

Evaluation of wind conditions at Siragrunnen

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Evaluation of wind conditions at Siragrunnen – phase 1.

The purpose of phase 1 is to evaluate the wind expectations based on existing wind data sources to establish a basis for preliminary energy calculations. Before investment decisions a measurement program is recommended.

Best sources for evaluation of the wind conditions from what has been seen so far is:

1. The data from measurement mast at Lista Fyr
2. The “upper air” data from NCAR in different variants

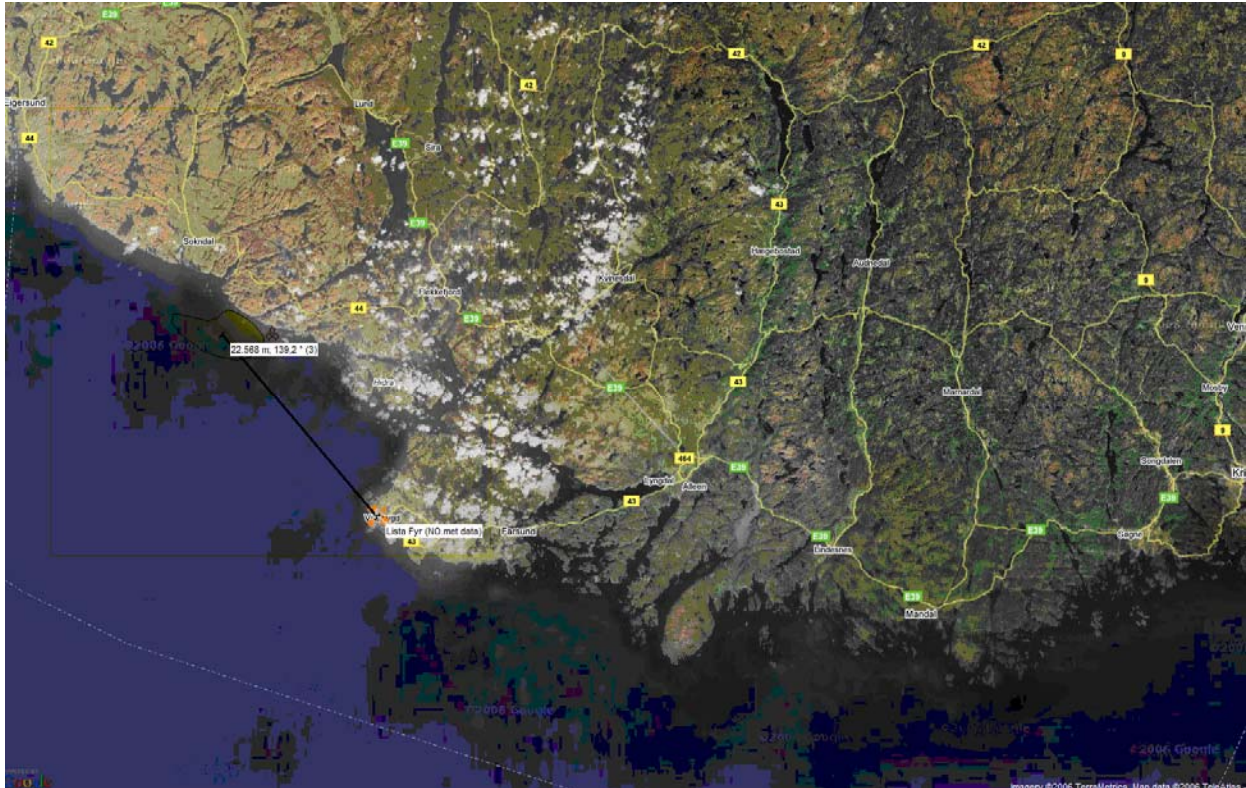


Figure 1 Lista is located 22.5 km SE of the site on a location that from a meso scale point of view look much similar to the offshore site.

The Lista Fyr wind measurements

There is established a 10m measurement mast at Lista, that has been in operation for decades. There are different ways to get access to the data “for free” – for the preliminary analyses these data is used. It has so far not been cleared up with the Norwegian Meteorological office to which extend the free data can be used for commercial purposes. Therefore this report so far must be considered only for internal use.

Data is partly downloaded from the Norwegian server “eKlima”, partly from a Russian server that store the results of the 6 hour weather reports from numerous meteorological stations over the world. The data from the two servers has been merged to get as complete a time series as possible. Data from 2000-2007 as 6 hour values is used.

