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Wind Resource Assessment – Østerild National Test Centre for Large Wind Turbines

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The generalized wind climates applied in the wind resource calculations for the seven test stands are based on correlations between a short period of on-site wind data from the wind lidars with a long-term reference.
The wind resource assessment for the seven test stands has been made applying the WAsP 11.1 and WindPRO 2.9 software packages.

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Content

Summary

This report presents a wind resource assessment for seven test stands at the Østerild National Test Centre for Large Wind Turbines in Denmark.
Calculations have been carried out mainly using wind data from three on-site wind lidars (Light Detection and Ranging), which have been installed, operated and maintained by DTU Wind Energy.
The generalized wind climates applied in the wind resource calculations for the seven test stands are based on correlations between a one year period (February 2010 to January 2011) of on-site wind data from the wind lidars West, North and South at 100, 120 and 140 m above ground level (AGL) with a 30-year period (1984 to 2013) of MERRA long-term reference wind data.
The wind resource assessment for the seven test stands has been made applying the WAsP 11.1 (DTU Wind Energy) and WindPRO 2.9 (EMD International A/S) software packages.

Based on the available information, the following main results have been derived:

1. Wind resource at 100 m AGL
   Average of seven long-term mean wind speeds : 8.25 m/s
   Average of seven long-term Weibull *A* parameters : 9.29 m/s
   Average of seven long-term Weibull *k* parameters : 2.60

2. Wind resource at 120 m AGL
   Average of seven long-term mean wind speeds : 8.74 m/s
   Average of seven long-term Weibull *A* parameters : 9.84 m/s
   Average of seven long-term Weibull *k* parameters : 2.61

3. Wind resource at 140 m AGL
   Average of seven long-term mean wind speeds : 9.12 m/s
   Average of seven long-term Weibull *A* parameters : 10.26 m/s
   Average of seven long-term Weibull *k* parameters : 2.62

The calculations include no array losses due to shadowing effects (wake loss) from one wind turbine to another within the Østerild test centre. Any shadowing effects from nearby wind turbines outside the test centre have also not been taken into account. This leads to an insignificant overestimation of the wind resources.
After the wind lidar measurements took place, part of the forest around the Østerild test centre has been cut down. The reduced terrain surface roughness has affected the wind resources at the Østerild test centre and this leads to a slight underestimation of the wind resources.
The influence of the shadowing effects and the reduced terrain surface roughness on the wind resources at the Østerild test centre are expected to be of the same (small) order of magnitude. So the combined influence on the wind resources is expected to be small.
However, since the influence of the reduced terrain surface roughness might be a bit larger than the influence of the shadowing effects, the wind resources presented in this report might be slightly underestimated.

1. Site

The Østerild National Test Centre for Large Wind Turbines is located on a coastal plain, approximately 60 km west of Aalborg in northern Jutland, Denmark, see Figure 1.
The terrain is flat, except for a small hill to the southwest at Hjardemål and some sand dunes to the north. The elevations of the seven test stands range from approximately 12 to 14 m ASL. The site has grasslands, and forests in the southern half of the test site with canopy heights between 10 m and 20 m. The surroundings are dominated by the North Sea, which is approximately 4 km to the north and 20 km to the west. There is also the Limfjord inlet about 6 km to the southeast.
The terrain surface roughness lengths are estimated at 0 (zero) m for the North Sea and the Limfjord, and a combined background roughness length of 0.8 m for grasslands and forests. Note that for this particular site the terrain surface modelling is not very critical in relation to wind resource assessment calculations because:

- No vertical extrapolations of the measured wind data are necessary (wind resource assessments are made at three measurement heights)
- Relatively short horizontal extrapolations of the measured wind data are necessary (wind resource assessments are made at the positions of the seven test stands, which are relatively close to the three wind lidar positions)

The only potentially relevant wind turbines and obstacles in the surroundings are a row of eight wind turbines 2.8 km west of test stand 6, another row of four wind turbines 2.3 km east of test stand 4, some buildings in the vicinity of test stand 3, and a building 1.8 km west of test stand 7. However, the influences of all these wind turbines and obstacles on the wind flow at the test stands are insignificant.

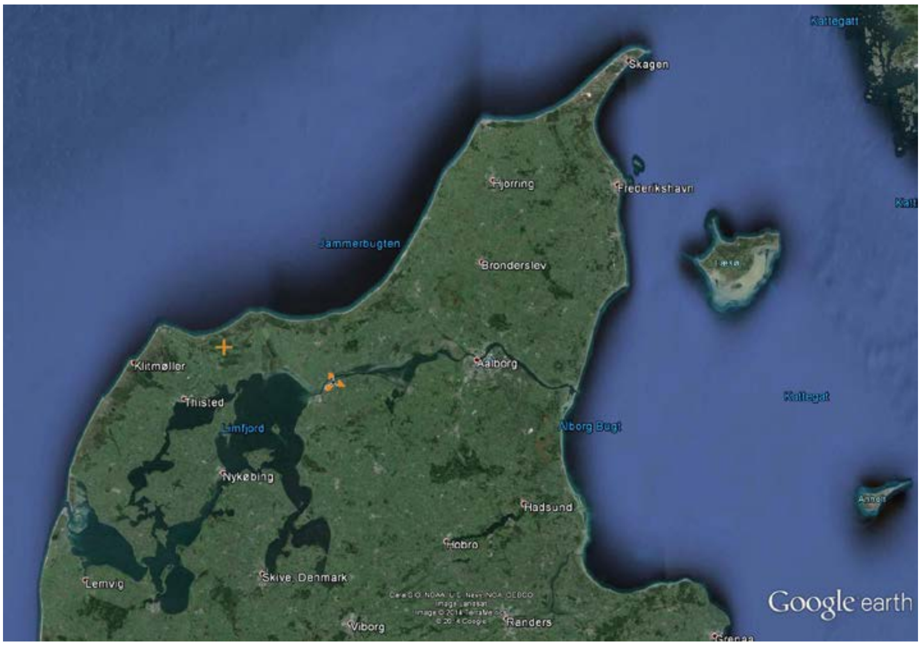

Figure 1: Google Earth image of the location of Østerild National Test Centre for Large Wind Turbines (orange cross) and MERRA long-term reference (orange anemometer symbol)

2. Wind data

This section briefly describes the wind data analysis and the expected long-term wind climate at the Østerild National Test Centre for Large Wind Turbines.

2.1 Wind lidars

The Østerild test centre had three wind lidars installed on the site with wind data recorded between 28/01/2010 and 05/11/2011.

The wind lidars are of the type WindCube WLS-7 (version 1) from the French manufacturer Leosphere. The WLS-7 wind lidars are able to measure wind speed and wind direction at up to 10 different heights AGL, formally between 40 and 200 m AGL.

The locations and measurement heights and measurement periods of the three installed wind lidars are listed in Table 1; the locations are further shown on a sketch map in Figure 9.

Wind lidar	Measurement height [m AGL]	UTM WGS84 zone 32		
		E [m]	N [m]	Elevation [m ASL]
Lidar West	45, 60, 80, 100, 120, 140, 170, 200, 250 and 300	492004	6326021	11
Lidar North	45, 60, 80, 100, 120, 140, 170, 200, 250 and 300	493536	6326157	14
Lidar South	45, 60, 80, 100, 120, 140, 170, 200, 250 and 300	492373	6322912	10

Table 1: Locations of the on-site wind lidars (elevations from height contour map)

The wind lidars West, North and South each measure one radial wind speed in a little more than one second. After each speed measurement, the lidar beam is rotated 90 degrees in azimuth. Radial speed measurements from four consecutive directions are required in order to calculate one horizontal wind speed and direction. In this way, a 10-minute mean speed is derived from about 550 radial wind speed scans.

2.2 Calibration of wind lidars

The accuracy of the lidar measurement systems was tested before the Østerild measurement campaign by performing a calibration against calibrated, mast-mounted cup anemometers. This took place at the 116 m meteorological mast at the Test Station for Large Wind Turbines at Høvsøre in Denmark. The measurements and results are fully documented in [1]. Overall it can be stated that the maximum deviation from the cup anemometer measurements was 2 per cent.

2.3 Processing of wind lidar data

The lidar will not report a wind speed if the measured carrier to noise ratio (CNR) is under a lower threshold (-22 dB). Thus a 10-minute period may have less than the nominal 550 wind speed observations. As a further guard against invalid data, we have excluded ten minute periods where less than 50 per cent of this nominal value are present. Since the signal strength reduces with measuring height, the data availability will generally decrease with increasing height. This tendency can be clearly seen in Table 2. Please see appendix A for more details on data availability.

Wind lidar and measurement height	**Wind data period**	**Wind data availability after filtering**
Lidar West at 100 m AGL	28/01/2010 to 05/11/2011	87.7 %
Lidar West at 120 m AGL	28/01/2010 to 05/11/2011	86.7 %
Lidar West at 140 m AGL	28/01/2010 to 05/11/2011	84.9 %
Lidar North at 100 m AGL	28/01/2010 to 17/05/2011	86.7 %
Lidar North at 120 m AGL	28/01/2010 to 17/05/2011	85.3 %
Lidar North at 140 m AGL	28/01/2010 to 17/05/2011	82.3 %
Lidar South at 100 m AGL	29/01/2010 to 05/11/2011	79.8 %
Lidar South at 120 m AGL	29/01/2010 to 05/11/2011	78.3 %
Lidar South at 140 m AGL	29/01/2010 to 05/11/2011	75.3 %

Table 2: Summary of filtered wind data

In order to avoid seasonal bias a number of full years should be applied for further analyses. Almost two years (21 months) are available from the Lidar West and Lidar South. However, 21 months might result in a significant seasonal bias. Therefore, one full year is used only.
For all three wind lidars, the data availability is decreasing over the data period. Therefore, one year from the earlier part of the data period is used.
This gives the lowest possible seasonal bias and the highest possible data availability.

Wind lidar and measurement height	**Wind data period**	**Wind data availability after filtering**
Lidar West at 100 m AGL	01/02/2010 to 31/01/2011	88.5 %
Lidar West at 120 m AGL	01/02/2010 to 31/01/2011	87.5 %
Lidar West at 140 m AGL	01/02/2010 to 31/01/2011	85.4 %
Lidar North at 100 m AGL	01/02/2010 to 31/01/2011	88.1 %
Lidar North at 120 m AGL	01/02/2010 to 31/01/2011	86.6 %
Lidar North at 140 m AGL	01/02/2010 to 31/01/2011	83.4 %
Lidar South at 100 m AGL	01/02/2010 to 31/01/2011	84.5 %
Lidar South at 120 m AGL	01/02/2010 to 31/01/2011	82.8 %
Lidar South at 140 m AGL	01/02/2010 to 31/01/2011	79.8 %

Table 3: Summary of filtered wind data based on 1 year wind data period

The following analyses are based on this one year wind data period. Note that the data availability is below the minimum 90 % data availability recommended for wind resource assessment by DTU Wind Energy. This is taken into consideration in the uncertainty on long-term correction, ref. Section 4.

2.3.1 Wind speed data

The mean wind speeds at 100, 120 and 140 m AGL at the locations of the three wind lidars are about 7.8, 8.2 and 8.6 m/s respectively based on one year wind data period.

A Weibull distribution is normally a good approximation to wind speed data and this assumption is also sound for the wind data measured at the Østerild test centre.

The values in Tables 4, 5 and 6 are based on the measured wind data from the wind lidars West, North and South at 100, 120 and 140 m AGL.

Wind speed at 100 m AGL		**Lidar West**	**Lidar North**	**Lidar South**
Mean wind speed from data	[m/s]	7.82	7.82	7.64
Mean wind speed from Weibull fit	[m/s]	7.90	7.90	7.69
Mean power density from Weibull fit	[W/m^2]	458	450	430

Table 4: Mean wind speed and power density of filtered data and fitted Weibull fits at wind lidars West, North and South at 100 m AGL based on 1 year wind data period

Wind speed at 120 m AGL		**Lidar West**	**Lidar North**	**Lidar South**
Mean wind speed from data	[m/s]	8.26	8.25	8.09
Mean wind speed from Weibull fit	[m/s]	8.36	8.36	8.14
Mean power density from Weibull fit	[W/m^2]	543	532	510

Table 5: Mean wind speed and power density of filtered data and fitted Weibull fits at wind lidars West, North and South at 120 m AGL based on 1 year wind data period

Wind speed at 140 m AGL		**Lidar West**	**Lidar North**	**Lidar South**
Mean wind speed from data	[m/s]	8.64	8.66	8.50
Mean wind speed from Weibull fit	[m/s]	8.75	8.78	8.58
Mean power density from Weibull fit	[W/m^2]	626	619	594

Table 6: Mean wind speed and power density of filtered data and fitted Weibull fits at wind lidars West, North and South at 140 m AGL based on 1 year wind data period

Note that all above mean wind speeds are based on one year wind data period. There is of course some year-to-year variability of the mean wind speed.

2.3.2 Wind direction data

Figure 2 shows the wind direction *frequency* distributions for the wind lidars West, North and South at 100 m AGL, indicating that a broad sector from southwest to northwest is the expected dominant wind direction. Figures 3 and 4 show the corresponding frequency distributions at 120 and 140 m AGL respectively.

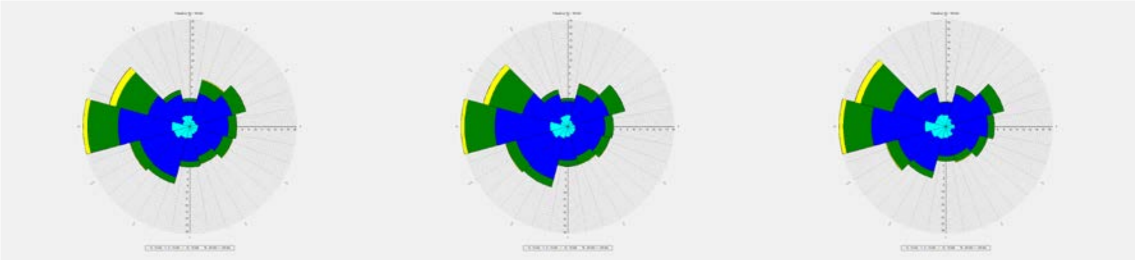

Figure 2: Wind direction frequency distributions of filtered data at wind lidars West, North and South (left to right) at 100 m AGL based on 1 year wind data period

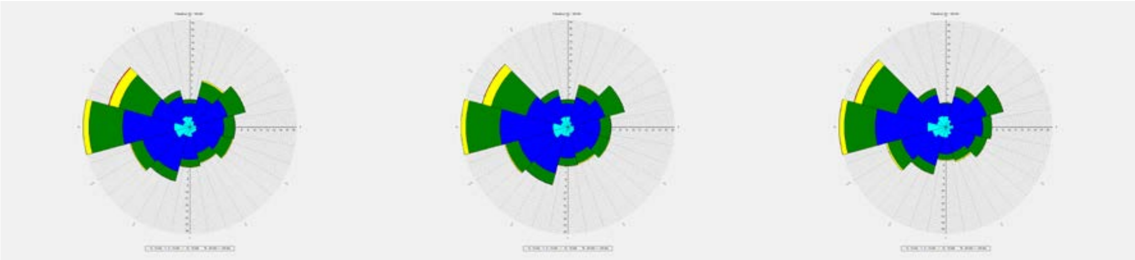

Figure 3: Wind direction frequency distributions of filtered data at wind lidars West, North and South (left to right) at 120 m AGL based on 1 year wind data period

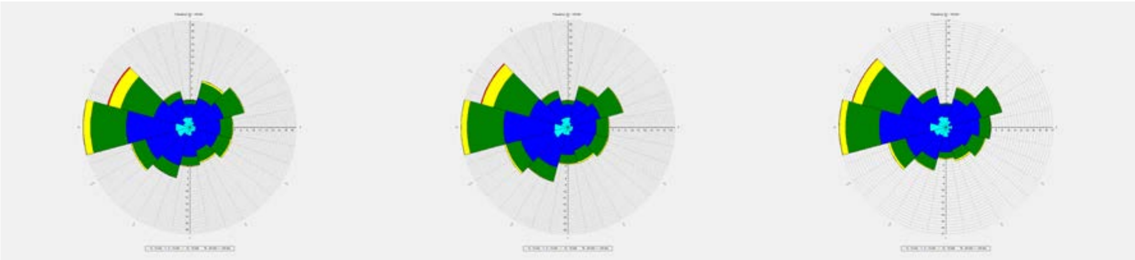

Figure 4: Wind direction frequency distributions of filtered data at wind lidars West, North and South (left to right) at 140 m AGL based on 1 year wind data period

Note that all above wind direction frequency distributions are based on one year wind data period. There is of course some year-to-year variability of the wind direction frequency distributions.

Figure 5 shows the wind direction *power density* distributions for the wind lidars West, North and South at 100 m AGL, indicating that the west and west-northwest sectors are the expected dominant wind energy directions. Figures 6 and 7 show the corresponding frequency distributions at 120 and 140 m AGL respectively.

