #40 – 10.0 m	5.4 m/s	16.7 m/s	25.8 m/s
Risø P2546A -48.8 m	6.3 m/s	19.7 m/s	30.0 m/s
NRG Icefree III - 47.5 m	7.0 m/s	20.9 m/s	31.0 m/s

Table 3 Monthly means for the Risø anemometer at 48.8 m height based on data for the period July 1 2007 – June 30 2009.

Month	mean wind speed [m/s]
January	7.1
February	7.5
March	6.9
April	6.1
May	4.9
June	4.2
July	4.1
August	5.2
September	6.4
October	6.6
November	7.4
December	9.0
Annual	6.3

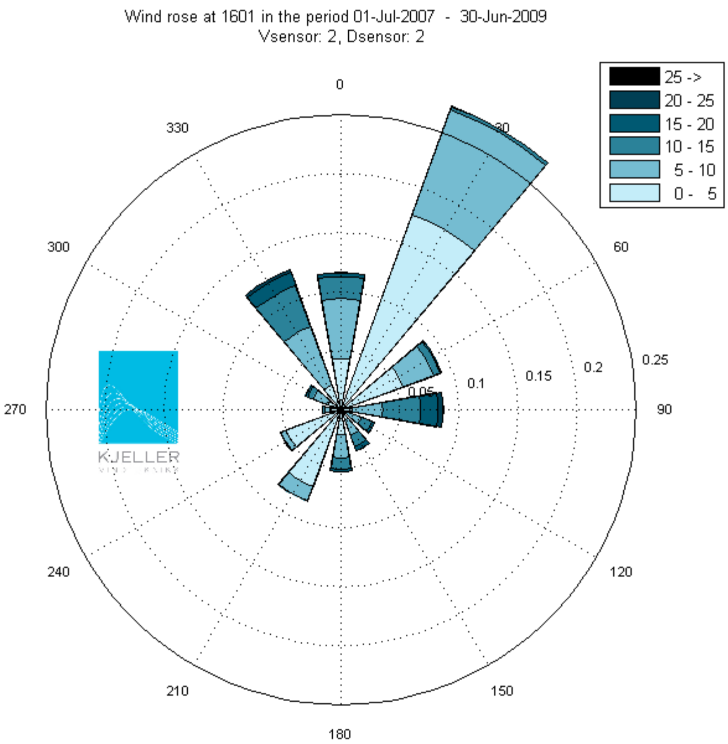

Figure 2 Wind rose for 6101 Nanortalik based on data for July 1 2007 – August 2 2009. The wind rose is plotted using the Risø anemometer at 48.8 m and NRG #200P wind wane at 41.4 m height.

Table 3 shows the monthly variation in wind speed. The highest wind speeds are found for the winter season (September-March), while the mean wind speed is clearly lower for the summer months (May-August). The total mean wind speed has decreased about 0.1 m/s compared to the previous note in August 2008, but the several monthly mean has increased in some months and decreased in some months.

The wind rose at 6101 Nanortalik is shown in Figure 2. Still the dominant wind direction is from sector 2 (N-NE) with a frequency of approximately 27%, but the wind from this sector is related to low wind speed. The sector 12 (N-NW) and sector 1(N) are generally related to higher wind speed and may thus be more relevant for wind power production. The frequency in these two sectors has fairly increased compared to last year.

The distribution for each sector is shown in Figure 3, the estimated weibull distribution is also shown. There are some clear discrepancies between the estimated weibull distribution and the measurements, especially in sector 9. There is large frequency of measurements in the range 3-6 m/s. This is typically a range with little power production. By using the weibull distribution to estimate the power production the measured frequency distribution is less optimal for wind power production than the estimated weibull-function. One should keep this in mind if estimating power production by using the annual mean value. The distribution for all sectors is shown in Figure 4