10,0m - Subst Mean wind speed	2000	2001	2002	2003	2004	2005	2006	2007	Mean	Mean of months
January	8,4	6,3	6,38	6,74	6,13		7,31	9,81	7,58	7,3
February	8,04	6,56	7,57	5,24	5,5	5,48	5,27	8,13	6,49	6,47
March	6,74	4,85	6,92	5,53	5,81	5,61	5,86	6,32	5,96	5,96
April	5,6	5,24	5,43	5,6	6,66	6,08	5,41	6,3	5,79	5,79
May	5,31	5,33	6,38	5,62	6,12	5,93	6,49	5,36	5,88	5,82
June	5,1	6,1	6,36	5,73	6,08	6,7	6,01	5,11	5,91	5,9

July	5,81	5,27	5,56	5,28	5,75	5,75	5,43	6,93	5,72	5,72
August	6,31	6,09	5,23	6,4	5,24	6,43	4,6	6,71	5,88	5,88
September	7,92	5,43	5,56	6,28	6,97	6,93	6,84	7,79	6,72	6,72
October	8,52	8,46	6,94	5,74	7,77	6,79	5,92	5,9	7,01	7,01
November	8,41	8,26	6,88	6,72	6,59	6,84	10,01	7,41	7,64	7,64
December	6,56	5,4	7,09	7,17	7,52	7,68	9,5	5,1	7	7
mean, all data	6,89	6,1	6,35	6,01	6,31	6,65	6,56	6,73	6,45	
mean of months	6,89	6,11	6,36	6	6,35	6,38	6,55	6,74		6,43

Measured mean is 6.43 m/s at 10 m a.g.l.

Below the distributions.

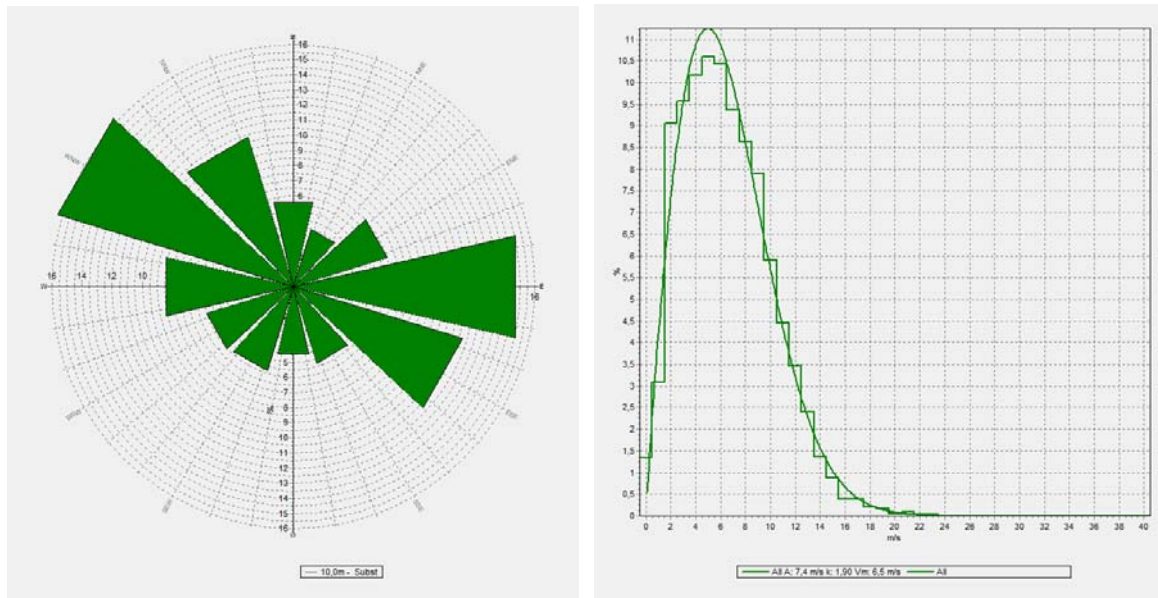


Figure 2 Direction distribution and Weibull distribution 2000-2007 at Lista Fyr. Mean wind speed: 6.5 m/s as Weibull weighted mean.