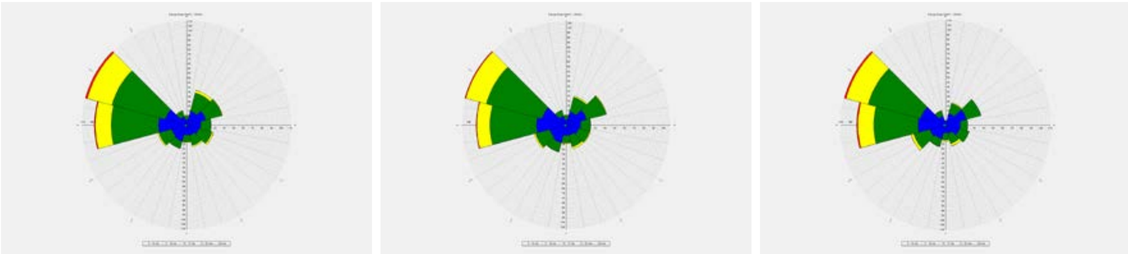

Figure 5: Wind direction power density distributions of filtered data at wind lidars West, North and South (left to right) at 100 m AGL based on 1 year wind data period

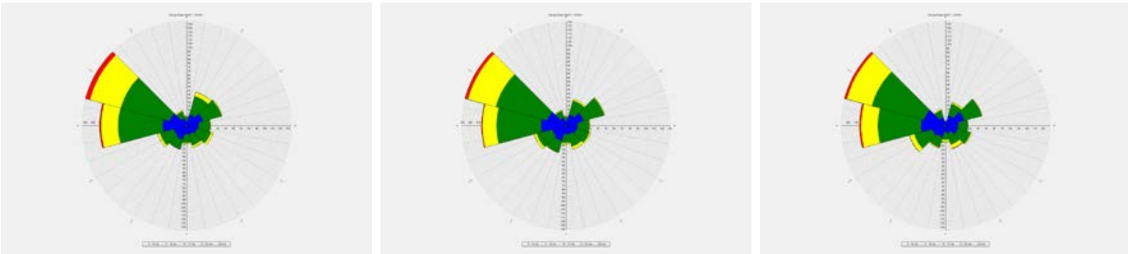

Figure 6: Wind direction power density distributions of filtered data at wind lidars West, North and South (left to right) at 120 m AGL based on 1 year wind data period

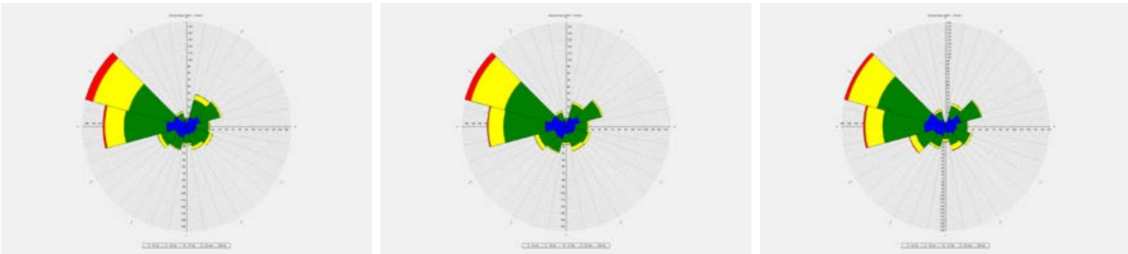

Figure 7: Wind direction power density distributions of filtered data at wind lidars West, North and South (left to right) at 140 m AGL based on 1 year wind data period

Note that all above wind direction power density distributions are based on one year wind data period. There is of course some year-to-year variability of the wind direction power density distributions.

2.4 Long-term reference data

To get an understanding of the long-term variation of the wind at the Østerild test centre, a correlation needs to be undertaken with a representative and reliable long-term reference.
No such long-term reference ground station is available near the Østerild test centre. Therefore, a MERRA (Modern Era Retrospective analysis for Research and Applications) data set is compared with the on-site wind data and used as a long-term reference.
The MERRA data set originates from the Global Modeling and Assimilation Office of NASA/Goddard Space Flight Center. The advantages of the MERRA data are that the period of MERRA data can be much longer than the period of on-site data. The data is neither subject to icing nor seasonal influences from vegetation and there should be no long-term trends if the long-term wind data period covers the most recent 30 years.
The MERRA data from the geographical position E 9.335, N 57.000 degrees at 50 m AGL is applied. This position is approximately 30 km east-southeast of the Østerild test centre so it is expected that the MERRA data represents a wind climate which is very similar to the wind climate at the test centre. This is supported by the similarity between the wind direction frequency/power density distributions of the wind data measured at the three wind lidars and the wind direction frequency/power density distribution of the MERRA long-term reference data, ref. Figures 2, 3, 4, 5, 6, 7 and 8.

50.0m - Mean wind speed	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
January	10.96	7.94	8.95	8.57	8.26	11.04	11.08	9.22	9.70	12.46	10.39	9.62	7.78	6.90	8.43
February	7.83	6.22	6.82	8.01	9.83	11.41	11.87	9.01	9.41	8.10	8.35	11.35	9.45	11.66	11.06
March	8.32	7.13	8.16	7.31	7.65	9.31	11.56	7.45	9.03	8.54	10.78	10.62	7.80	9.36	8.64
April	6.32	7.77	6.35	6.95	6.64	7.77	7.75	7.76	7.54	7.63	7.87	7.79	5.93	8.62	6.87
May	5.75	6.32	8.10	6.64	6.58	7.65	5.87	7.23	6.69	6.81	6.38	6.35	7.01	7.01	6.69
June	8.17	5.69	6.20	6.68	5.25	5.52	6.05	6.93	6.26	7.36	8.95	6.94	6.35	6.62	7.70
July	7.01	6.52	7.50	7.98	7.55	6.45	7.65	6.38	6.94	7.77	5.56	6.58	7.49	5.68	8.05
August	5.65	8.20	7.45	7.00	7.54	7.85	6.93	7.27	8.18	7.39	6.77	5.88	7.21	4.78	8.17
September	6.79	8.52	9.21	7.68	8.59	6.65	7.75	8.11	7.25	8.39	8.34	8.32	6.58	8.64	6.99
October	9.81	7.57	8.37	8.95	8.31	8.61	8.58	7.87	7.44	7.16	8.48	8.49	8.45	8.34	10.63
November	9.80	8.48	10.30	6.92	8.75	7.86	6.90	9.38	9.68	7.57	9.12	8.43	9.74	8.33	7.08
December	8.62	8.51	9.65	8.19	10.74	8.52	9.04	9.54	8.76	10.06	9.74	6.60	7.18	7.31	9.23
mean, all data	7.92	7.41	8.10	7.57	7.97	8.21	8.41	8.00	8.07	8.28	8.39	8.06	7.58	7.73	8.28
mean of months	7.92	7.41	8.09	7.57	7.97	8.22	8.42	8.01	8.07	8.27	8.39	8.08	7.58	7.77	8.29

50.0m - Mean wind speed	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Mean	Mean of months
January	9.20	10.78	7.50	9.90	9.41	7.92	11.56	7.95	12.13	11.23	8.36	8.15	8.04	9.64	7.89	9.36	9.37
February	8.97	10.61	9.16	11.03	5.75	8.01	9.29	7.24	9.30	10.71	6.75	6.67	10.03	8.56	6.96	8.98	8.98
March	7.99	8.88	7.16	9.31	6.78	8.17	7.28	7.05	8.86	8.84	7.67	7.69	8.34	9.09	8.13	8.43	8.43
April	7.60	6.06	6.68	6.55	7.36	7.01	6.81	7.10	7.61	5.78	5.55	7.70	7.22	7.06	7.87	7.12	7.12
May	6.77	6.62	6.78	6.84	6.61	7.75	6.55	7.74	7.02	4.91	7.44	6.79	8.17	6.90	6.93	6.83	6.83
June	6.52	7.84	7.36	8.09	7.37	7.71	7.01	6.48	5.56	8.05	6.27	6.62	7.18	7.47	7.20	6.91	6.91
July	5.78	6.12	6.10	6.56	6.21	6.46	6.27	5.48	7.75	6.29	6.80	6.47	5.69	6.62	6.26	6.67	6.67
August	5.30	7.58	7.24	6.08	6.54	6.58	6.88	5.38	7.69	6.96	7.52	6.87	7.18	6.05	6.86	6.90	6.90
September	7.03	8.71	7.59	6.49	7.30	8.63	7.44	7.99	9.32	6.47	8.55	7.98	8.28	9.18	6.42	7.84	7.84
October	8.78	8.63	9.63	8.66	7.38	8.81	7.21	7.29	6.63	9.44	8.33	7.95	9.02	8.05	8.52	8.38	8.38
November	8.57	9.15	9.49	7.70	7.71	8.49	8.73	10.50	9.21	8.99	10.05	9.27	7.73	8.28	8.40	8.69	8.69
December	9.96	7.82	7.39	8.16	9.34	9.54	9.63	10.62	7.59	7.16	7.59	7.49	10.67	8.93	11.07	8.82	8.82
mean, all data	7.70	8.22	7.66	7.93	7.32	7.92	7.88	7.56	8.22	7.89	7.58	7.47	8.12	7.98	7.72	7.91	
mean of months	7.71	8.23	7.67	7.95	7.31	7.92	7.89	7.57	8.22	7.90	7.57	7.47	8.13	7.99	7.71		7.91

Table 7: Monthly wind speeds of MERRA long-term reference data at 50 m AGL

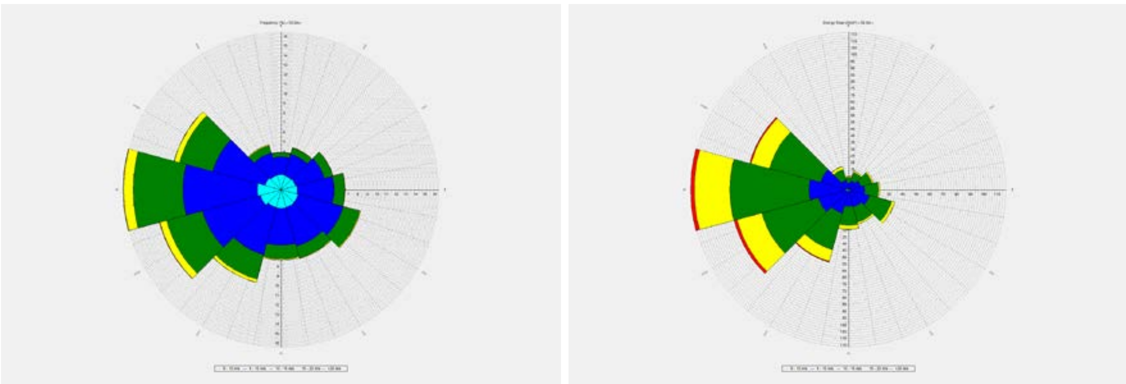

Figure 8: Wind direction frequency (left) and power density (right) distributions of MERRA long-term reference data at 50 m AGL

Figure 8 confirms that a broad sector from southwest to northwest is the expected dominant wind direction. The west-southwest, west and west-northwest wind direction sectors also represent the highest mean wind speeds and thus the most wind energy.

2.5 Long-term correlation

Correlation analyses were made to determine the level of correlation between the wind speed data from each of the on-site wind lidars at 100, 120 and 140 m AGL and the MERRA long-term reference data. The correlation analyses gave correlation coefficients (*R*) of 0.94 to 0.97, based on a one-month averaging period, ref. Table 8. The correlation coefficients are very high and also sufficiently high for long-term wind speed corrections applying the MERRA data.
The MERRA data set from the geographical position E 9.335, N 57.000 degrees is applied because it has the better correlation with the on-site wind lidar data (of the four nearest MERRA data sets).

Long-term correlation coefficient (*R*)	Lidar West	Lidar North	Lidar South
100 m AGL	0.95	0.95	0.94
120 m AGL	0.96	0.96	0.95
140 m AGL	0.96	0.97	0.96

Table 8: Correlation coefficients (R) for correlations of on-site wind lidar data with MERRA long-term reference data, based on a one month averaging period

2.6 Long-term correction

The on-site wind lidar data have been long-term corrected on the basis of the long-term correlation analyses. One full year (February 2010 to January 2011) of wind data from three on-site wind lidars and 30 full years (1984-2013) of MERRA long-term reference data have been used to estimate the wind climate at the Østerild test centre.
Long-term correction has been made using the Wind Energy Index method (Wind Index Method in WindPRO) [2]. The Wind Energy Index method is described by using the ratio between a) the long-term mean wind energy at the long-term reference and b) the short-term mean energy at the long-term reference, which is concurrent with the short-term wind data period at the site. Applying this ratio to the short-term mean energy at the site gives the long-term mean energy at the site. The results are long-term *energy* correction ratios of 1.06 to 1.10 (+6 % to +10 %), which are applied to the short-term mean *energy* for the three wind lidars and the three measurement heights (this roughly corresponds to long-term *wind speed* correction ratios of 1.03 to 1.05).

Long-term correction ratio	Lidar West	Lidar North	Lidar South
100 m AGL	1.09	1.10	1.08
120 m AGL	1.08	1.09	1.07
140 m AGL	1.06	1.07	1.06

Table 9: Estimated long-term energy correction factors at wind lidars West, North and South at 100, 120 and 140 m AGL

The different long-term energy correction factors are mainly due to the different wind data availability after filtering for the three wind lidars and the three measurement heights.
Note that for the Wind Energy Index method, no long-term correction is applied to the short-term wind direction data. So the wind direction frequency distributions for the wind lidars at the three measurement heights remain uncorrected.

3. Wind resource

This section presents the estimated wind resource at the Østerild National Test Centre for Large Wind Turbines.

3.1 WAsP wind flow model

WAsP (Wind Atlas Analysis and Application Program) version 11.1.16 has been applied for wind flow modelling. WAsP is considered the wind energy industry-standard software for wind resource assessment and siting of wind turbines and wind farms.

WAsP modelling includes analysing observed wind data to calculate so-called generalised wind climates (wind atlas data sets). These generalised wind climates are subsequently applied to estimate wind climates at particular wind turbine positions. In order for WAsP to calculate the effects of the surrounding terrain on the wind at a given site, it is necessary to describe systematically the most important features of the surrounding terrain.

Applying WAsP, it is possible to estimate the wind resources at the Østerild test centre, based on the inputs of wind data and a description of the elevation and land cover. Details of the WAsP model and its validation are given by Troen and Petersen [3].

3.2 Basis of wind resource calculations

The WAsP wind resource calculations are based on:

- Wind data (one full year) from the wind lidars West, North and South at 100, 120 and 140 m AGL, ref. section 2
- MERRA data (30 years) from the geographical position E 9.335, N 57.000 degrees at 50 m AGL, ref. section 2
- Height contour lines in a WAsP map file
- Roughness change lines in a WAsP map file
- The calculations include no array losses due to shadowing effects (wake effects) from one test stand to another within the Østerild test centre
- Any neighbouring wind turbines have not been taken into account

Note that after the wind lidar measurements took place, part of the forest around the Østerild test centre has been cut down. This was done in order to reduce the terrain surface roughness and thereby achieve on-site turbulence levels and wind shear conditions in compliance with international standards.

As a side effect, the reduced terrain surface roughness also affects the wind resources at the Østerild test centre. So the wind data from the three wind lidars might not be entirely representative of the present wind resources. This has also not been taken into account and it leads to a slightly underestimated wind resource.

3.3 Test stands

The row of the seven test stands at the Østerild test centre is aligned in the north-south direction. The elevations of the test stand positions vary between 12 and 14 m ASL (elevations from height contour lines) and there is a 600 m distance between neighbouring test stands. The North Sea coastline is seen approximately 4 km to the north of the test centre.
The layout of the seven test stands is shown in Figure 9. Please see section 3.5 for a list of the test stands.

Figure 9: Google Earth image of seven test stand positions and three wind lidars

3.4 Estimated wind resource

Figure 10 shows the positions of the seven test stands in a 120 m AGL wind resource map of the Østerild test centre. The grid is 1 km squares based on the coordinate system UTM WGS84 zone 32.

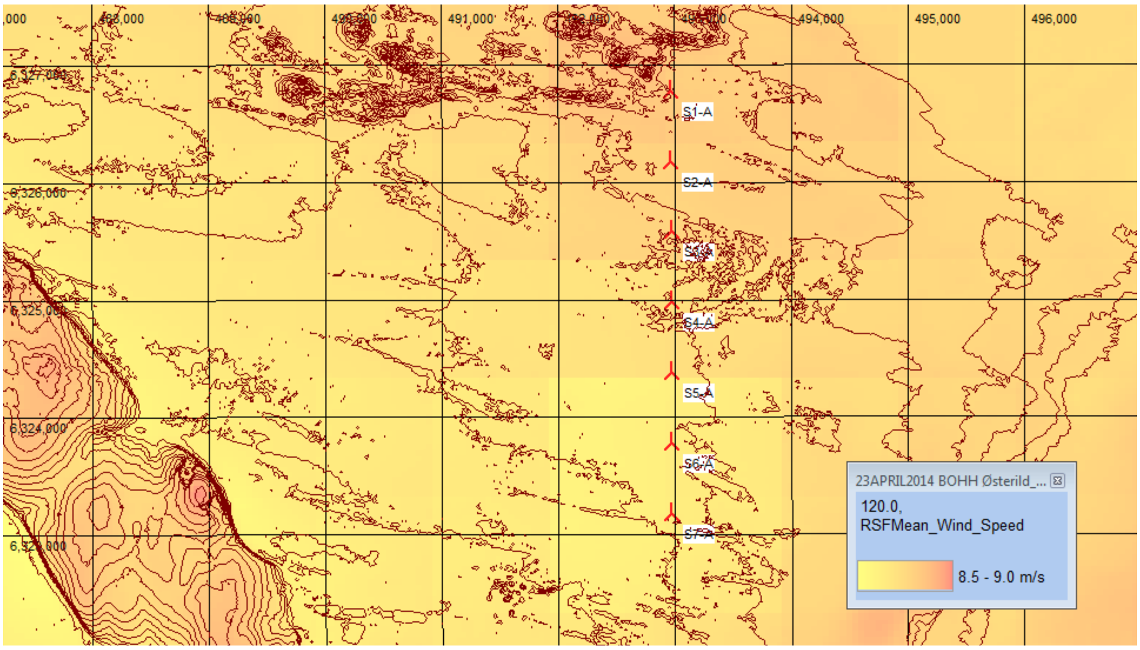

Figure 10: Estimated annual mean wind speed at 120 m AGL

3.5 Estimated long-term mean wind speeds

The long-term mean wind speed is estimated for the seven test stands at 100, 120 and 140 m AGL. The Tables 10, 11 and 12 below list the positions and the estimated long-term mean wind speeds for the test stands at 100, 120 and 140 m AGL respectively.