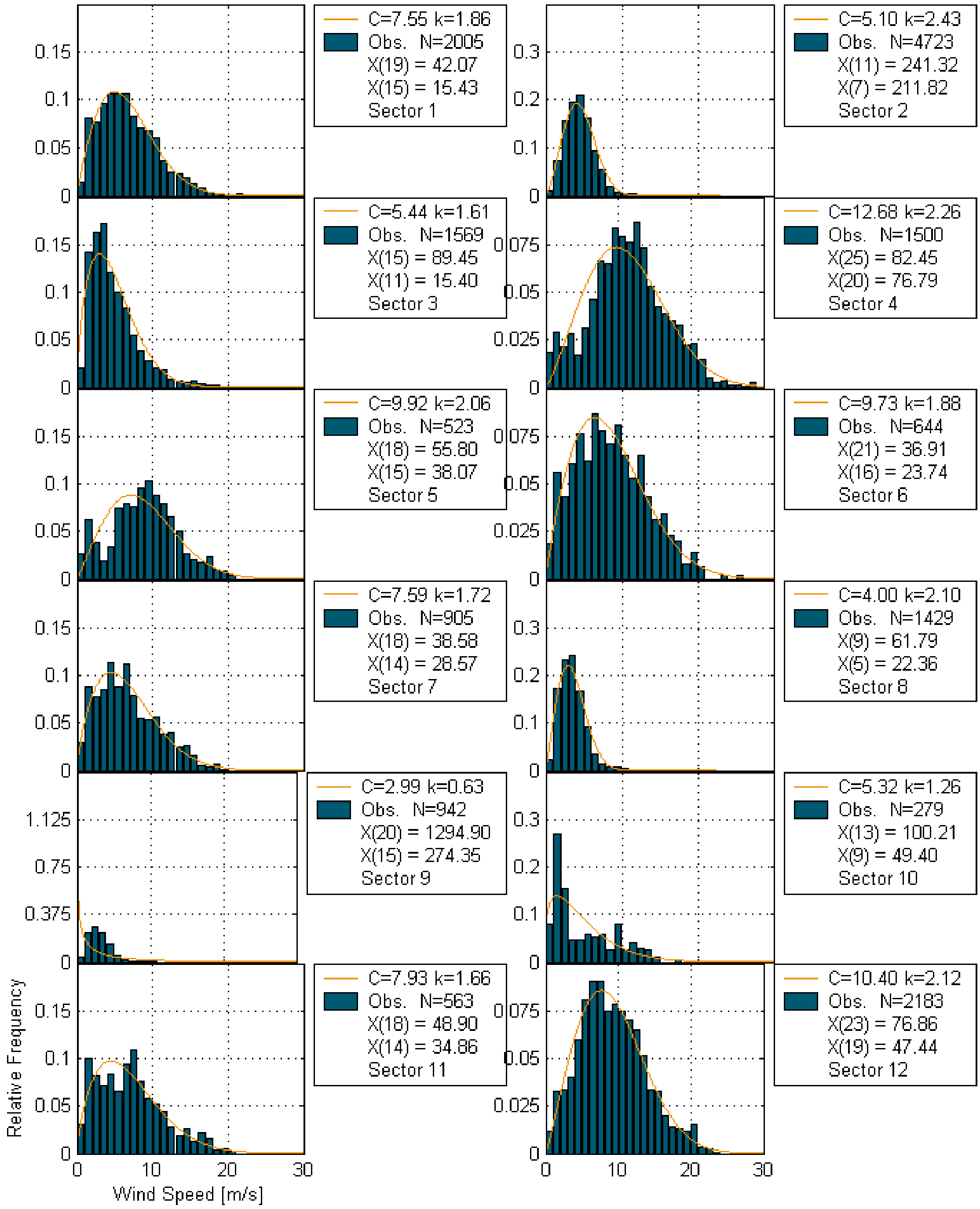

Figure 3 Distribution of wind speed for 12 sectors, and estimated weibull distribution for each sector. Sector 1 is north (345°-15°), each sector covers 30° in clockwise direction. The distribution is calculated using the Risø anemometer at 48.8 m and NRG #200P wind wane at 41.4 m height.

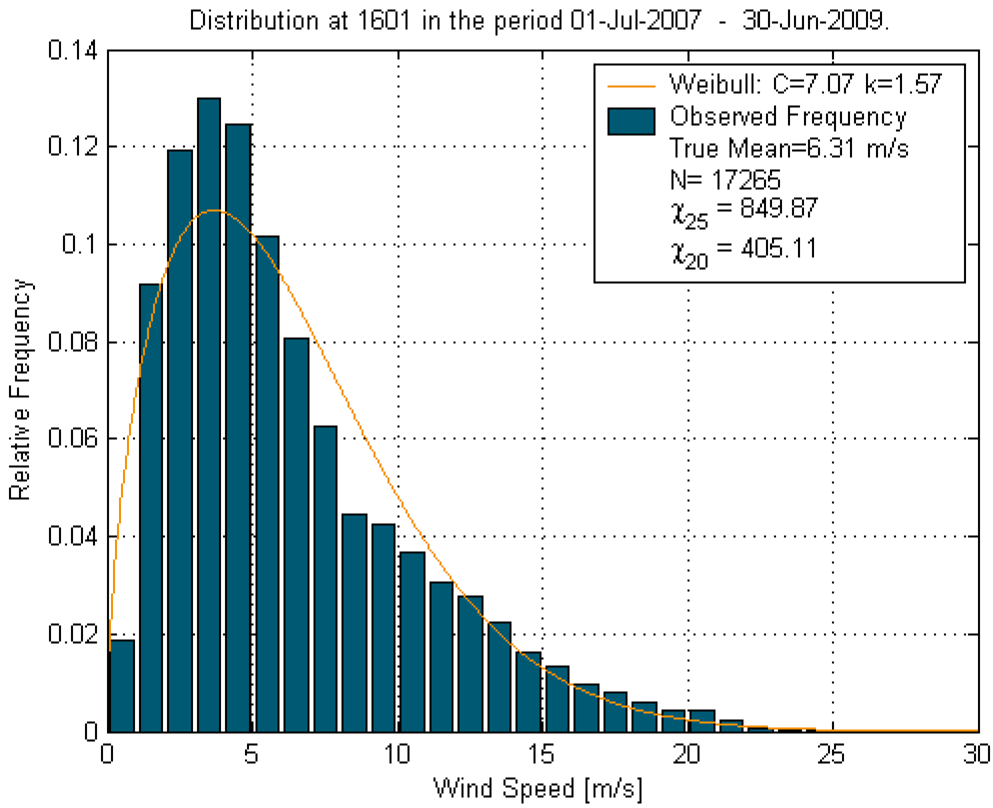

Figure 4 Distribution of wind speed and calculated weibull distribution for 6101 Nanortalik. The distribution is calculated using the Risø anemometer at 48.8 m and NRG #200P wind wane at 41.4 m height.

Possible reference data

Possible reference data for this site can be the WMO met station also located at Nanortalik Heliport. These data can give valuable information about the long term expected wind climate at Nanortalik. There is not made any further attempts to get these data, but it should be considered for the main report for this site.

Data from NCEP/NCAR reanalysis has been evaluated for this site, but not found to be representative for Nanortalik.

Summary

Icing seems to be a minor problem at this site during 2 year of observations. Annual mean wind speed has been measured to 6.3 m/s at 50m height. The annual mean wind speed has decreased about 0.1 m/s compared to one year of measurements. The main wind direction is from sector 2, with large members also from sectors 1 and 12. The distribution of the wind speed measurements appears to be less optimal for wind power production than the estimated weibull distribution. This must be considered when estimating power production using the mean value with a weibull distribution.