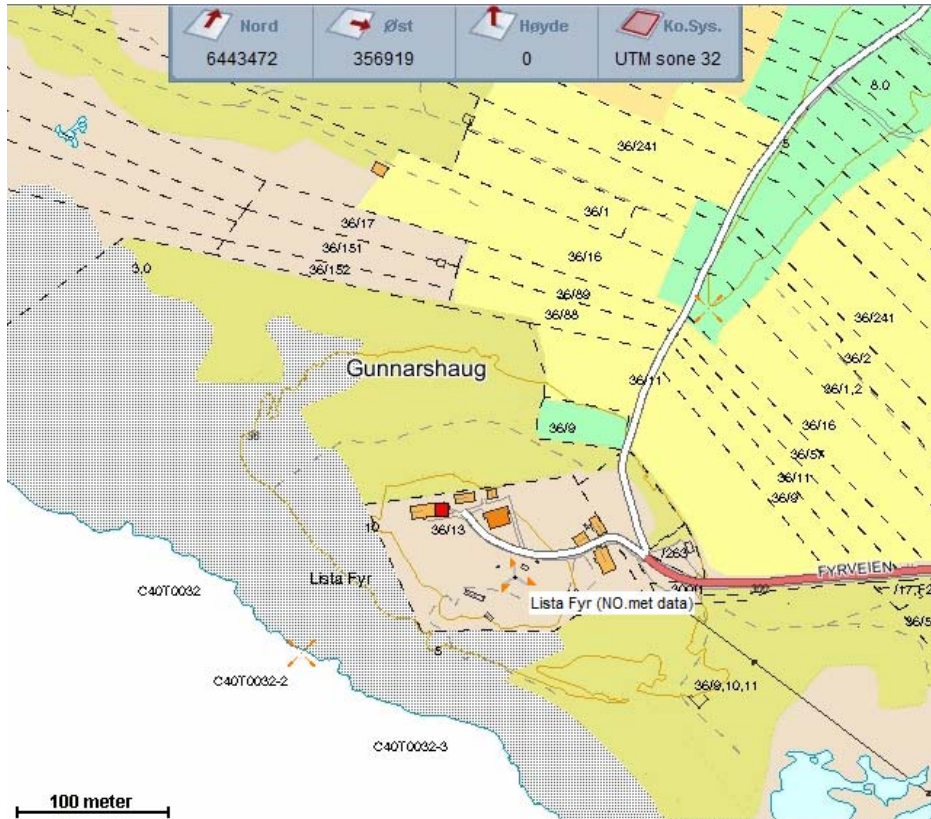
The mean wind speed of 6.5 m/s at just 10m measurement height indicates good wind conditions while the mast only is positioned at a small hill, see photo below.



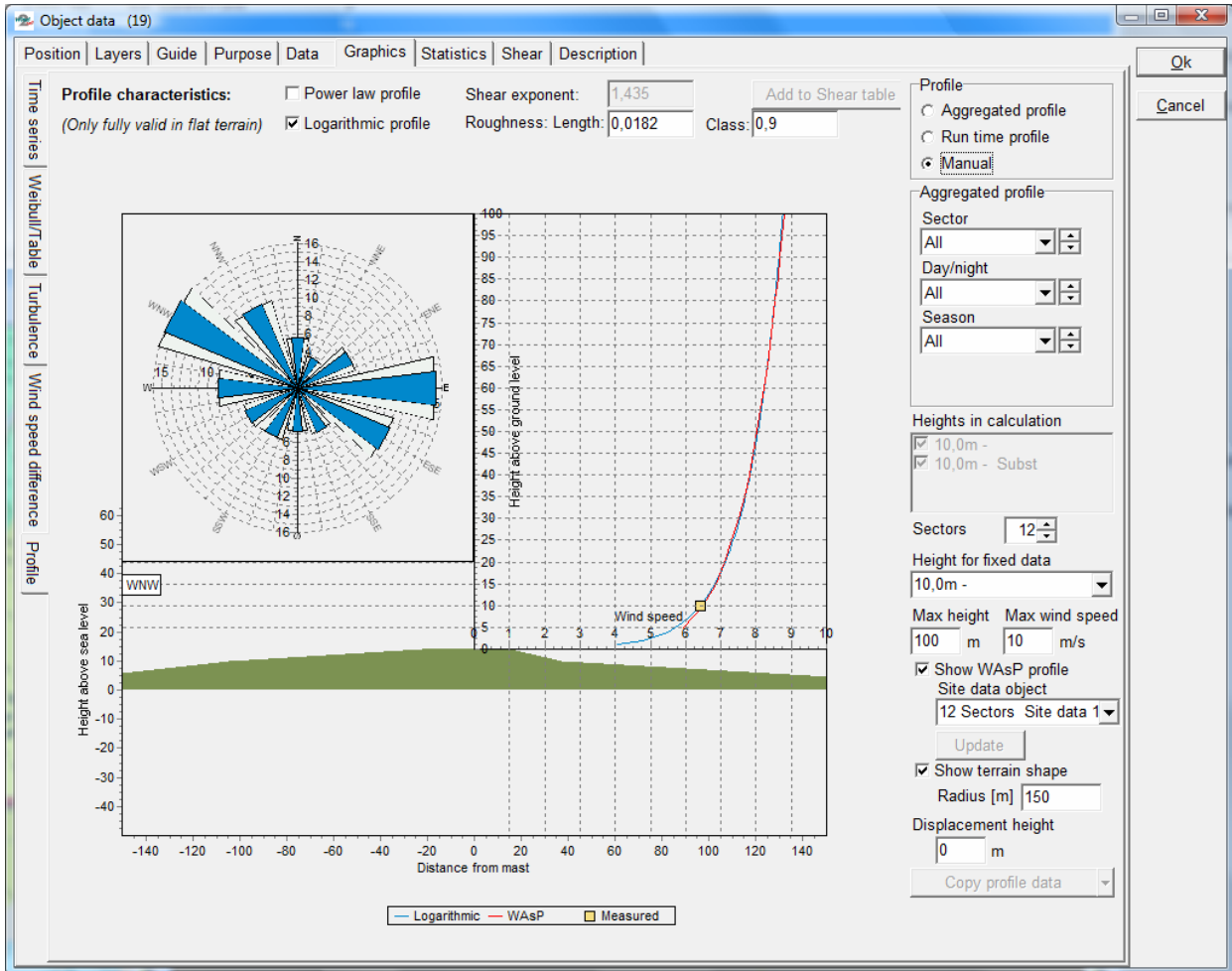
Figure 3 Measurement mast seen from NW . [Source Internet]