Test stand	UTM WGS84 zone 32 E [m]	UTM WGS84 zone 32 N [m]	Long-term mean wind speed [m/s]	Long-term Weibull *A* parameter [m/s]	Long-term Weibull *k* parameter
1	492967	6326734	8.32	9.37	2.61
2	492967	6326134	8.32	9.36	2.62
3	492967	6325534	8.30	9.34	2.61
4	492967	6324934	8.27	9.31	2.61
5	492967	6324334	8.22	9.26	2.60
6	492967	6323734	8.18	9.21	2.58
7	492967	6323134	8.14	9.17	2.57
Average			8.25	9.29	2.60

Table 10: Long-term mean wind speeds at 100 m AGL

Test stand	UTM WGS84 zone 32 E [m]	UTM WGS84 zone 32 N [m]	Long-term mean wind speed [m/s]	Long-term Weibull *A* parameter [m/s]	Long-term Weibull *k* parameter
1	492967	6326734	8.80	9.91	2.62
2	492967	6326134	8.80	9.91	2.63
3	492967	6325534	8.79	9.89	2.62
4	492967	6324934	8.76	9.86	2.62
5	492967	6324334	8.72	9.81	2.61
6	492967	6323734	8.67	9.76	2.60
7	492967	6323134	8.63	9.72	2.59
Average			8.74	9.84	2.61

Table 11: Long-term mean wind speeds at 120 m AGL

Test stand	UTM WGS84 zone 32 E [m]	UTM WGS84 zone 32 N [m]	Long-term mean wind speed [m/s]	Long-term Weibull *A* parameter [m/s]	Long-term Weibull *k* parameter
1	492967	6326734	9.17	10.32	2.62
2	492967	6326134	9.17	10.32	2.62
3	492967	6325534	9.16	10.31	2.62
4	492967	6324934	9.14	10.28	2.62
5	492967	6324334	9.10	10.24	2.62
6	492967	6323734	9.06	10.20	2.61
7	492967	6323134	9.03	10.17	2.60
Average			9.12	10.26	2.62

Table 12: Long-term mean wind speeds at 140 m AGL

4. Uncertainty

4.1 Wind speed uncertainty

The uncertainty in any wind resource assessment is highly dependent on the local wind climate and topography, the quality of the on-site wind data and long-term reference data, the wind flow model, etc. Table 13 lists the wind speed uncertainty factors, which should at least be included in an estimate of the total uncertainty for any wind resource assessment. Some of the uncertainty factors are not easy to estimate. However, in general it might be helpful to at least consider the following:

- Uncertainty on wind measurements includes: Instrument type, mounting and calibration of instruments as well as any periods of missing/invalid wind data
- Uncertainty on long-term correction includes: Level of correlation between on-site wind data and long-term reference data as well as any periods of missing/invalid wind data
- Uncertainty on year-to year variability includes: Duration and variation of long-term reference data as well as any periods of missing/invalid wind data
- Uncertainty on vertical and horizontal extrapolation includes: Complexity of terrain, atmospheric stability, accuracy and sufficiency of terrain description (height contour lines and roughness change lines), accuracy in the position of observation site and predicted site, ability of the applied wind flow model to make self-prediction of measured wind data, vertical and horizontal distance between observation site and predicted site, as well as any obstacles

Uncertainty category	**Uncertainty factor**	**Estimated level (1-year period)**	**Estimated level (30-years period)**
Wind data	Wind measurements	4 %	4 %
	Long-term correction	2 %	2 %
	Year-to-year variability	6 %	1 %
Flow model	Vertical extrapolation	0 %	0 %
	Horizontal extrapolation	2 %	2 %
Total uncertainty	RMS of uncertainty factors	8 %	5 %

Table 13: Estimated wind speed uncertainty factors and total mean wind speed uncertainty

Please note that all uncertainty factors are considered to be uncorrelated and given as standard deviations for Gaussian distributions. With this assumption the total uncertainty can be calculated as the root-mean-square (RMS) of the uncertainty factors.
It is seen in Table 13 that there is an estimated 8 per cent total uncertainty on the estimated mean wind speeds based on a one-year averaging period and an estimated 5 per cent total uncertainty on the estimated mean wind speeds based on a 30-year averaging period.
The estimated levels of uncertainty are relatively low and this is mainly due to:

- Good correlation with a representative and reliable long-term reference
- No vertical extrapolation and short horizontal extrapolation of measured wind data

4.2 Cross-prediction

A cross-prediction between the three wind lidars has been made, applying the wind lidar data and WAsP calculations for each lidar position to predict the wind speeds at the two other lidar positions. The cross-prediction results and the estimated cross-prediction errors can be seen in Tables 14, 15 and 16 below.

	Predictor lidar	**Lidar West**	**Lidar North**	**Lidar South**
Predicted lidar	**Level [m AGL]**	**100**	**100**	**100**
Lidar West	**100**	-1.0 %	-1.2 %	-4.7 %
Lidar North	**100**	-0.8 %	-1.0 %	-4.6 %
Lidar South	**100**	+2.8 %	2.6 %	-1.1 %

Table 14: Cross-prediction error between wind lidars West, North and South at 100 m AGL based on 8.7 months of concurrent wind data

	Predictor lidar	**Lidar West**	**Lidar North**	**Lidar South**
Predicted lidar	**Level [m AGL]**	**120**	**120**	**120**
Lidar West	**120**	-0.4 %	-0.5 %	-4.0 %
Lidar North	**120**	-0.3 %	-0.4 %	-3.9 %
Lidar South	**120**	+3.2 %	+3.1 %	-0.5 %

Table 15: Cross-prediction error between wind lidars West, North and South at 120 m AGL based on 8.7 months of concurrent wind data

	Predictor lidar	**Lidar West**	**Lidar North**	**Lidar South**
Predicted lidar	**Level [m AGL]**	**140**	**140**	**140**
Lidar West	**140**	-0.3 %	-0.3 %	-3.3 %
Lidar North	**140**	-0.2 %	-0.3 %	-3.3 %
Lidar South	**140**	+2.8 %	+2.7 %	-0.3 %

Table 16: Cross-prediction error between wind lidars West, North and South at 140 m AGL based on 8.7 months of concurrent wind data

The cross-prediction analysis shows that all self-prediction errors are about one per cent only or less and this is acceptable.
The cross-prediction analysis also shows that the cross-prediction errors between the lidars West and North are about one per cent only and this is satisfactory.
However, the analysis also shows a significant cross-prediction error when modelling the wind speeds at Lidar West and Lidar North from Lidar South and vice versa. This is likely due to difficulty in cross-predicting wind resources between positions, which have different distances to the North Sea. Therefore, the wind resource calculations for each of the seven test stands have been made applying wind data from all three wind lidars – weighed according to the distance between the test stands and the wind lidars.

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EMD International A/S
The MERRA long-term reference data set applied is provided and processed by EMD International A/S.

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Appendix A Wind data availabilities

This appendix presents the wind data availabilities for the three wind lidars (appendices A1 to A3) at 100, 120 and 140 m AGL.

A.1. Lidar West

Lidar West at 100 m AGL

100.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	98.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	140	144	140
02/2010	99.0	144	144	144	143	144	144	144	144	144	144	143	144	144	144	144	144	144	144	144	138	144	144	143	131	135	144	135	143			
03/2010	95.1	144	83	118	144	117	107	144	144	132	132	144	144	144	144	144	144	132	144	132	144	144	144	144	144	132	144	142	144	144	144	140
04/2010	87.1	144	144	144	144	144	144	144	144	144	144	144	126	144	139	143	123	0	0	0	80	143	144	144	144	144	132	144	144	144	142	
05/2010	87.8	144	144	126	143	143	144	144	144	144	144	96	140	132	144	105	144	144	144	144	132	144	144	144	138	144	143	140	91	0	0	86
06/2010	98.0	132	144	144	144	144	144	144	141	144	137	143	144	144	138	144	138	138	144	115	144	144	138	144	138	144	144	144	144	138	144	
07/2010	92.5	144	144	113	0	78	144	144	141	144	144	119	139	144	142	138	144	135	144	138	138	138	144	144	144	138	138	138	138	144	142	144
08/2010	97.7	144	138	144	143	134	144	144	138	144	142	141	133	142	144	144	141	144	144	144	143	138	144	129	137	138	144	144	138	138	140	138
09/2010	86.7	138	138	144	101	122	138	138	138	138	144	134	138	138	135	129	143	130	137	138	134	144	138	132	134	144	134	0	0	86	140	
10/2010	77.3	144	138	137	144	144	134	139	144	144	143	138	138	140	138	143	138	78	110	110	114	108	109	48	103	125	138	116	46	0	0	0
11/2010	72.0	62	138	124	121	126	138	117	137	124	48	125	93	64	138	105	138	134	138	144	91	138	134	139	112	35	0	0	65	45	138	
12/2010	89.9	138	138	90	144	102	99	81	124	125	129	144	138	135	144	144	130	144	60	117	113	144	144	144	144	144	143	136	144	144	144	144
01/2011	79.5	144	130	139	140	122	120	138	129	122	144	129	142	40	0	0	0	86	144	144	138	128	144	27	142	140	144	144	144	98	144	144
02/2011	83.3	136	139	137	110	144	119	98	144	132	139	139	144	131	144	130	0	0	30	144	144	144	144	144	119	136	81	144	144			
03/2011	93.0	144	144	144	144	144	144	144	144	107	107	131	108	109	133	144	144	144	118	144	144	144	144	144	144	144	142	135	144	131	110	85
04/2011	98.3	144	144	135	144	126	143	144	144	143	142	144	140	144	144	144	134	144	144	126	144	144	144	144	144	138	138	144	144	144	144	
05/2011	82.4	144	139	139	144	144	144	144	144	144	144	102	144	144	36	0	0	80	122	144	144	144	126	133	141	136	137	98	61	107	144	105
06/2011	92.1	144	144	144	144	138	137	144	127	132	144	98	141	78	144	144	90	109	111	139	136	144	132	119	144	144	144	144	144	130	144	
07/2011	90.1	144	120	144	144	144	125	144	105	120	144	144	144	138	73	99	134	98	115	135	141	144	70	106	140	141	144	144	144	144	144	144
08/2011	88.9	144	144	144	125	119	139	111	123	138	139	116	144	144	97	144	144	142	144	102	144	131	144	125	102	141	120	114	107	109	109	120
09/2011	57.7	134	99	144	144	133	67	87	87	144	140	21	0	0	0	0	0	0	0	0	0	55	136	144	144	144	106	144	144	144	131	
10/2011	89.4	143	139	136	144	62	72	118	143	110	95	114	144	144	144	144	144	141	61	108	144	132	144	144	144	144	129	144	144	144	128	142
11/2011	98.8	144	144	136	144	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	87.7																															

Lidar West at 120 m AGL

120.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	97.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	140	144	137
02/2010	97.0	144	138	144	137	144	144	144	144	144	144	142	144	144	135	144	144	144	133	142	128	144	142	143	131	126	138	120	139			
03/2010	93.3	144	82	118	143	115	107	131	131	124	132	144	144	144	144	144	144	132	140	132	144	144	144	143	133	132	144	119	143	144	144	136
04/2010	86.7	144	144	144	144	144	141	144	144	144	144	142	124	144	139	142	123	0	0	0	80	143	144	144	144	144	124	144	144	144	139	
05/2010	87.4	144	144	122	144	143	144	144	144	144	144	96	136	132	144	100	144	144	141	140	132	144	144	144	138	144	143	140	91	0	0	86
06/2010	97.5	132	144	144	144	144	144	142	141	144	137	138	144	144	138	144	138	138	144	115	144	144	138	144	126	144	144	144	144	138	144	
07/2010	92.4	144	144	111	0	78	144	144	140	144	144	117	139	144	142	138	144	135	144	138	138	138	144	144	144	138	138	138	137	144	142	144
08/2010	97.5	143	138	144	142	134	144	144	138	144	142	139	133	142	144	144	140	144	144	144	142	138	144	127	135	138	144	144	138	137	139	138
09/2010	86.2	138	138	144	101	117	138	138	138	138	144	134	138	136	131	126	139	130	137	138	134	144	138	131	130	144	134	0	0	86	141	
10/2010	76.2	144	138	137	144	144	134	139	142	144	140	138	138	137	135	143	138	76	111	106	112	105	108	30	95	125	138	115	46	0	0	0
11/2010	71.0	62	138	123	120	122	138	117	137	124	47	121	89	60	137	104	138	128	138	144	87	138	135	140	107	31	0	0	59	44	138	
12/2010	88.4	138	138	81	141	100	98	68	110	125	121	144	138	134	144	144	129	144	59	115	111	144	144	144	144	144	143	132	144	144	139	144
01/2011	77.1	144	126	140	140	115	118	137	108	119	144	125	140	32	0	0	0	86	144	144	122	120	143	1	138	139	144	144	144	97	144	144
02/2011	82.1	136	139	137	101	144	119	88	144	132	135	138	144	130	144	130	0	0	30	144	144	144	144	144	119	136	55	144	144			
03/2011	91.4	144	144	144	144	144	144	142	144	103	105	130	97	102	89	144	144	144	119	144	144	144	144	144	144	143	142	134	144	131	110	84
04/2011	97.6	144	144	125	144	124	143	144	144	142	142	144	140	144	144	144	132	144	144	125	144	144	144	144	144	133	129	144	144	144	144	
05/2011	82.1	144	138	139	144	144	144	144	144	144	144	102	144	144	36	0	0	80	121	144	144	144	123	132	141	136	137	97	57	107	144	102
06/2011	91.9	144	144	143	144	138	137	144	126	128	144	98	140	77	144	144	90	109	111	138	136	144	132	119	144	144	144	144	144	130	144	
07/2011	88.7	144	116	144	144	143	124	144	105	119	144	144	144	138	73	99	127	84	113	134	140	144	51	100	140	141	144	144	144	144	144	141
08/2011	88.6	144	144	144	125	118	139	111	123	137	138	116	144	142	97	144	144	142	144	102	144	131	144	125	99	141	120	113	106	105	109	120
09/2011	57.2	134	98	144	144	133	65	87	85	144	140	21	0	0	0	0	0	0	0	0	0	54	133	144	144	140	105	144	144	143	124	
10/2011	88.4	139	139	135	144	59	64	118	142	108	95	114	144	144	144	144	144	140	55	108	144	130	144	144	144	144	126	144	144	144	128	130
11/2011	98.6	144	144	136	143	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	86.7																															

Lidar West at 140 m AGL

140.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	96.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	140	144	130
02/2010	92.1	142	126	142	126	144	144	144	140	144	144	142	144	144	121	144	144	144	113	131	111	144	142	143	128	107	86	103	126			
03/2010	88.1	144	82	118	140	113	95	102	68	78	113	139	138	144	144	144	144	132	120	127	143	144	143	140	129	132	143	109	143	144	143	133
04/2010	84.7	142	143	144	144	140	128	144	144	144	142	123	111	144	130	139	123	0	0	0	80	143	144	143	144	144	116	139	144	144	133	
05/2010	86.0	144	143	111	143	143	144	144	144	144	144	96	128	132	144	93	140	144	121	135	132	144	144	142	138	144	143	140	88	0	0	86
06/2010	96.0	132	144	144	144	144	144	133	141	144	133	115	143	144	138	144	138	138	144	115	144	144	138	142	100	144	144	144	144	138	144	
07/2010	92.0	144	144	111	0	78	144	144	136	144	144	117	137	144	142	137	144	134	144	138	138	138	144	144	144	138	138	138	134	143	140	144
08/2010	96.5	142	138	144	141	132	144	144	135	144	140	137	128	140	144	142	138	141	143	144	141	136	144	120	131	138	144	144	138	135	139	138
09/2010	85.7	138	138	144	100	122	138	138	138	138	144	129	138	135	127	120	134	130	137	138	134	144	138	130	127	144	134	0	0	86	138	
10/2010	74.9	144	138	137	144	144	134	137	141	144	139	138	138	132	131	143	138	71	109	101	110	103	104	11	88	125	138	116	46	0	0	0
11/2010	69.5	62	138	122	115	118	138	115	137	125	43	118	83	51	136	104	138	126	138	144	81	137	135	137	106	22	0	0	52	43	138	
12/2010	86.3	138	138	75	140	96	96	63	79	124	109	142	138	133	144	144	123	144	53	111	104	144	144	144	144	144	143	128	144	143	135	144
01/2011	73.9	144	122	139	132	97	115	133	73	116	144	122	140	25	0	0	0	86	144	144	111	99	133	0	133	139	144	144	143	96	144	138
02/2011	80.4	136	138	134	100	144	117	69	144	132	126	136	144	130	144	130	0	0	30	144	144	144	144	144	118	136	25	144	144			
03/2011	88.7	144	144	135	119	144	141	141	144	103	104	130	76	95	76	144	144	144	117	144	129	144	144	144	144	139	142	134	144	131	110	64
04/2011	95.5	132	132	111	144	125	142	144	144	132	129	143	140	144	131	144	121	140	144	125	144	144	144	144	144	133	128	144	144	144	144	
05/2011	81.2	144	138	132	144	144	144	144	144	144	144	101	142	144	36	0	0	80	117	144	144	144	116	130	140	133	137	97	52	101	144	100
06/2011	90.6	144	143	134	144	138	137	128	123	126	144	98	138	77	144	144	86	109	111	138	135	144	132	119	144	144	141	134	144	128	141	
07/2011	86.4	144	107	144	144	131	113	144	105	115	144	144	144	138	73	99	121	70	111	134	140	144	34	83	140	141	144	144	144	144	143	132
08/2011	88.1	144	144	144	124	118	139	110	121	136	138	116	144	140	97	144	144	141	144	102	144	130	144	125	95	141	120	111	106	103	107	119
09/2011	56.1	134	96	144	144	133	65	84	83	144	140	21	0	0	0	0	0	0	0	0	0	53	125	144	144	127	102	144	144	130	123	
10/2011	87.5	137	137	135	144	56	60	117	141	103	94	112	144	144	144	144	144	140	49	105	144	129	144	144	144	144	125	144	144	144	128	122
11/2011	98.3	144	143	136	142	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	84.9																															