Figure 1 Photo from south shows how the mast is located at a small hill in a very flat terrain. [Source Internet]

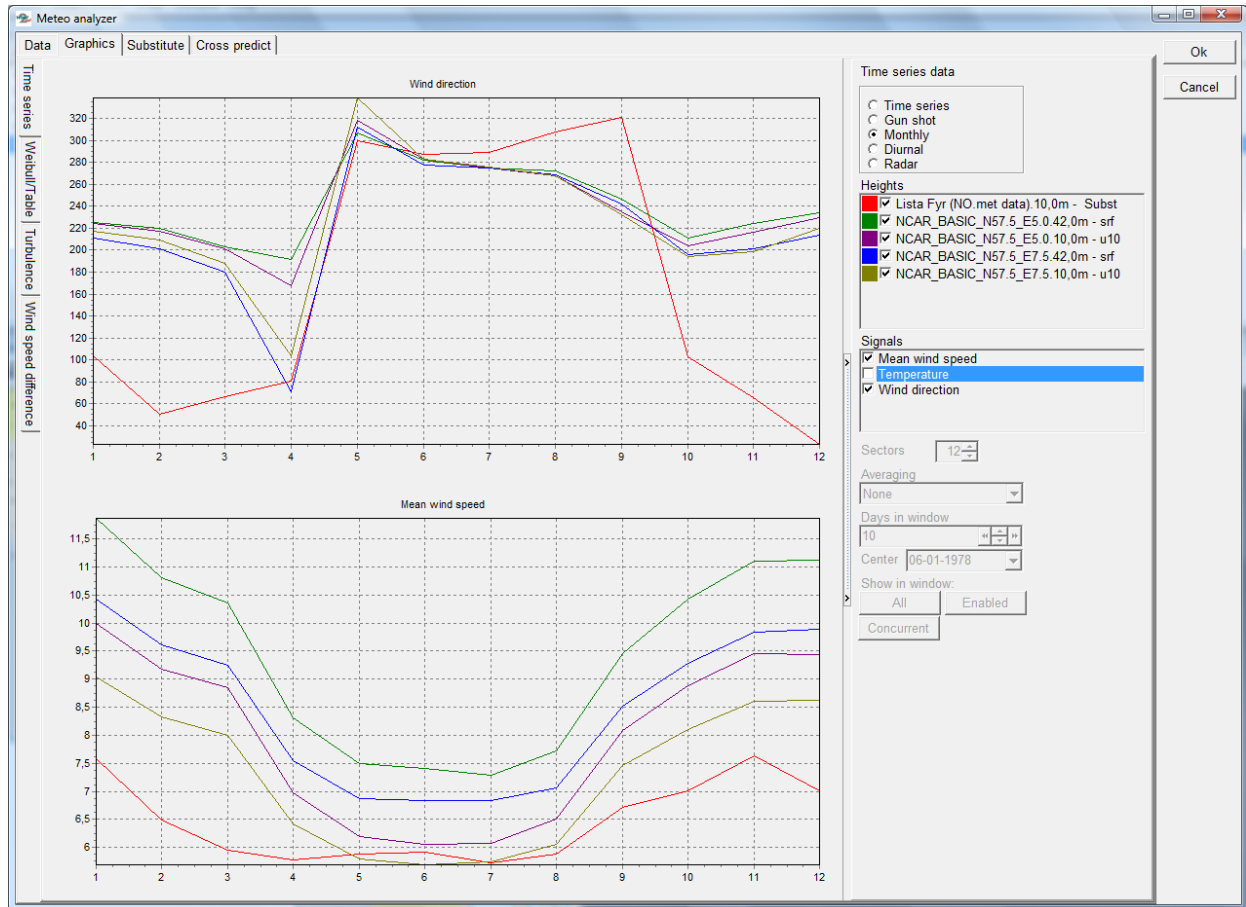


Figur 2 Map with mast position. The red dot is the light tower. There are some buildings in the near surroundings, but these are not assumed to influence the measurements essential. [Source Internet]



Figur 3 Profile for the measurement mast position. At 100m a.g.l. the expected mean wind speed is expected to round 8.8 m/s. The mast is located 14 m a.g.l according to met.no. The elevation data has been established based on these information's, and so is the calculated wind statistic.

Monthly variations and comparison to NCAR data



Figur 4 Based on the 8 year Lista data and last 30 y NCAR data from two nearest NCAR data points (Offshore), it can be seen that the NCAR data assume essential higher wind speeds in winter months.

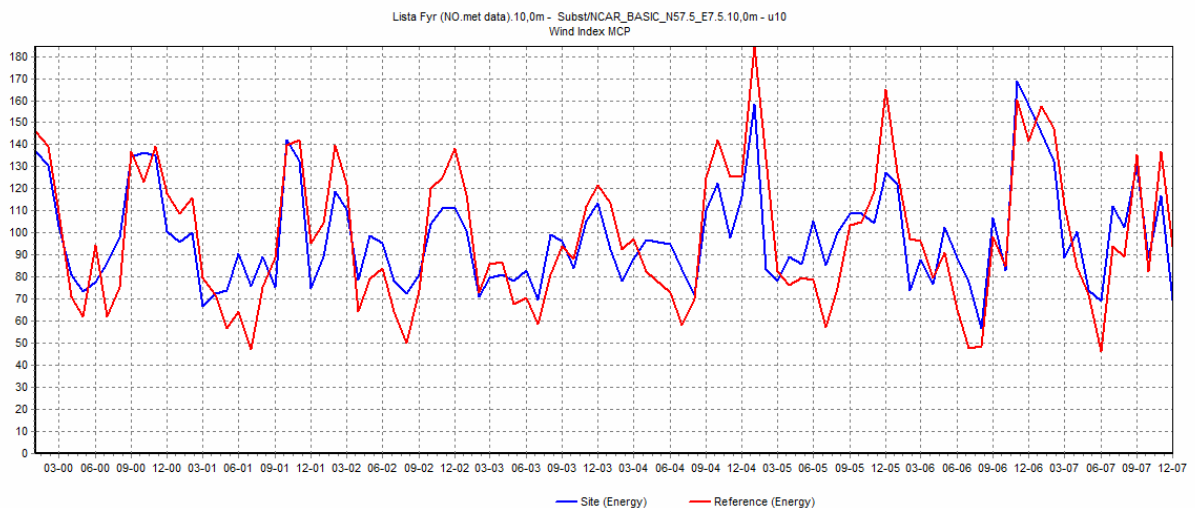
The higher wind speeds seen in NCAR data is partly based in the offshore locations of the NCAR data.



Figur 5 The two NCAR data points is located round 90 km from location – very far offshore and therefore these data not can be used for giving information of the expected wind speed, but can be used for estimations on the long term variations.

Long term variations

While the wind conditions in Northern Europe has shown to vary much from decade to decade, the 8 year Lista data might not be representative. We use therefore the NCAR 30 year data to estimate if the 8 year of data seems to be long term representative.



Figur 6 Correlation between wind index generated from the Eastern NCAR data point and Lista data.

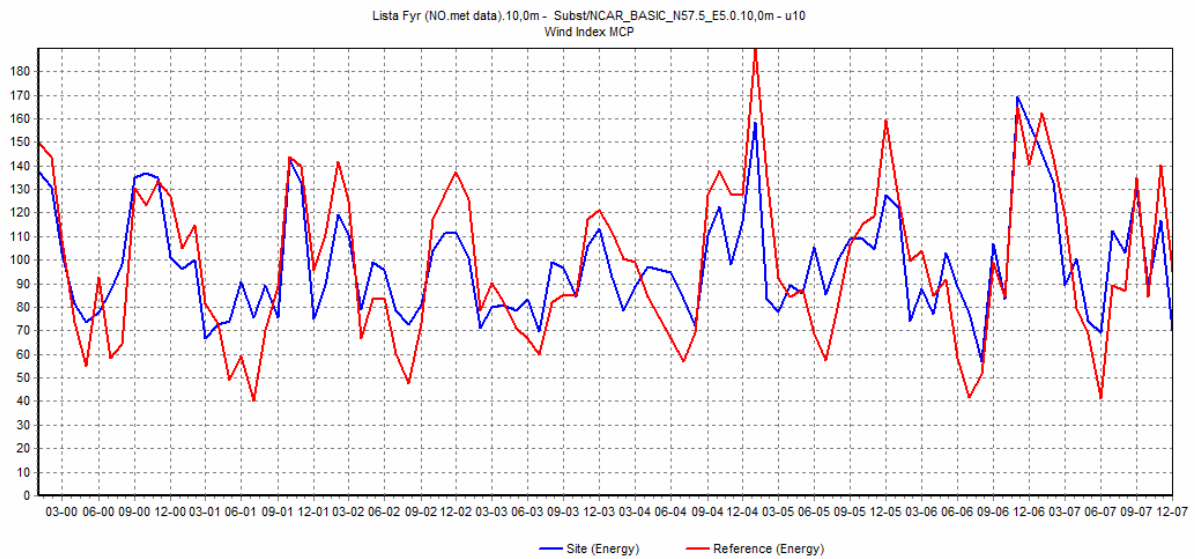


Figure 7 Similar graph for the western NCAR data point.

The two NCAR 30 year data sets indicated that **the 8 year Lista data provide an energy level round 2% below long term average**. Due to the relative low correction, we keep this as an “upside” and continue using the 8 year data from Lista as basis for further calculations.