A.2. Lidar North

Lidar North at 100 m AGL

100.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	98.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	139	144	142
02/2010	88.1	144	143	144	143	144	144	144	144	144	144	144	144	144	144	144	144	144	143	144	61	0	0	77	136	137	135	132	143			
03/2010	98.1	144	141	143	144	144	143	143	144	132	144	144	144	144	144	144	144	132	144	132	144	144	144	144	144	132	144	141	143	144	132	128
04/2010	97.9	144	142	132	144	132	132	144	144	144	132	144	142	132	144	132	144	144	144	132	142	144	144	144	144	144	144	144	144	144	143	
05/2010	89.6	144	144	115	143	144	144	144	144	144	144	143	144	144	144	112	137	144	144	144	144	144	144	144	144	144	142	143	89	0	0	97
06/2010	94.1	144	144	144	144	138	144	110	142	144	100	96	142	144	138	124	132	138	144	100	144	138	144	144	144	144	140	144	138	140	134	
07/2010	89.9	144	144	103	133	138	138	138	120	144	138	111	127	138	138	134	133	118	118	144	144	143	138	144	144	144	144	144	69	126	63	110
08/2010	81.8	139	138	135	126	123	144	138	143	138	88	0	89	100	138	144	73	115	106	117	109	117	137	98	67	118	138	144	143	120	130	136
09/2010	88.4	138	144	144	107	134	144	144	144	144	125	116	143	133	92	50	82	99	117	141	104	130	144	140	116	144	138	144	144	141	135	
10/2010	85.7	144	136	131	138	138	93	138	144	138	142	144	144	142	144	136	144	81	89	115	107	109	124	38	65	123	144	109	126	127	130	144
11/2010	64.1	137	111	91	119	101	139	124	144	92	35	113	63	43	133	118	144	144	144	136	56	137	119	56	73	3	0	0	38	13	143	
12/2010	88.5	144	144	63	135	132	117	42	134	139	130	141	144	102	144	144	123	144	61	137	64	144	144	144	144	144	144	140	144	144	143	130
01/2011	90.7	144	144	144	129	114	124	127	118	105	143	125	144	139	111	119	135	137	144	144	143	133	144	36	136	139	144	144	135	117	144	142
02/2011	87.5	128	119	109	104	144	115	86	140	130	121	109	144	140	144	127	34	118	144	144	144	144	144	144	144	138	84	144	144			
03/2011	91.5	144	144	144	144	144	144	144	144	106	108	123	108	107	106	140	144	144	91	144	144	144	144	144	144	144	144	134	144	127	111	88
04/2011	98.8	118	144	141	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	134	144	144	144	144	144	138	135	144	144	144	144	
05/2011	20.8	144	143	142	67	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All	86.7																															

Lidar North at 120 m AGL

120.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	97.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	139	144	138
02/2010	85.9	142	138	144	138	144	144	144	144	144	144	142	144	144	135	144	144	144	132	143	52	0	0	77	134	127	125	117	135			
03/2010	96.3	144	139	142	144	144	143	132	141	125	142	144	144	144	144	144	144	132	138	131	144	144	144	142	130	132	144	116	141	144	131	124
04/2010	97.3	144	136	132	144	130	132	144	144	144	132	144	140	132	144	130	144	144	144	132	141	144	143	143	144	144	135	144	144	144	140	
05/2010	88.6	144	144	115	139	144	144	144	144	144	144	143	133	144	144	102	133	144	138	136	144	144	144	144	144	144	142	143	86	0	0	97
06/2010	92.8	144	144	144	144	138	144	100	142	144	97	86	142	144	138	118	132	138	144	97	144	138	144	144	133	144	140	144	138	139	123	
07/2010	89.3	144	144	102	131	138	138	138	118	144	138	107	126	138	135	134	131	117	117	144	144	143	138	144	144	144	144	144	63	125	60	109
08/2010	81.4	139	138	135	125	120	144	138	141	138	88	0	89	96	138	144	73	115	103	117	109	116	136	98	66	118	138	144	143	118	129	136
09/2010	86.9	138	144	144	106	105	144	144	144	144	124	109	136	133	91	50	76	94	116	141	102	129	144	137	114	144	138	144	144	141	132	
10/2010	84.3	144	136	129	138	138	92	135	142	138	139	144	144	135	139	136	144	81	89	111	97	108	122	25	63	122	144	109	126	127	130	134
11/2010	62.4	137	114	88	115	93	139	123	144	92	33	109	53	37	133	117	144	144	144	136	55	137	119	52	71	3	0	0	31	1	133	
12/2010	86.9	144	144	59	128	113	113	40	123	139	124	141	144	101	144	144	118	144	59	136	61	144	144	144	144	144	144	141	144	144	140	129
01/2011	87.1	144	143	144	126	94	123	126	87	104	142	124	142	124	103	110	136	137	144	144	127	125	139	1	133	139	144	144	135	116	144	142
02/2011	85.5	128	119	109	95	144	115	73	140	130	113	109	144	140	144	127	28	117	144	144	144	144	144	144	144	138	37	144	144			
03/2011	89.9	144	144	144	144	144	144	143	144	106	107	123	101	95	60	139	144	144	90	144	144	144	144	144	144	144	144	134	144	127	111	83
04/2011	98.0	112	144	135	144	144	144	144	144	144	144	144	143	144	142	144	144	144	144	128	144	144	144	144	144	133	127	144	144	144	144	
05/2011	20.8	144	143	141	67	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All	85.3																															

Lidar North at 140 m AGL

140.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	94.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	139	144	123
02/2010	80.4	141	115	142	126	144	144	144	141	144	144	142	144	144	123	144	144	144	115	130	46	0	0	77	126	101	72	93	111			
03/2010	90.5	144	139	137	141	140	129	103	69	77	126	136	135	144	144	144	144	132	120	126	144	144	144	136	127	132	143	111	138	144	129	119
04/2010	93.4	133	131	132	135	125	106	144	144	140	121	129	109	132	134	126	144	144	144	132	139	144	143	142	144	144	122	137	144	144	127	
05/2010	85.7	143	128	97	135	144	144	144	144	144	144	142	107	142	144	96	122	144	113	130	144	144	144	142	144	144	142	140	79	0	0	97
06/2010	89.6	107	119	144	144	138	144	94	141	144	90	62	140	144	138	113	132	138	144	95	144	138	144	142	106	144	140	144	138	139	121	
07/2010	88.3	144	144	102	125	138	138	138	112	144	138	104	126	138	133	132	128	115	116	144	144	142	138	144	144	144	144	144	56	120	57	107
08/2010	80.6	139	138	135	122	120	144	138	141	138	88	0	89	93	138	137	73	115	101	117	107	114	135	99	63	114	138	144	142	111	128	136
09/2010	82.2	137	141	144	40	46	138	144	144	144	123	101	133	133	85	47	68	90	113	141	92	128	144	135	114	144	138	144	144	141	117	
10/2010	82.0	144	135	128	138	138	91	132	140	138	139	144	144	130	129	135	140	81	88	102	92	103	117	10	61	120	144	109	126	127	130	106
11/2010	61.0	136	112	86	113	90	139	122	144	91	25	101	51	33	132	116	144	144	144	135	52	130	119	49	69	2	0	0	26	0	130	
12/2010	84.8	144	144	52	124	111	107	39	97	139	110	138	144	101	144	144	107	144	51	136	60	144	144	144	144	144	144	136	144	144	132	128
01/2011	82.0	144	120	140	110	87	122	125	60	100	141	124	139	89	96	101	136	136	144	144	117	89	133	0	117	133	144	144	135	113	144	133
02/2011	84.4	125	119	108	94	143	114	59	140	129	106	109	144	139	144	126	27	117	144	144	144	144	144	144	144	138	28	144	144			
03/2011	86.5	144	144	130	111	144	142	141	144	105	106	123	83	89	36	139	144	144	89	144	131	144	144	144	144	137	141	133	144	125	110	62
04/2011	95.0	92	131	117	141	142	141	143	144	129	125	142	141	144	130	144	133	139	144	125	144	144	144	144	144	132	127	144	144	144	144	
05/2011	20.6	144	141	139	67	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All	82.3																															

A.3. Lidar South

Lidar South at 100 m AGL

100.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	144	141
02/2010	76.7	142	65	0	80	144	144	144	144	144	144	144	144	144	144	144	144	144	116	144	21	0	0	91	136	93	105	106	123			
03/2010	91.8	113	141	144	144	91	139	144	144	144	144	144	144	144	144	48	98	132	144	126	144	144	144	132	143	132	139	139	107	132	136	132
04/2010	90.8	107	101	144	118	144	138	6	144	144	144	144	140	144	138	144	144	144	144	144	78	144	144	142	144	144	138	144	144	144	80	
05/2010	81.0	112	144	134	132	144	144	144	144	144	144	99	93	72	144	90	23	144	144	144	144	144	144	144	144	144	144	116	69	0	0	86
06/2010	97.6	144	131	144	144	144	144	83	129	138	142	144	144	144	144	144	144	144	144	143	144	144	144	144	144	144	144	144	144	144	138	
07/2010	56.9	144	144	137	142	144	144	144	142	144	144	38	0	0	0	0	0	0	0	0	0	0	0	0	70	144	144	144	140	144	142	143
08/2010	97.6	143	144	144	140	140	144	144	144	144	143	135	142	144	144	144	140	144	144	144	143	143	144	133	138	120	109	144	144	141	142	144
09/2010	98.3	144	144	144	144	124	144	144	144	144	144	139	144	143	140	134	143	139	144	144	144	144	144	143	137	144	144	144	144	144	126	
10/2010	85.3	144	144	144	144	144	142	141	144	144	142	144	144	134	144	144	144	139	138	142	142	131	144	89	135	135	144	137	47	0	0	0
11/2010	75.2	65	144	142	144	141	144	112	97	143	144	138	116	104	142	137	144	144	144	144	144	144	144	144	143	39	0	0	0	0	0	
12/2010	71.0	0	0	0	28	30	52	0	123	1	57	129	30	138	144	144	134	144	144	144	144	144	144	144	144	144	144	144	144	144	143	144
01/2011	91.3	144	144	144	116	96	107	142	119	121	144	124	141	135	126	137	140	126	144	144	143	133	144	43	144	137	144	144	144	118	144	144
02/2011	89.0	124	125	140	104	144	129	106	144	131	112	137	144	105	144	128	46	115	144	144	144	144	144	144	115	139	103	144	144			
03/2011	92.9	144	144	144	144	144	124	144	144	93	110	128	114	118	142	144	144	144	114	144	144	144	144	144	144	144	140	143	138	132	110	93
04/2011	81.1	128	142	134	132	91	120	126	144	113	21	100	127	141	144	136	92	141	115	115	126	95	100	121	108	72	123	138	137	108	114	
05/2011	81.5	128	131	103	135	144	130	119	125	127	115	67	142	144	94	81	84	137	115	101	144	144	99	118	131	133	131	118	78	100	144	75
06/2011	70.0	135	102	69	78	78	112	125	99	47	103	76	112	66	141	114	69	75	102	109	119	126	130	91	138	112	120	124	86	67	100	
07/2011	58.6	114	50	144	144	137	92	69	50	115	107	95	70	95	73	81	90	55	104	118	78	49	19	0	92	133	85	38	105	49	78	89
08/2011	56.0	40	103	90	92	102	78	76	15	40	55	86	81	129	97	131	110	136	60	26	63	33	92	80	80	110	115	80	44	63	84	111
09/2011	63.9	98	126	144	132	127	19	50	20	125	130	88	65	35	82	77	96	116	78	87	80	67	46	110	129	144	115	89	144	78	63	
10/2011	65.9	65	99	99	132	75	14	85	71	106	68	84	61	78	95	86	96	104	15	71	97	85	129	101	144	138	105	144	126	137	114	117
11/2011	94.4	144	140	125	132	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	79.8																															

Lidar South at 120 m AGL

120.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	96.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	144	133
02/2010	74.4	142	58	0	80	144	144	144	144	144	144	142	144	144	142	144	144	144	94	141	18	0	0	91	134	82	86	89	116			
03/2010	89.8	112	141	144	144	89	138	134	143	137	144	144	144	144	144	48	98	132	141	122	144	144	144	132	123	132	133	120	106	130	132	125
04/2010	89.4	107	99	144	113	143	112	6	144	144	144	144	136	144	135	140	144	144	144	144	76	144	144	140	144	144	127	144	144	144	79	
05/2010	80.3	110	144	126	132	144	144	144	144	144	144	98	91	67	144	90	18	144	139	140	144	144	144	144	144	144	144	116	68	0	0	84
06/2010	96.9	144	131	144	144	144	144	82	129	138	138	134	143	144	144	144	144	144	144	140	144	144	144	144	135	144	144	144	144	142	137	
07/2010	55.8	144	144	128	138	144	144	144	130	144	144	37	0	0	0	0	0	0	0	0	0	0	0	0	70	144	144	144	126	144	140	140
08/2010	95.8	142	144	144	139	139	144	144	140	144	139	129	131	137	144	143	134	140	142	144	137	137	144	123	131	120	109	144	143	140	142	144
09/2010	96.9	144	144	144	143	116	144	144	144	144	143	130	142	140	133	123	141	138	141	144	138	144	144	142	128	144	144	144	144	144	126	
10/2010	83.8	144	144	144	144	144	136	141	144	144	141	144	144	128	142	144	144	135	132	137	138	130	144	68	125	135	144	135	47	0	0	0
11/2010	73.6	65	142	133	137	137	144	112	97	143	142	135	109	95	140	136	144	144	144	144	142	143	144	144	135	28	0	0	0	0	0	
12/2010	69.2	0	0	0	28	28	28	0	97	0	40	129	30	138	144	144	129	144	144	144	142	144	144	144	144	144	144	144	144	144	138	144
01/2011	88.4	144	142	144	109	80	107	142	96	111	144	123	141	128	125	130	140	126	144	144	136	128	144	6	140	136	144	144	144	117	144	144
02/2011	87.2	124	124	136	101	144	126	88	144	129	108	137	144	103	144	127	39	113	144	144	144	144	144	144	115	138	78	144	144			
03/2011	91.2	144	144	144	144	144	124	143	144	93	109	126	107	104	105	144	144	144	114	144	144	144	144	144	144	144	140	143	138	131	110	81
04/2011	79.7	120	140	123	132	90	118	124	144	109	21	100	125	141	144	136	92	141	115	107	126	95	99	121	106	68	113	137	137	106	113	
05/2011	81.1	127	131	103	135	144	130	119	125	127	114	64	142	144	92	81	84	137	115	97	144	144	98	118	129	133	131	118	78	98	144	74
06/2011	69.4	135	102	64	72	77	110	125	99	46	103	76	112	64	141	114	69	75	101	107	119	126	130	89	138	112	119	124	84	67	99	
07/2011	56.1	114	49	144	144	130	85	67	47	114	105	95	66	91	70	79	85	55	104	118	74	48	18	0	81	132	85	38	105	42	56	62
08/2011	54.9	39	103	89	92	100	73	75	15	40	55	86	73	113	96	129	110	136	60	26	63	31	91	80	75	108	115	77	44	63	83	111
09/2011	63.1	98	126	144	129	127	18	50	19	125	128	88	65	35	82	77	96	115	77	87	80	67	43	108	128	141	115	89	144	70	54	
10/2011	65.4	63	98	98	132	75	11	85	71	106	68	82	61	78	95	85	96	104	15	71	93	83	129	101	144	138	103	144	126	137	113	113
11/2011	94.0	144	140	124	130	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	78.3																															

Lidar South at 140 m AGL

140.0m -	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
01/2010	95.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	144	128
02/2010	70.9	141	53	0	65	144	144	144	142	144	144	138	144	144	131	144	144	144	84	125	17	0	0	91	129	69	56	75	103			
03/2010	84.3	112	137	144	143	84	128	110	74	92	121	144	138	144	144	48	98	132	123	120	144	144	144	125	121	132	131	110	105	126	125	121
04/2010	85.9	106	91	144	97	139	107	6	144	143	141	122	108	144	129	134	144	144	143	144	73	142	144	136	144	144	109	136	144	142	67	
05/2010	78.4	101	133	103	132	144	144	144	144	144	144	98	89	64	144	90	12	144	124	132	144	144	144	142	144	144	144	116	67	0	0	83
06/2010	94.9	135	126	144	144	144	144	82	128	138	122	112	143	144	144	144	144	144	144	136	144	144	144	143	110	144	144	144	144	142	136	
07/2010	54.0	144	144	113	130	143	144	144	120	144	144	37	0	0	0	0	0	0	0	0	0	0	0	0	70	144	144	144	94	143	128	137
08/2010	93.8	140	144	144	137	139	144	144	137	144	135	125	125	127	144	138	128	134	139	143	129	133	144	115	121	120	109	144	143	131	142	144
09/2010	93.1	144	138	144	134	66	144	144	144	144	138	119	139	135	124	104	131	131	139	144	120	144	144	141	122	144	144	144	144	144	126	
10/2010	80.9	144	144	140	144	144	121	140	141	144	140	144	144	128	134	143	144	127	124	127	132	126	140	40	103	134	144	130	47	0	0	0
11/2010	71.1	65	140	123	127	130	144	112	97	142	135	116	96	92	138	131	144	144	144	144	140	141	144	141	125	17	0	0	0	0	0	
12/2010	66.8	0	0	0	27	28	8	0	56	0	22	127	30	138	144	144	117	144	142	144	139	144	144	144	144	144	144	144	144	144	134	144
01/2011	83.5	144	139	144	86	60	102	142	52	102	144	122	141	108	113	106	140	126	144	144	124	112	136	0	133	136	144	144	143	116	144	135
02/2011	84.3	117	122	124	99	144	120	62	144	126	96	133	144	103	144	127	31	113	144	144	144	144	144	144	113	138	47	144	144			
03/2011	88.3	144	144	130	128	144	120	142	144	92	108	124	90	96	79	144	144	144	114	144	136	144	144	144	144	144	137	142	137	131	110	55
04/2011	77.2	105	131	113	132	89	117	121	144	104	21	100	125	140	128	135	82	137	115	102	125	91	97	121	102	65	112	137	136	100	109	
05/2011	80.2	127	129	102	135	144	130	114	120	127	113	63	140	144	91	78	83	137	114	95	144	144	97	118	129	131	129	117	75	97	144	70
06/2011	65.0	135	99	51	66	68	106	103	97	42	101	76	112	60	141	110	66	75	100	106	119	124	130	87	137	111	113	87	37	62	87	
07/2011	51.0	112	43	144	144	125	46	62	43	110	105	90	61	87	57	75	76	55	103	117	67	42	17	0	52	127	82	36	100	36	7	54
08/2011	50.4	37	101	47	90	100	71	69	10	37	52	84	52	66	96	124	106	134	56	26	61	29	86	79	72	97	112	63	41	61	81	110
09/2011	60.3	97	99	144	128	121	14	50	18	119	126	86	62	33	82	76	92	113	77	87	79	66	42	108	127	123	114	88	140	45	47	
10/2011	63.6	50	96	96	132	74	9	82	68	105	68	82	56	77	94	72	95	103	13	70	93	82	127	101	144	138	101	143	125	137	104	100
11/2011	93.3	144	136	124	130	104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
All	75.3																															

Appendix B Long-term corrected wind distributions

This appendix presents the long-term corrected wind distributions for the seven test stands (appendices B1 to B7) at 100, 120 and 140 m AGL.
Note, that only the wind *speed* distributions are long-term corrected. No long-term correction is applied to the wind *direction* distributions. All wind direction distributions remain uncorrected and are based on a one-year period only.
There is of course some year-to-year variability of the wind direction distributions. So the wind direction distributions may not be completely representative of the long-term.

B.1. Test stand 1

S1-A at 100 m AGL

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PARK - Wind Data Analysis

Calculation:S1-A at 100 m**Wind data:**A - S1-A 100 m; Hub height: 100.0

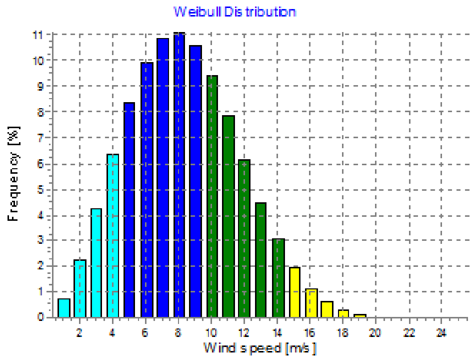
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,734
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (3)

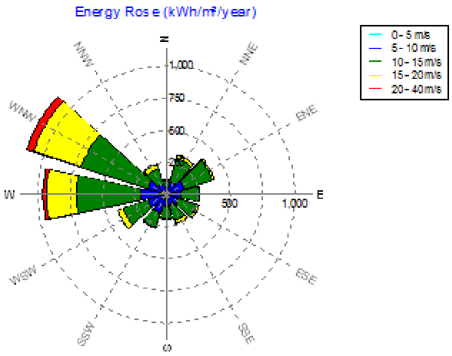
Wind data
Wind statistics

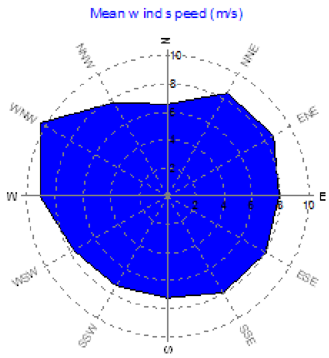
	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.395_N57.000).wws	1	36
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.395_N57.000).wws	1	53
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.395_N57.000).wws	4	11

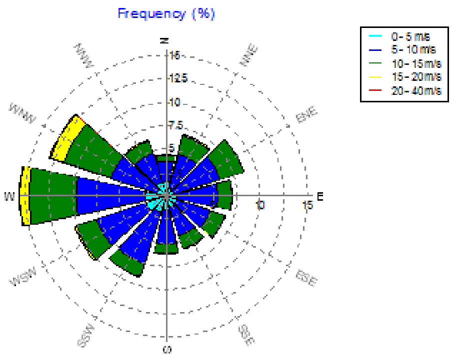
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.40	6.55	2.182	4.4
1 NNE	9.51	8.49	2.979	6.8
2 ENE	9.57	8.62	3.564	8.7
3 E	8.84	7.93	3.229	7.1
4 ESE	9.00	8.02	2.928	6.6
5 SSE	8.83	7.85	2.600	5.9
6 S	8.14	7.23	2.607	6.2
7 SSW	8.24	7.37	3.033	9.0
8 WSW	8.66	7.69	2.518	10.3
9 W	10.17	9.03	2.615	15.6
10 WNW	11.65	10.39	2.916	13.1
11 NNW	8.59	7.61	2.346	6.3
All	9.37	8.32	2.607	100.0









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S1-A at 120 m AGL

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PARK - Wind Data Analysis

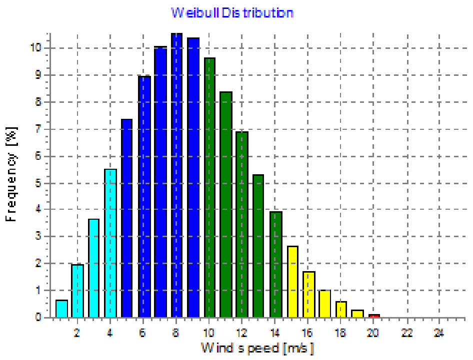
Calculation:S1-A at 120 m**Wind data:**A - S1-A 120 m; Hub height: 120.0

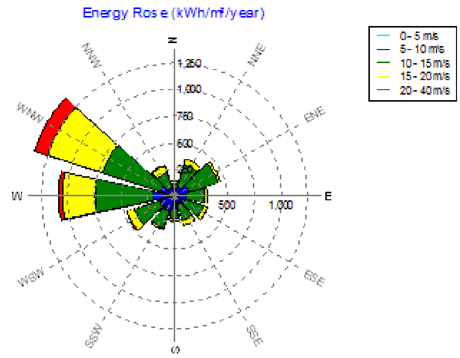
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,734
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (10)

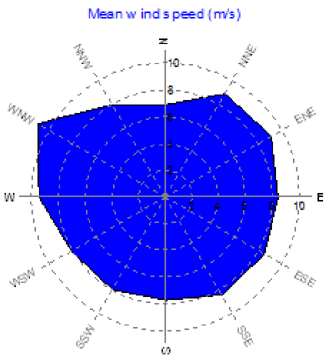
Wind data Wind statistics	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	1	36
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	1	53
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	4	11

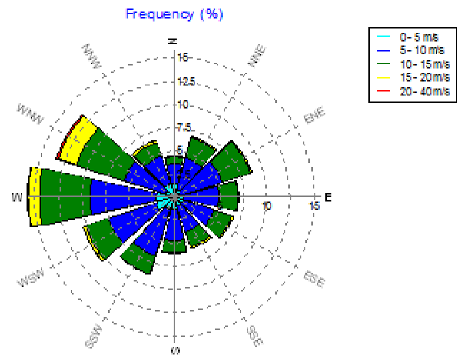
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.74	6.85	2.146	4.4
1 NNE	9.90	8.84	2.967	6.8
2 ENE	10.10	9.11	3.725	8.7
3 E	9.44	8.45	3.197	6.9
4 ESE	9.61	8.57	2.939	6.6
5 SSE	9.53	8.47	2.654	5.8
6 S	8.68	7.71	2.572	6.1
7 SSW	8.89	7.94	3.057	8.7
8 WSW	9.14	8.11	2.502	10.4
9 W	10.60	9.42	2.670	15.8
10 WNW	12.28	10.94	2.869	13.4
11 NNW	9.01	7.98	2.271	6.4
All	9.91	8.80	2.619	100.0









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S1-A at 140 m AGL

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PARK - Wind Data Analysis

Calculation:S1-A at 140 m**Wind data:**A - S1-A 140 m; Hub height: 140.0

Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,734
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (17)

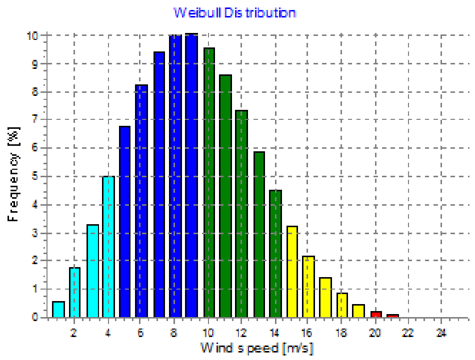
Wind data
Wind statistics

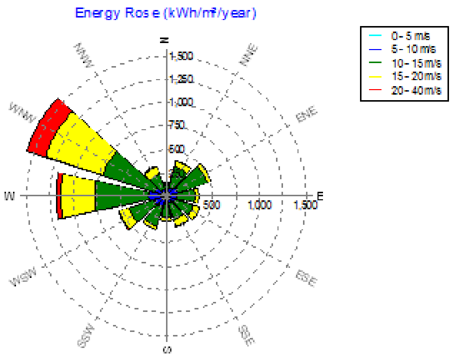
	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	1	36
DKLidar Nord - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	1	53
DKLidar Syd - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	4	11

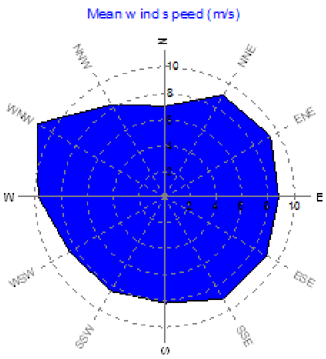
Weibull Data

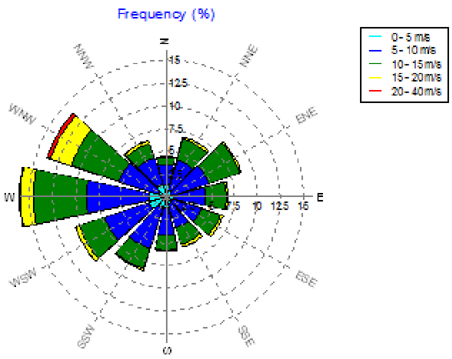
Current site

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.88	6.98	2.119	4.4
1 NNE	10.16	9.06	2.943	6.9
2 ENE	10.51	9.49	3.756	8.6
3 E	9.87	8.83	3.107	6.7
4 ESE	10.17	9.08	2.975	6.5
5 SSE	10.21	9.08	2.744	5.8
6 S	9.15	8.12	2.541	5.9
7 SSW	9.37	8.36	2.971	8.4
8 WSW	9.50	8.42	2.479	10.5
9 W	10.89	9.69	2.709	16.1
10 WNW	12.69	11.31	2.822	13.8
11 NNW	9.32	8.25	2.236	6.5
All	10.32	9.17	2.615	100.0









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B.2. Test stand 2

S2-A at 100 m AGL

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PARK - Wind Data Analysis

Calculation:S2-A at 100 m**Wind data:**A - S2-A 100 m; Hub height: 100.0

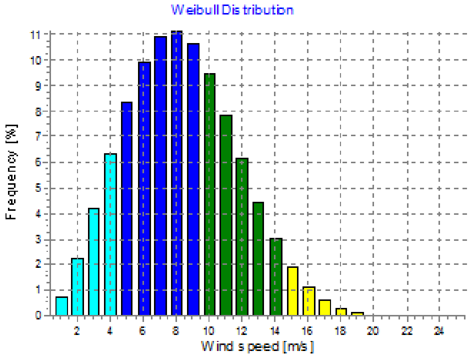
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,134
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (4)

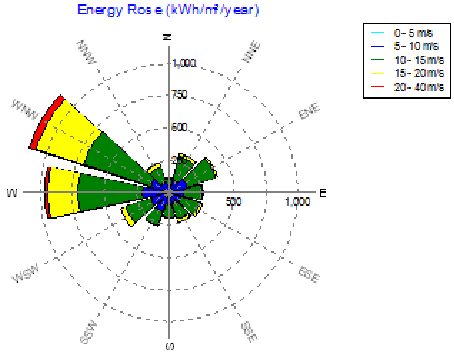
Wind data
Wind statistics

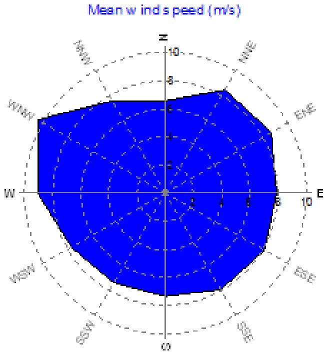
	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	1	33
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	1	57
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	3	10

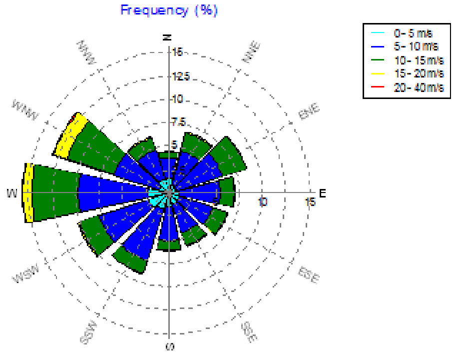
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.37	6.52	2.182	4.4
1 NNE	9.49	8.48	3.002	6.8
2 ENE	9.60	8.64	3.580	8.7
3 E	8.84	7.92	3.236	7.0
4 ESE	9.02	8.05	2.916	6.6
5 SSE	8.86	7.87	2.600	6.0
6 S	8.17	7.26	2.611	6.2
7 SSW	8.23	7.35	3.033	9.0
8 WSW	8.64	7.66	2.521	10.2
9 W	10.16	9.03	2.623	15.6
10 WNW	11.63	10.38	2.936	13.1
11 NNW	8.52	7.55	2.357	6.3
All	9.36	8.32	2.615	100.0









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S2-A at 120 m AGL

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PARK - Wind Data Analysis

Calculation:S2-A at 120 m**Wind data:**A - S2-A 120 m; Hub height: 120.0

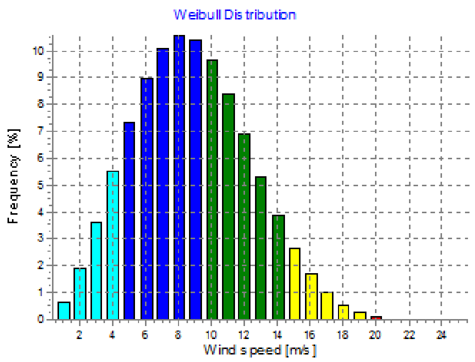
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,134
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (11)

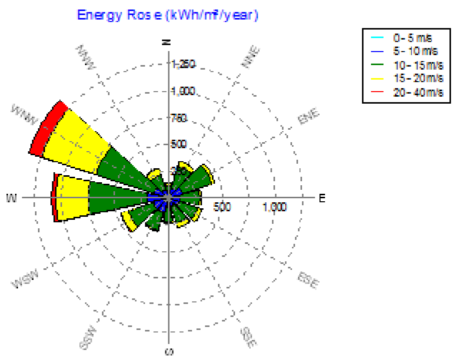
Wind data
Wind statistics

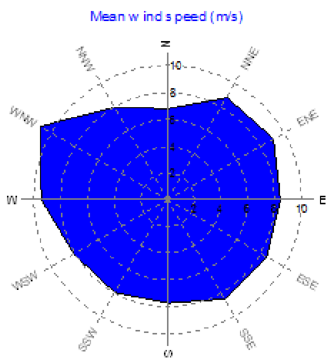
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	1	33
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	1	57
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	5	10