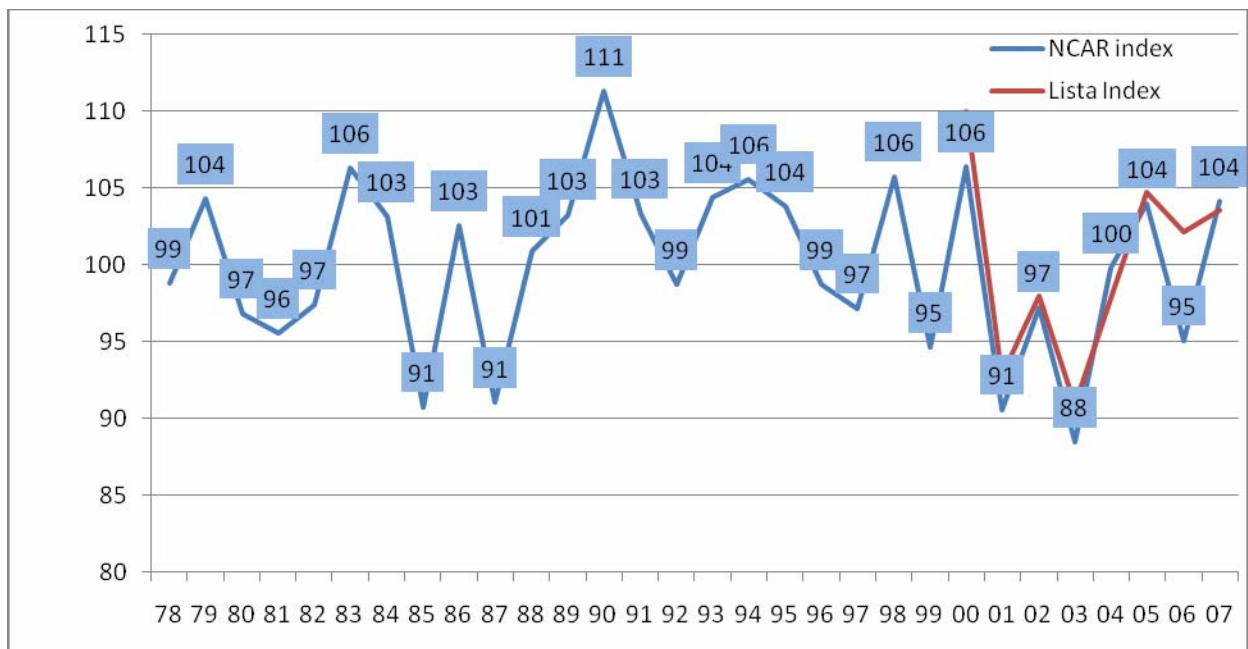


Figure 8 The recent 30 years wind index based on NCAR eastern point compared to the Lista data. For 2006 there are quite large divergence, but for the other years, very fine correlation.