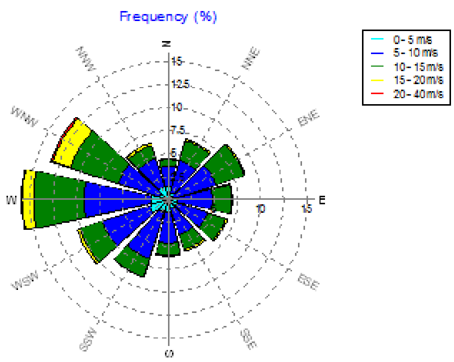
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.71	6.83	2.150	4.4
1 NNE	9.88	8.82	2.994	6.8
2 ENE	10.13	9.14	3.740	8.7
3 E	9.43	8.45	3.201	6.8
4 ESE	9.63	8.59	2.932	6.7
5 SSE	9.55	8.49	2.650	5.8
6 S	8.72	7.74	2.572	6.1
7 SSW	8.87	7.93	3.057	8.7
8 WSW	9.11	8.08	2.506	10.4
9 W	10.60	9.42	2.682	15.8
10 WNW	12.27	10.94	2.885	13.3
11 NNW	8.97	7.95	2.283	6.4
All	9.91	8.80	2.627	100.0









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S2-A at 140 m AGL

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PARK - Wind Data Analysis

Calculation:S2-A at 140 m**Wind data:**A - S2-A 140 m; Hub height: 140.0

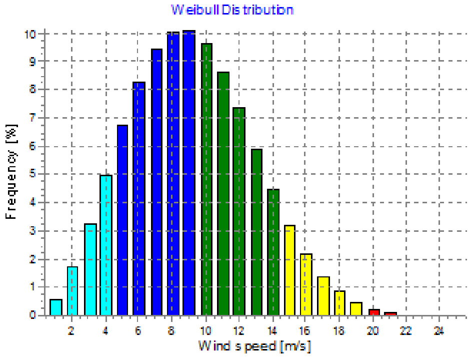
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,326,134
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (18)

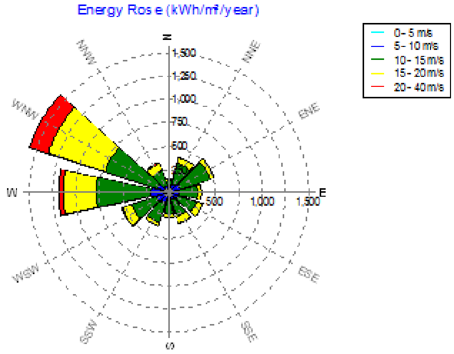
Wind data
Wind statistics

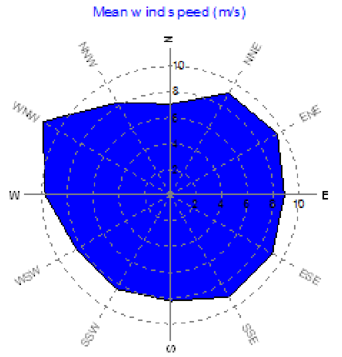
	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	1	33
DKLidar Nord - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	1	57
DKLidar Syd - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basis_E08.995_N57.000).wws	9	10

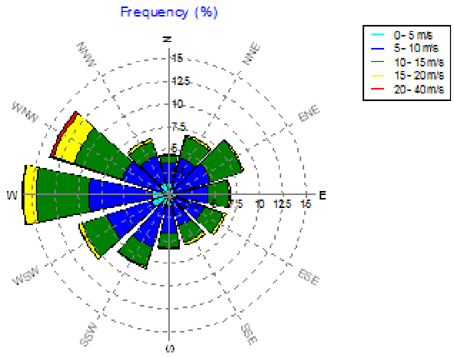
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.89	6.99	2.123	4.4
1 NNE	10.15	9.06	2.967	6.9
2 ENE	10.54	9.53	3.779	8.6
3 E	9.86	8.82	3.111	6.7
4 ESE	10.17	9.07	2.963	6.5
5 SSE	10.23	9.10	2.744	5.8
6 S	9.19	8.16	2.541	5.9
7 SSW	9.35	8.35	2.971	8.4
8 WSW	9.47	8.40	2.479	10.5
9 W	10.89	9.69	2.725	16.1
10 WNW	12.70	11.31	2.834	13.7
11 NNW	9.30	8.24	2.244	6.5
All	10.32	9.17	2.623	100.0









WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

B.3. Test stand 3

S3-A at 100 m AGL

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Calculated:
28/04/2014 12:59/2.9.269

PARK - Wind Data Analysis

Calculation:S3-A at 100 m**Wind data:**A - S3-A 100 m; Hub height: 100.0

Site coordinates

UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,325,534

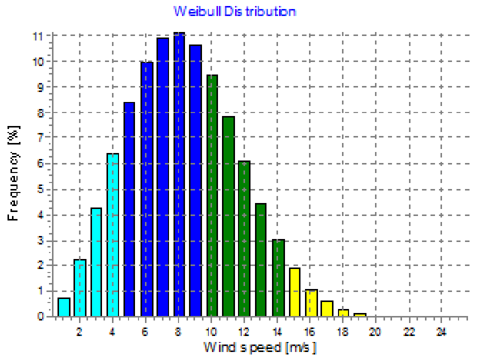
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (5)

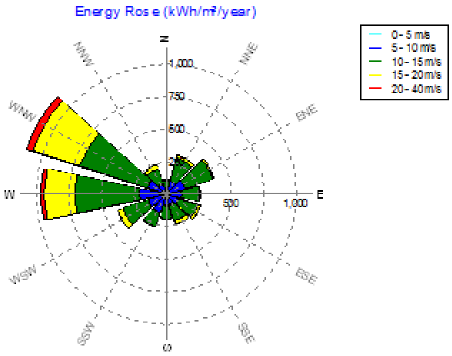
Wind data
Wind statistics

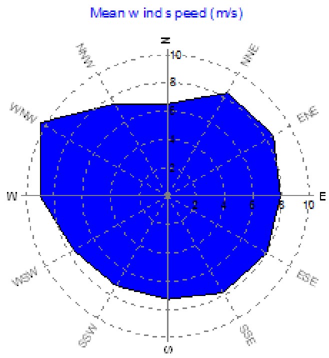
	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	1	37
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	1	48
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	3	15

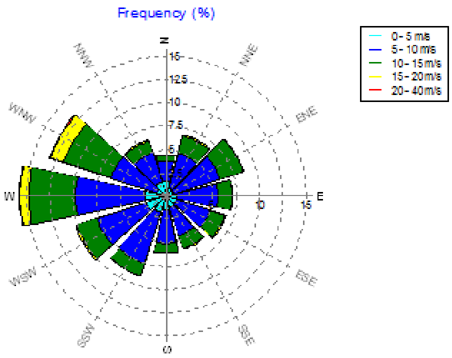
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.30	6.47	2.205	4.4
1 NNE	9.45	8.43	3.002	6.8
2 ENE	9.55	8.60	3.580	8.7
3 E	8.83	7.91	3.232	7.1
4 ESE	9.06	8.08	2.928	6.7
5 SSE	8.86	7.87	2.592	6.0
6 S	8.16	7.25	2.588	6.2
7 SSW	8.19	7.32	3.018	9.0
8 WSW	8.65	7.68	2.525	10.2
9 W	10.15	9.01	2.611	15.7
10 WNW	11.59	10.34	2.924	13.1
11 NNW	8.45	7.49	2.357	6.3
All	9.34	8.30	2.611	100.0









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S3-A at 120 m AGL

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PARK - Wind Data Analysis

Calculation:S3-A at 120 m**Wind data:**A - S3-A 120 m; Hub height: 120.0

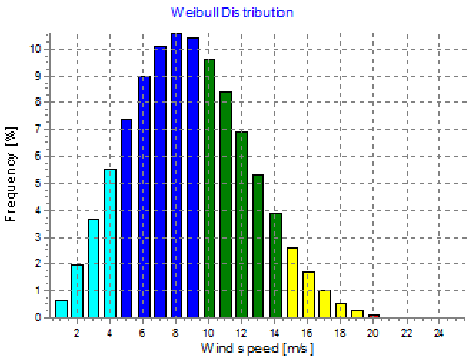
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,325,534
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (12)

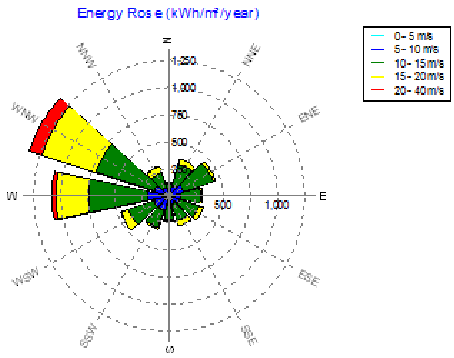
Wind data
Wind statistics

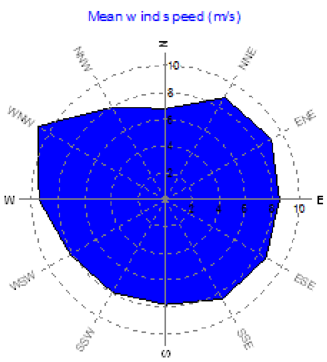
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]_N57.000).wws	1	37
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]_N57.000).wws	1	48
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]_N57.000).wws	5	15

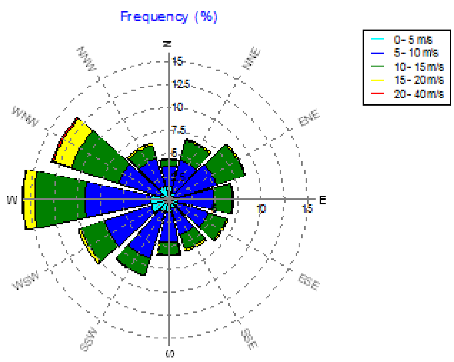
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.64	6.77	2.162	4.4
1 NNE	9.85	8.80	2.982	6.9
2 ENE	10.09	9.11	3.740	8.7
3 E	9.42	8.44	3.201	6.9
4 ESE	9.66	8.62	2.936	6.7
5 SSE	9.55	8.49	2.639	5.8
6 S	8.71	7.73	2.549	6.1
7 SSW	8.84	7.90	3.033	8.6
8 WSW	9.14	8.11	2.506	10.3
9 W	10.58	9.40	2.670	15.8
10 WNW	12.23	10.90	2.881	13.4
11 NNW	8.90	7.89	2.283	6.4
All	9.89	8.79	2.623	100.0









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S3-A at 140 m AGL

WindPRO version 2.9.269 Nov 2013

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28/04/2014 13:47/2.9.269

PARK - Wind Data Analysis

Calculation:S3-A at 140 m**Wind data:**A - S3-A 140 m; Hub height: 140.0

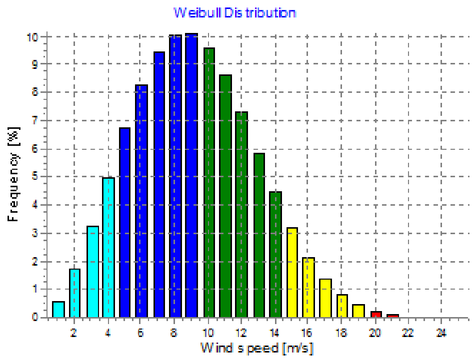
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,325,534
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (19)

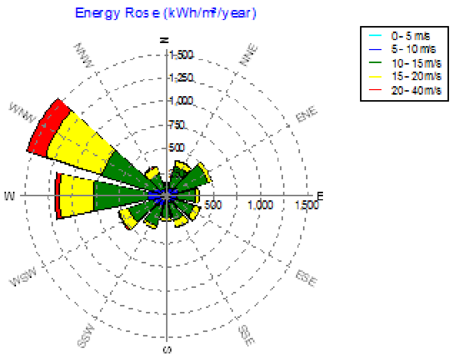
Wind data
Wind statistics

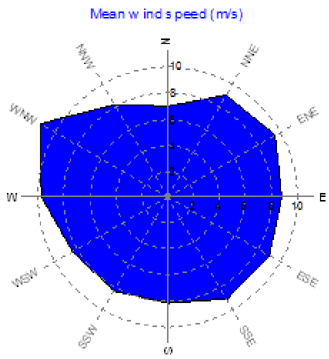
	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.335_N57.000).wws	1	37
DKLidar Nord - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.335_N57.000).wws	1	48
DKLidar Syd - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.335_N57.000).wws	5	15

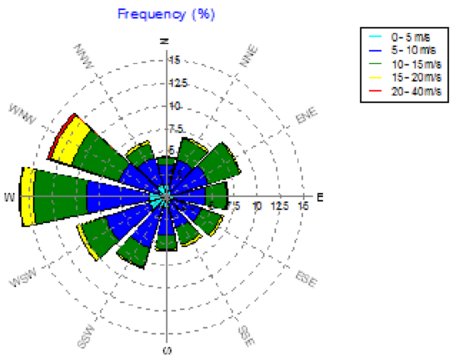
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.84	6.94	2.139	4.4
1 NNE	10.13	9.04	2.959	6.9
2 ENE	10.52	9.50	3.768	8.6
3 E	9.85	8.81	3.115	6.7
4 ESE	10.17	9.08	2.967	6.6
5 SSE	10.23	9.10	2.732	5.8
6 S	9.18	8.15	2.518	5.9
7 SSW	9.32	8.32	2.947	8.3
8 WSW	9.52	8.44	2.486	10.4
9 W	10.88	9.68	2.713	16.1
10 WNW	12.66	11.28	2.838	13.8
11 NNW	9.27	8.21	2.244	6.5
All	10.31	9.16	2.623	100.0









WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

B.4. Test stand 4

S4-A at 100 m AGL

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28/04/2014 13:00/2.9.269

PARK - Wind Data Analysis

Calculation:S4-A at 100 m**Wind data:**A - S4-A 100 m; Hub height: 100.0

Site coordinates

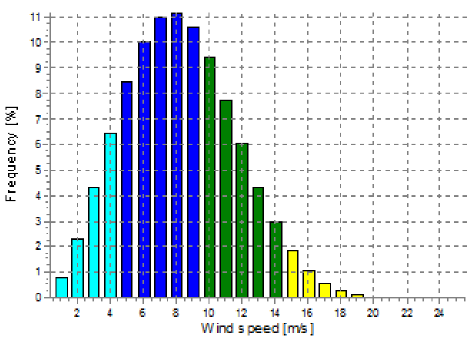
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,934

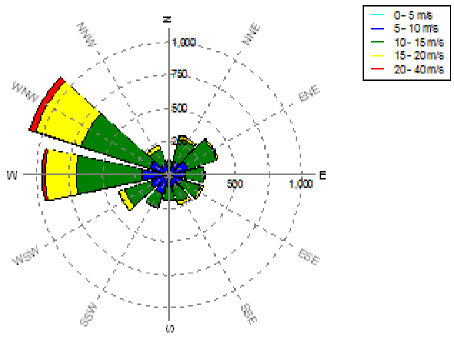
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (6)

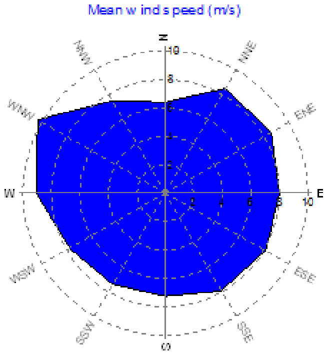
Wind data Wind statistics	Distance [km]	Weight [%]
DK Lidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	1	33
DK Lidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	1	33
DK Lidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.333_N57.000).wws	2	33

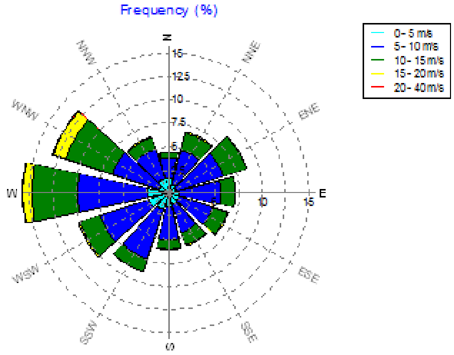
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.21	6.39	2.232	4.4
1 NNE	9.40	8.39	2.990	6.8
2 ENE	9.52	8.58	3.604	8.7
3 E	8.85	7.93	3.232	7.1
4 ESE	9.03	8.06	2.963	6.6
5 SSE	8.82	7.83	2.561	5.9
6 S	8.15	7.23	2.545	6.1
7 SSW	8.20	7.32	2.986	8.9
8 WSW	8.66	7.69	2.514	10.2
9 W	10.11	8.98	2.592	15.7
10 WNW	11.48	10.24	2.904	13.1
11 NNW	8.38	7.42	2.354	6.3
All	9.31	8.27	2.607	100.0









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S4-A at 120 m AGL

WindPRO version 2.9.269 Nov 2013

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PARK - Wind Data Analysis

Calculation:S4-A at 120 m**Wind data:**A - S4-A 120 m; Hub height: 120.0

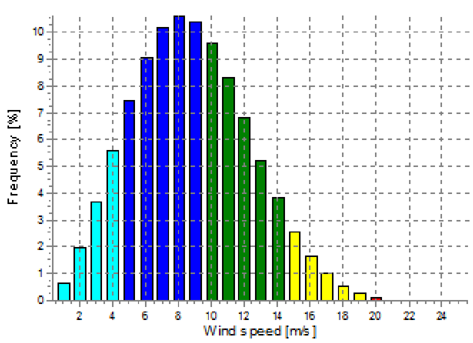
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,934
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (13)

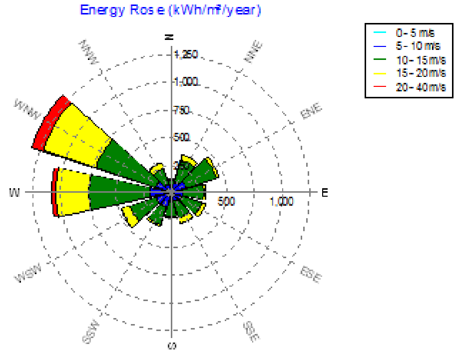
Wind data
Wind statistics

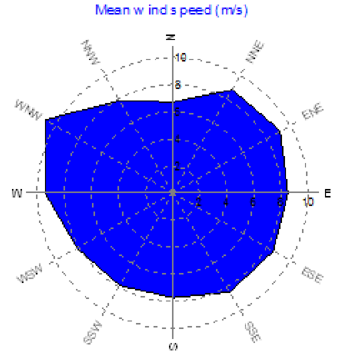
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.993_N57.000).wws	1	33
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.993_N57.000).wws	1	33
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.993_N57.000).wws	2	33

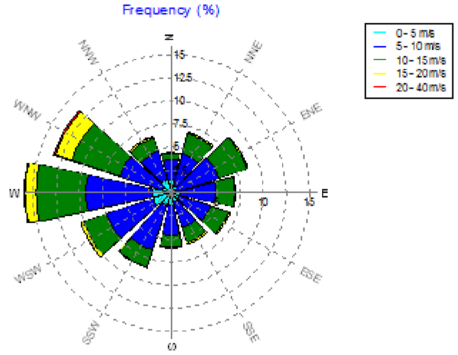
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.55	6.69	2.182	4.4
1 NNE	9.83	8.77	2.963	6.9
2 ENE	10.09	9.11	3.748	8.7
3 E	9.43	8.45	3.197	6.9
4 ESE	9.63	8.59	2.963	6.7
5 SSE	9.54	8.47	2.607	5.8
6 S	8.70	7.72	2.502	6.0
7 SSW	8.84	7.89	2.990	8.5
8 WSW	9.16	8.12	2.494	10.3
9 W	10.54	9.36	2.650	15.9
10 WNW	12.10	10.79	2.877	13.4
11 NNW	8.83	7.83	2.283	6.4
All	9.86	8.76	2.619	100.0









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PARK - Wind Data Analysis

Calculation:S4-A at 140 m**Wind data:**A - S4-A 140 m; Hub height: 140.0

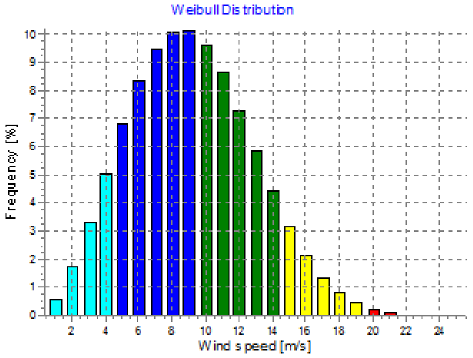
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,934
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (20)

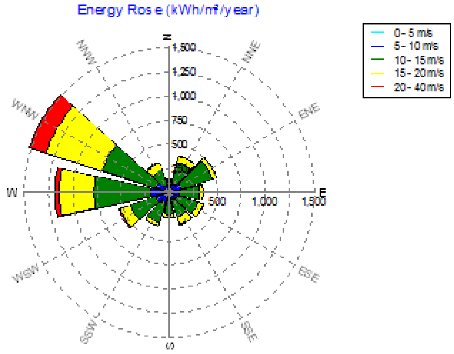
Wind data
Wind statistics

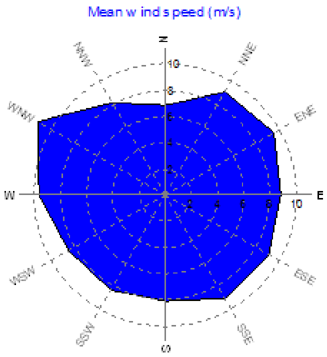
	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	1	[illegible]
DKLidar Nord - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	1	[illegible]
DKLidar Syd - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	[illegible]	[illegible]

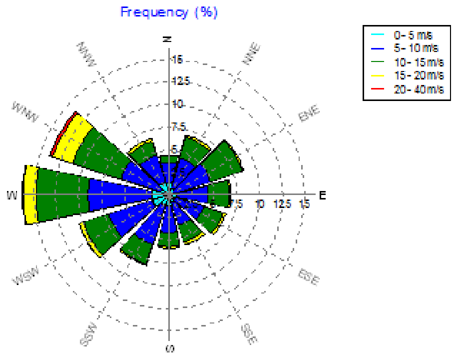
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.75	6.87	2.154	4.4
1 NNE	10.12	9.03	2.936	6.9
2 ENE	10.54	9.52	3.775	8.7
3 E	9.86	8.82	3.119	6.8
4 ESE	10.15	9.06	2.990	6.6
5 SSE	10.22	9.09	2.701	5.8
6 S	9.15	8.11	2.475	5.8
7 SSW	9.33	8.32	2.900	8.2
8 WSW	9.55	8.47	2.482	10.4
9 W	10.85	9.65	2.697	16.2
10 WNW	12.53	11.17	2.846	13.8
11 NNW	9.20	8.15	2.244	6.5
All	10.28	9.14	2.623	100.0









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B.5. Test stand 5

S5-A at 100 m AGL

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PARK - Wind Data Analysis

Calculation:S5-A at 100 m **Wind data:**A - S5-A 100 m; Hub height: 100.0

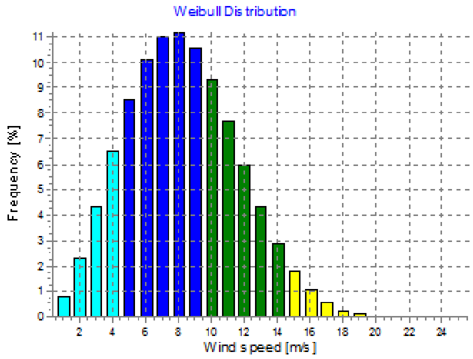
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,334
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (7)

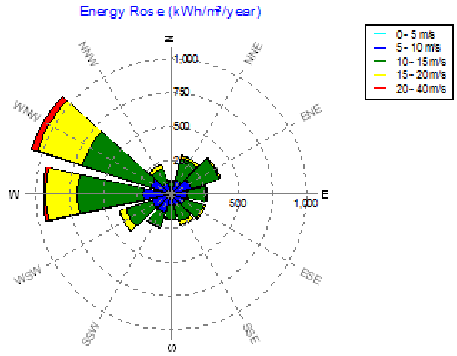
Wind data
Wind statistics

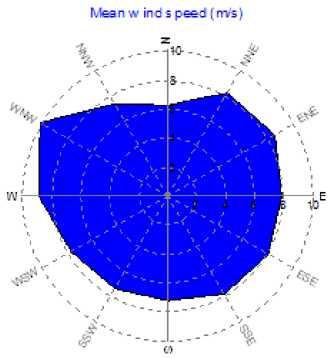
	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.330_N57.000).wws	2	31
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.330_N57.000).wws	2	31
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.330_N57.000).wws	2	38

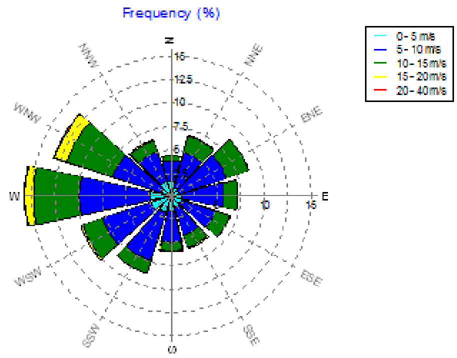
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.09	6.28	2.264	4.4
1 NNE	9.28	8.28	2.971	6.8
2 ENE	9.45	8.52	3.619	8.8
3 E	8.82	7.91	3.240	7.2
4 ESE	8.99	8.03	3.018	6.6
5 SSE	8.79	7.80	2.525	5.9
6 S	8.11	7.20	2.498	6.0
7 SSW	8.19	7.31	2.943	8.7
8 WSW	8.68	7.71	2.506	10.2
9 W	10.06	8.93	2.572	15.7
10 WNW	11.36	10.13	2.873	13.3
11 NNW	8.31	7.36	2.354	6.4
All	9.26	8.22	2.600	100.0









WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

S5-A at 120 m AGL

WindPRO version 2.9.269 Nov 2013

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28/04/2014 13:14/2.9.269

PARK - Wind Data Analysis

Calculation:S5-A at 120 m**Wind data:**A - S5-A 120 m; Hub height: 120.0

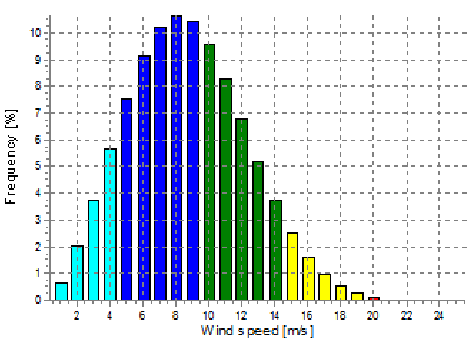
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,334
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (14)

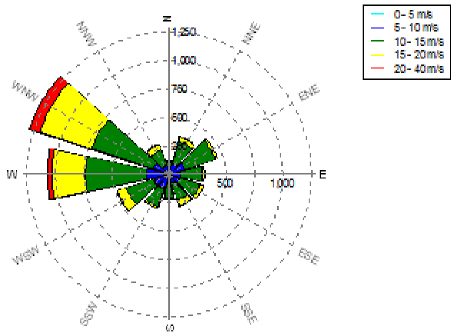
Wind data
Wind statistics

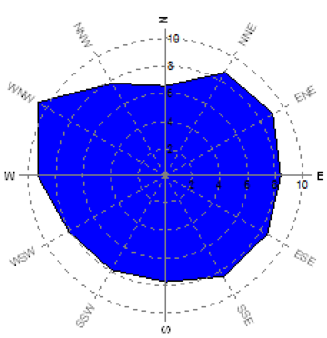
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	2	31
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	2	31
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	2	38

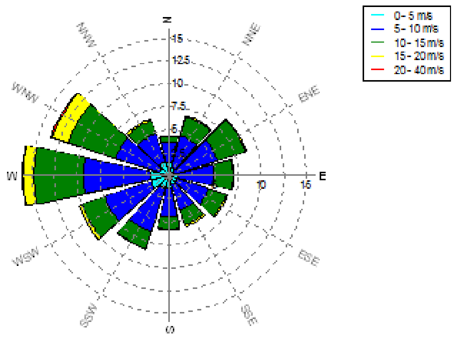
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.42	6.57	2.205	4.3
1 NNE	9.72	8.67	2.939	6.8
2 ENE	10.03	9.06	3.756	8.8
3 E	9.41	8.42	3.197	7.0
4 ESE	9.59	8.56	3.006	6.7
5 SSE	9.54	8.47	2.564	5.8
6 S	8.66	7.68	2.439	5.9
7 SSW	8.84	7.89	2.932	8.4
8 WSW	9.18	8.14	2.482	10.3
9 W	10.49	9.32	2.627	16.0
10 WNW	11.98	10.68	2.873	13.6
11 NNW	8.77	7.77	2.287	6.5
All	9.81	8.72	2.611	100.0









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S5-A at 140 m AGL

WindPRO version 2.9.269 Nov 2013

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PARK - Wind Data Analysis

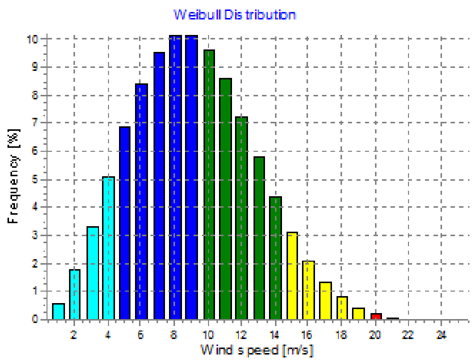
Calculation:S5-A at 140 m**Wind data:**A - S5-A 140 m; Hub height: 140.0

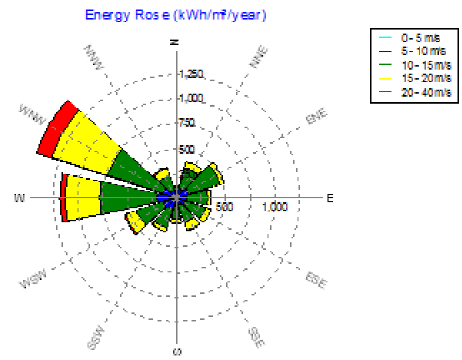
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,324,334
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (21)

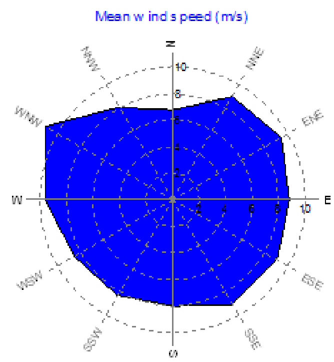
Wind data Wind statistics	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_E08.996_N57.000).wws	2	31
DKLidar Nord - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_E08.996_N57.000).wws	2	31
DKLidar Syd - 140 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_E08.996_N57.000).wws	2	38

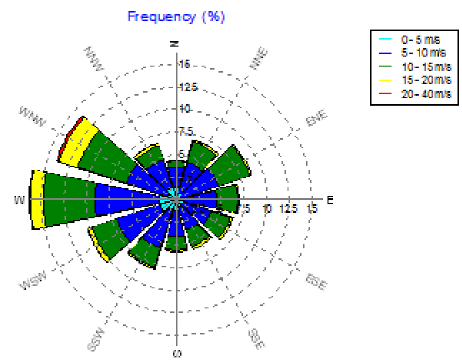
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.63	6.76	2.170	4.4
1 NNE	10.03	8.95	2.908	6.9
2 ENE	10.50	9.49	3.783	8.7
3 E	9.83	8.79	3.131	6.9
4 ESE	10.13	9.05	3.033	6.6
5 SSE	10.19	9.06	2.662	5.7
6 S	9.05	8.02	2.412	5.7
7 SSW	9.32	8.31	2.838	8.0
8 WSW	9.60	8.51	2.479	10.3
9 W	10.81	9.61	2.682	16.2
10 WNW	12.41	11.06	2.854	14.0
11 NNW	9.14	8.09	2.244	6.6
All	10.24	9.10	2.619	100.0









WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

B.6. Test stand 6

S6-A at 100 m AGL

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PARK - Wind Data Analysis

Calculation:S6-A at 100 m**Wind data:**A - S6-A 100 m; Hub height: 100.0

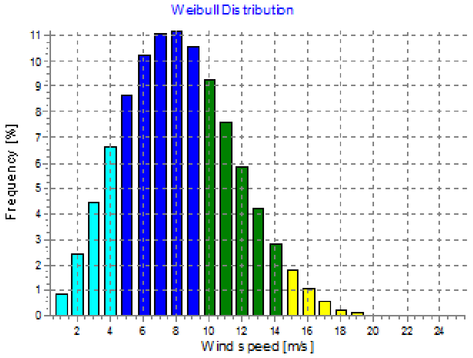
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,734
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (8)

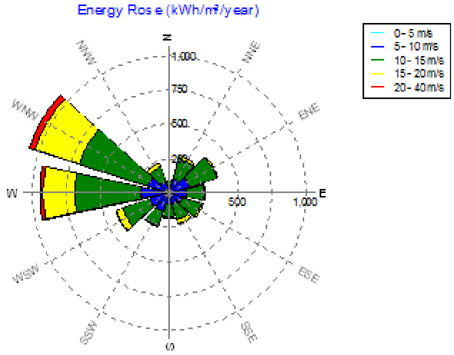
Wind data
Wind statistics

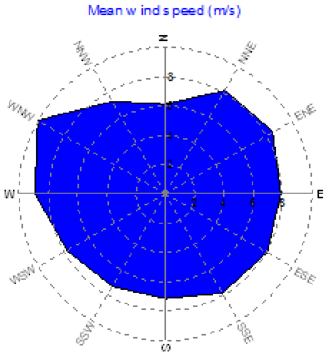
	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.995_N57.000).wws	2	33
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.995_N57.000).wws	2	33
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.995_N57.000).wws	1	33

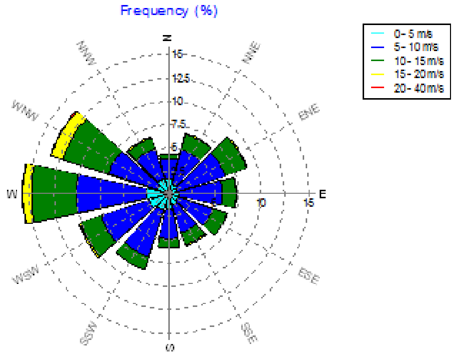
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	6.96	6.16	2.303	4.3
1 NNE	9.14	8.16	2.947	6.8
2 ENE	9.38	8.46	3.635	8.8
3 E	8.76	7.85	3.256	7.3
4 ESE	8.96	8.01	3.088	6.6
5 SSE	8.76	7.77	2.479	5.9
6 S	8.08	7.17	2.439	5.9
7 SSW	8.21	7.32	2.893	8.6
8 WSW	8.72	7.73	2.494	10.2
9 W	10.01	8.89	2.541	15.8
10 WNW	11.24	10.01	2.834	13.4
11 NNW	8.25	7.31	2.350	6.4
All	9.21	8.18	2.584	100.0