Establishment of wind statistic

Roughness

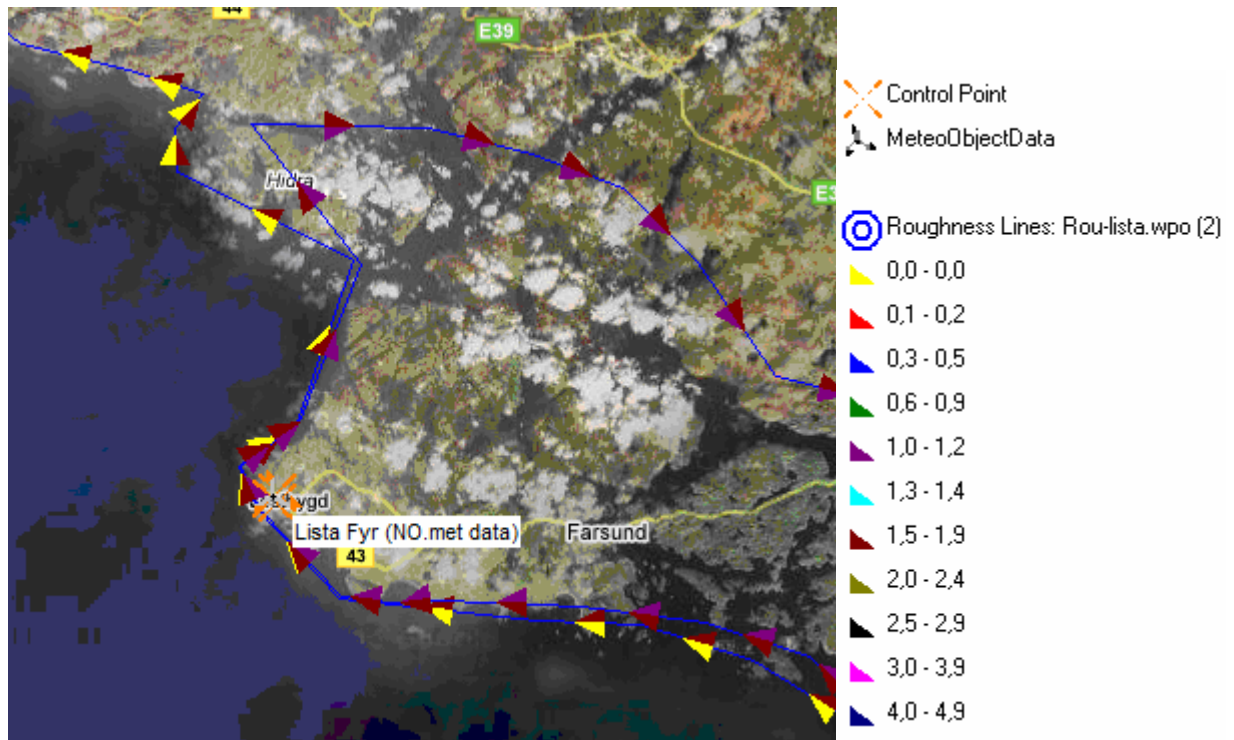


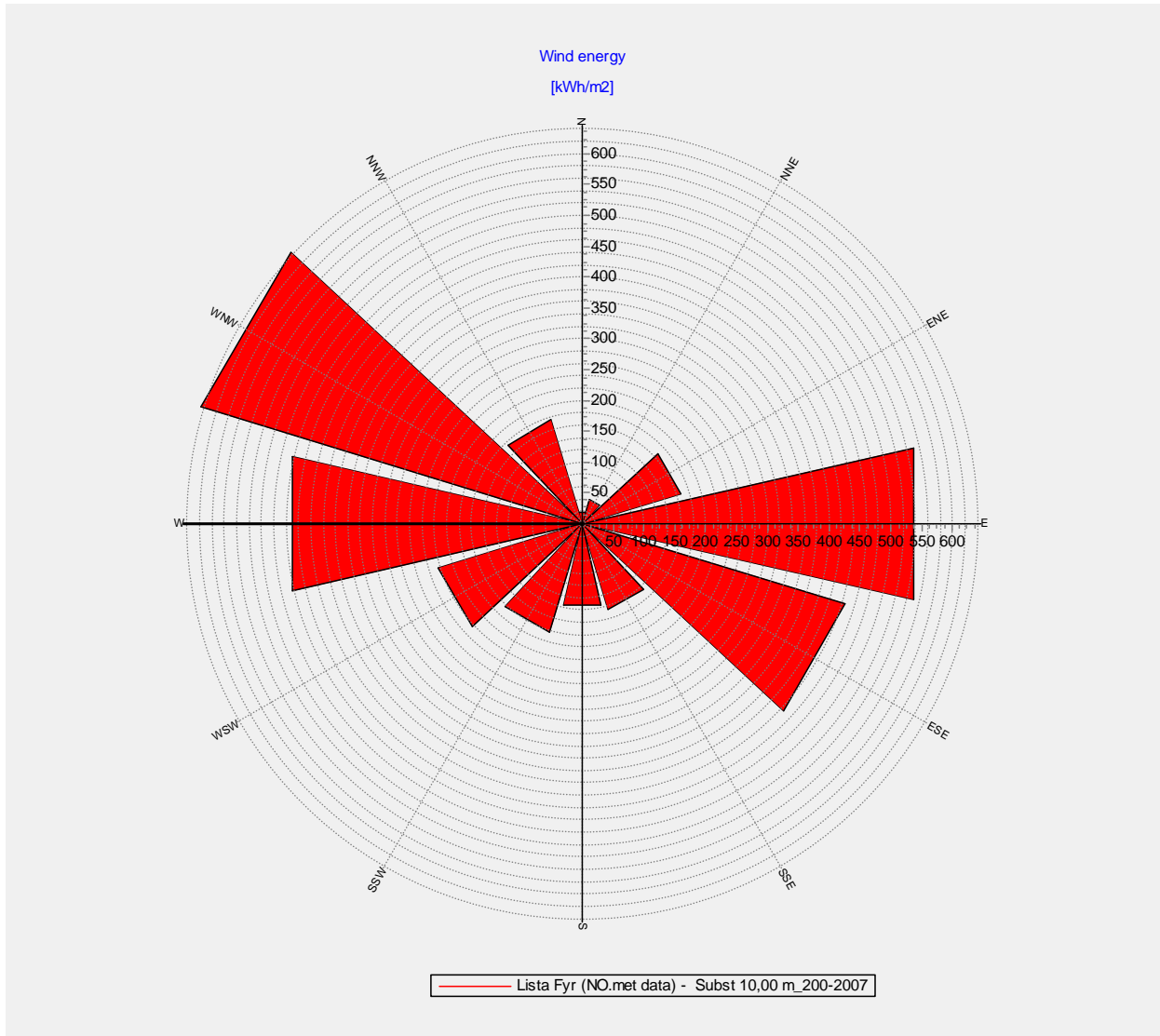
Figure 10 The roughness around the mast has been established as class 1 in the mast surroundings and class 1.5 further away. The sea is class 0.