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S6-A at 120 m AGL

WindPRO version 2.9.269 Nov 2013

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PARK - Wind Data Analysis

Calculation:S6-A at 120 m**Wind data:**A - S6-A 120 m; Hub height: 120.0

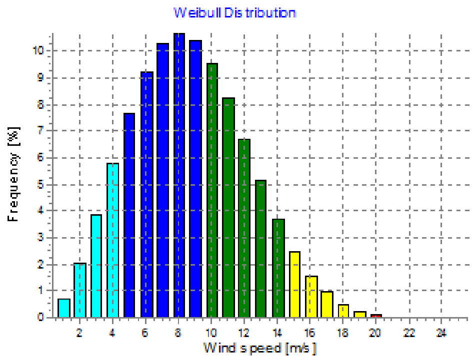
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,734
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (15)

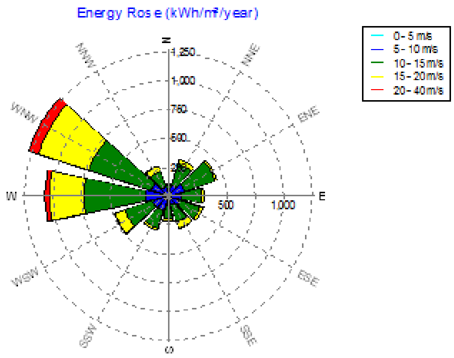
Wind data
Wind statistics

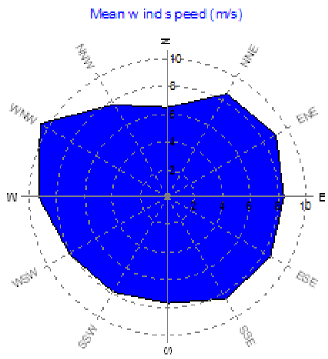
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	2	33
DKLidar Nord - 120 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	2	33
DKLidar Syd - 120 m - 1 year - FEB 2010 to JAN 2011 (Wind Index MCP using MERRA_basic_[illegible]).wws	1	33

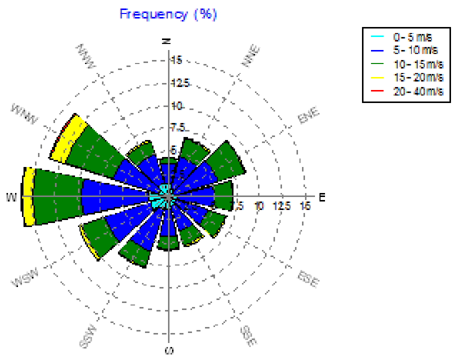
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.27	6.44	2.229	4.3
1 NNE	9.60	8.56	2.908	6.8
2 ENE	9.96	9.00	3.764	8.9
3 E	9.34	8.36	3.201	7.1
4 ESE	9.58	8.56	3.057	6.7
5 SSE	9.52	8.45	2.514	5.8
6 S	8.60	7.62	2.369	5.8
7 SSW	8.84	7.88	2.861	8.2
8 WSW	9.22	8.17	2.463	10.3
9 W	10.43	9.27	2.600	16.0
10 WNW	11.84	10.55	2.861	13.7
11 NNW	8.73	7.73	2.291	6.5
All	9.76	8.67	2.600	100.0









S6-A at 140 m AGL

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PARK - Wind Data Analysis

Calculation:S6-A at 140 m**Wind data:**A - S6-A 140 m; Hub height: 140.0

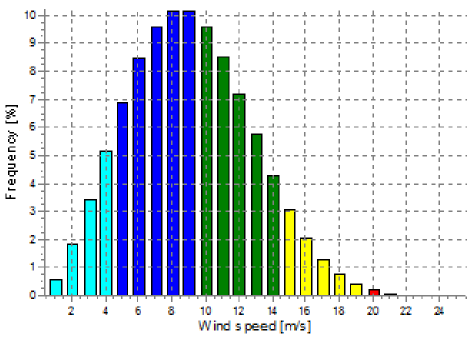
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,734
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (22)

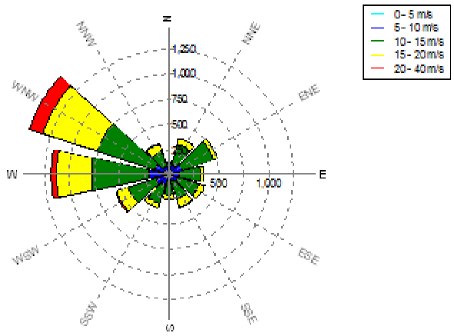
Wind data
Wind statistics

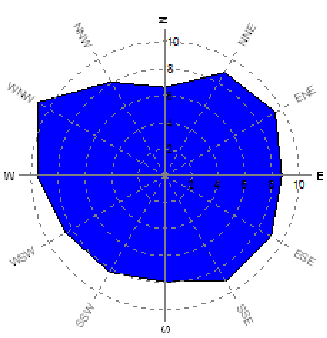
	Distance [km]	Weight [%]
DKLidar Vest - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	2	33
DKLidar Nord - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	2	33
DKLidar Syd - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.335_N57.000).wws	1	33

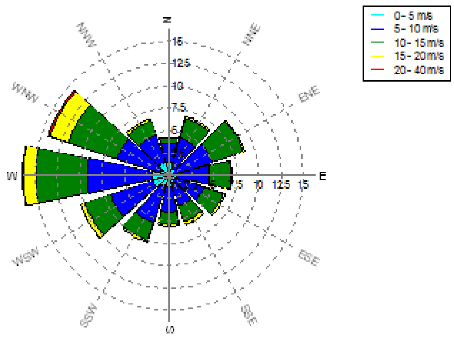
Weibull Data

Sector	Current site A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.49	6.63	2.186	4.3
1 NNE	9.93	8.85	2.873	6.8
2 ENE	10.45	9.44	3.791	8.8
3 E	9.76	8.73	3.146	7.0
4 ESE	10.15	9.07	3.088	6.6
5 SSE	10.17	9.03	2.619	5.7
6 S	8.95	7.93	2.338	5.6
7 SSW	9.32	8.30	2.760	7.8
8 WSW	9.66	8.57	2.471	10.3
9 W	10.77	9.57	2.662	16.3
10 WNW	12.28	10.95	2.861	14.2
11 NNW	9.09	8.05	2.248	6.7
All	10.20	9.06	2.611	100.0









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B.7. Test stand 7

S7-A at 100 m AGL

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PARK - Wind Data Analysis

Calculation:S7-A at 100 m **Wind data:**A - S7-A 100 m; Hub height: 100.0

Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,134
VESTAS V112 3000 112.0 !O! hub: 100.0 m (TOT: 156.0 m) (9)

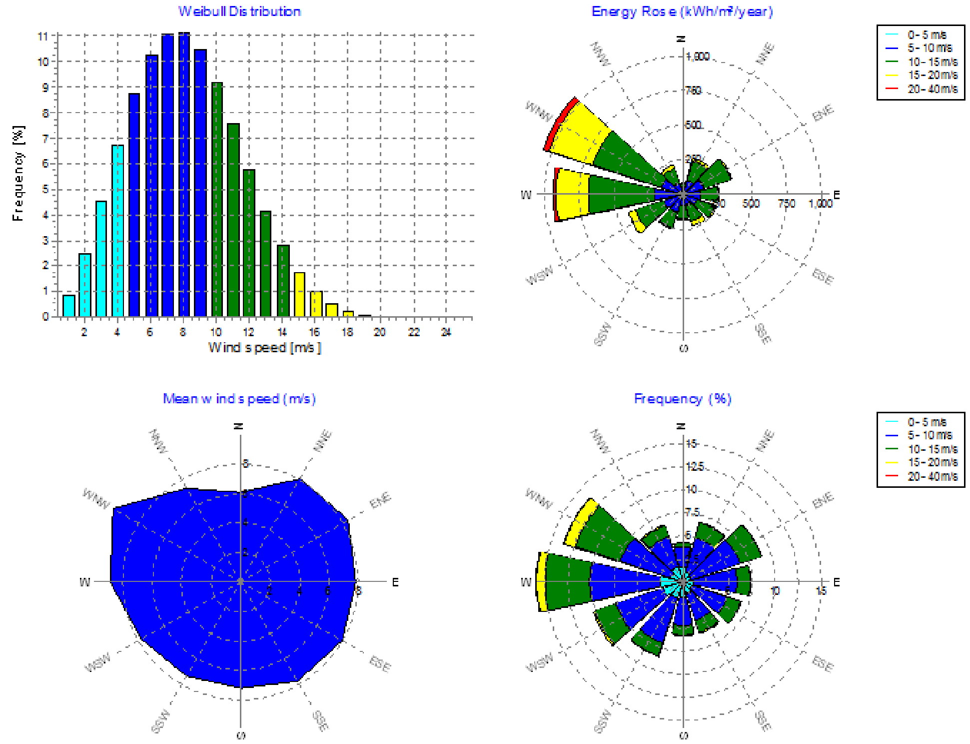
Wind data
Wind statistics

	Distance [km]	Weight [%]
DKLidar Vest - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.33G_N57.000).wws	3	15
DKLidar Nord - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.33G_N57.000).wws	3	15
DKLidar Syd - 100 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E09.33G_N57.000).wws	1	71

Weibull Data

Current site

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	6.82	6.05	2.338	4.2
1 NNE	9.01	8.04	2.928	6.7
2 ENE	9.32	8.41	3.650	8.9
3 E	8.70	7.80	3.264	7.3
4 ESE	8.90	7.96	3.150	6.6
5 SSE	8.74	7.75	2.436	5.8
6 S	8.06	7.14	2.385	5.8
7 SSW	8.22	7.33	2.850	8.4
8 WSW	8.75	7.77	2.479	10.2
9 W	9.97	8.84	2.518	15.9
10 WNW	11.13	9.91	2.795	13.6
11 NNW	8.19	7.26	2.346	6.5
All	9.17	8.14	2.568	100.0



WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

S7-A at 120 m AGL

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PARK - Wind Data Analysis

Calculation:S7-A at 120 m**Wind data:**A - S7-A 120 m; Hub height: 120.0

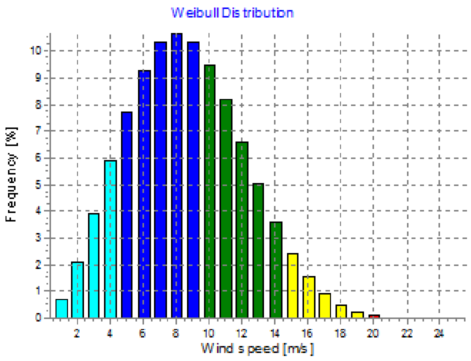
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,134
VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (16)

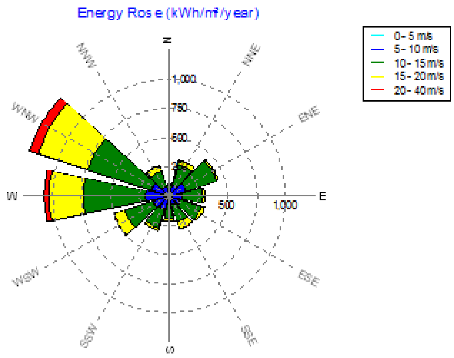
Wind data
Wind statistics

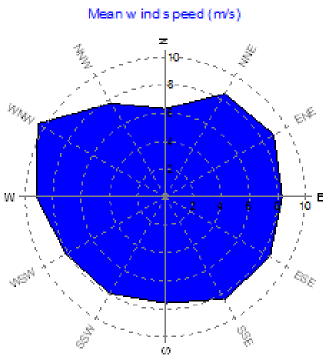
	Distance [km]	Weight [%]
DKLidar Vest - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	3	15
DKLidar Nord - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	3	15
DKLidar Syd - 120 m - 1 year - FEB 2010 to JUN 2011 (Wind Index MCP using MERRA_basic_E08.995_N57.000).wws	1	71

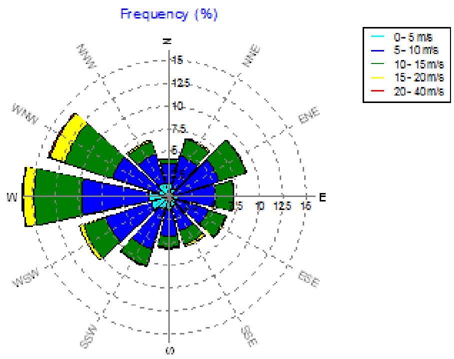
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.14	6.32	2.252	4.2
1 NNE	9.49	8.46	2.881	6.7
2 ENE	9.91	8.96	3.771	8.9
3 E	9.25	8.29	3.201	7.1
4 ESE	9.57	8.56	3.107	6.7
5 SSE	9.49	8.42	2.471	5.7
6 S	8.54	7.57	2.299	5.6
7 SSW	8.84	7.87	2.791	8.0
8 WSW	9.25	8.21	2.447	10.3
9 W	10.39	9.22	2.576	16.1
10 WNW	11.72	10.44	2.850	13.9
11 NNW	8.68	7.69	2.295	6.6
All	9.72	8.63	2.588	100.0









WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tel. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

S7-A at 140 m AGL

WindPRO version 2.9.269 Nov 2013

Project:
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Calculated:
28/04/2014 13:54/2.9.269

PARK - Wind Data Analysis

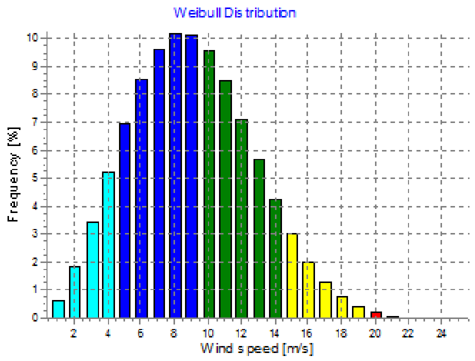
Calculation: S7-A at 140 m **Wind data:** A - S7-A 140 m; Hub height: 140.0

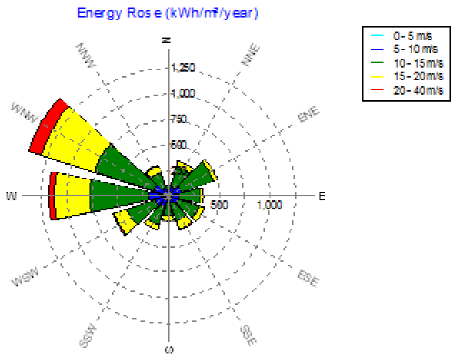
Site coordinates
UTM (north)-WGS84 Zone: 32 East: 492,967 North: 6,323,134
VESTAS V112 3000 112.0 !O! hub: 140.0 m (TOT: 196.0 m) (23)

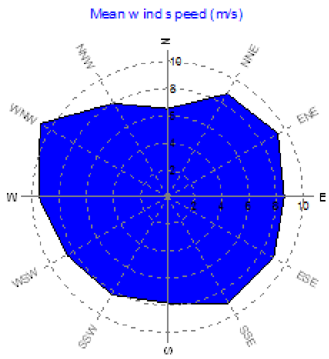
Wind data Wind statistics	Distance [km]	Weight [%]
DK Lidar Vest - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind index MCP using MERRA_basic_E08.[illegible]_N57.000).wws	3	15
DK Lidar Nord - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind index MCP using MERRA_basic_E08.[illegible]_N57.000).wws	3	15
DK Lidar Syd - 140 m - 1 year - FEB 2010 to JUN 2011 (Wind index MCP using MERRA_basic_E08.[illegible]_N57.000).wws	1	71

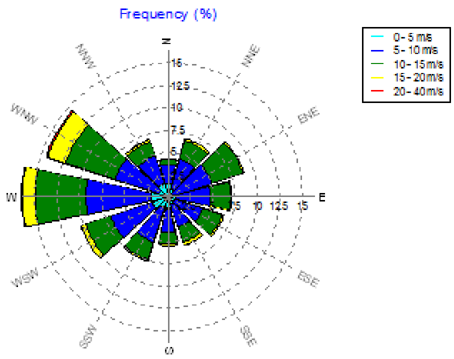
Weibull Data

	Current site			
Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.35	6.51	2.201	4.3
1 NNE	9.83	8.76	2.842	6.8
2 ENE	10.41	9.41	3.799	8.9
3 E	9.68	8.67	3.158	7.0
4 ESE	10.17	9.10	3.135	6.5
5 SSE	10.16	9.03	2.576	5.7
6 S	8.87	7.85	2.268	5.4
7 SSW	9.33	8.30	2.689	7.6
8 WSW	9.72	8.62	2.459	10.3
9 W	10.73	9.54	2.646	16.4
10 WNW	12.17	10.85	2.869	14.4
11 NNW	9.05	8.01	2.248	6.8
All	10.17	9.03	2.604	100.0









DTU Wind Energy is a department of the Technical University of Denmark with a unique integration of research, education, innovation and public/private sector consulting in the field of wind energy. Our activities develop new opportunities and technology for the global and Danish exploitation of wind energy. Research focuses on key technical-scientific fields, which are central for the development, innovation and use of wind energy and provides the basis for advanced education at the education.

We have more than 240 staff members of which approximately 60 are PhD students. Research is conducted within nine research programmes organized into three main topics: Wind energy systems, Wind turbine technology and Basics for wind energy.

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