Obstacles

We have not considered obstacles, even though there are some houses in the near surroundings of the mast. Our experience is that obstacles shall be handled very carefully, and often lead to over prediction of the wind climate. Excluding the obstacles leave a little upside in the later energy calculations.

The wind statistic

Based on wind data 2000-2007 (8 year) 6 hour values from Lista 10m measurement mast and the terrain description described above, the wind statistic are generated.

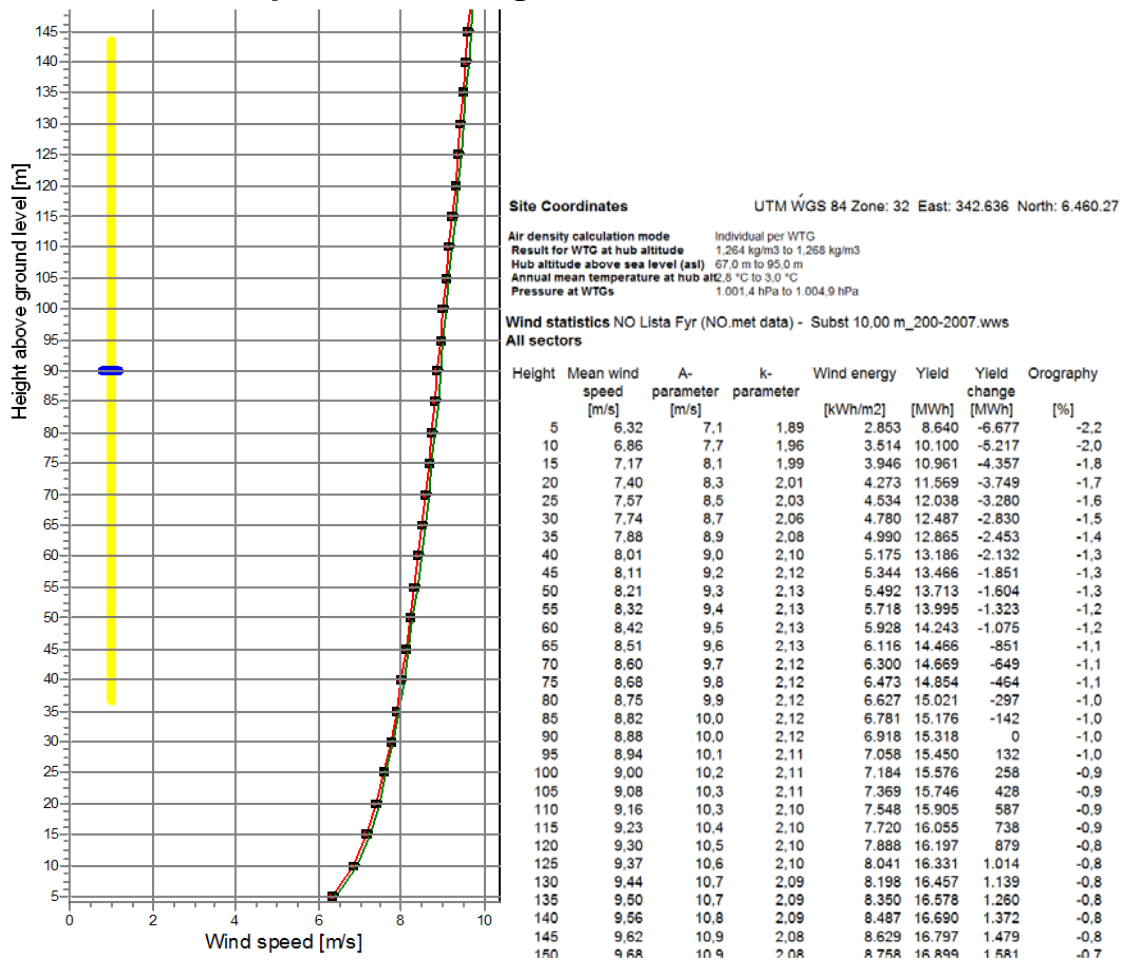


Figur 11 The wind statistic showing the energy distribution cleaned for local terrain influence.

An important value is the “WTG energy level”, which is calculated to 100.9 %, meaning that a wind turbine at a location within the region where this wind statistic describes the wind climate will produce relative to 1025 kWh/m²/y at roughness class 1 at 50 m hub height. This corresponds to an average Danish location.

We feel very confident that the WTG energy level corresponds well to Danish conditions due to the location near to Denmark.

Calculated wind profile at Siragrunnen



Figur 12 Calculated wind profile at Siragrunnen ased on the established wind statistic. At 90 m a.s.l. 8.8 m/s is calculated – but still very uncertain due to partly the distance from measurement mast to site, partly the low height of measurement mast and finally lack of knowledge on the used equipment and its calibration.