Comune di SAN MARCO DEI CAVOTI

(Provincia di Benevento)

PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO EOLICO DA 29,4 MW

in località "Ielardi, Macchioni, Montagna, Riccetto e Franzese"

Elaborato 17	**VALUTAZIONE DEL VENTO E DELL'ENERGIA – RILEVAZIONE ANEMOMETRICA**

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DATA Marzo 2022

SPAZIO PER I VISTI

WIND AND ENERGY ASSESSMENT

for the

San Marco dei Cavoti Wind Project

Italy

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November 2011

REPORT No. 291120110001
Issue 01
Status FINAL
Classification: Client's Discretion

Revision History

REVISION	DATE OF RELEASE	PURPOSE
Draft version	November 29th 2011	Initial Release DRAFT
Final version	November 2011	Clients approval

List of content:

References:

- [1] Wind data from Molinara 50m meteorological station.
- [2] IEC 61400-12-1, "Wind turbines - Part 12-1: Power performance measurements of electricity producing wind turbines".
- [3] Historical wind data from NCEP/NCAR.
- [4] Wind data measured on site of San Marco.
- [5] Google Earth.

Preface:

Ecoenergia Srl of Cervinara (AV), Italy is developing a 48MW wind energy project in San Marco, Campagnia and has requested KenTec Denmark ApS to assess the wind and energy potential based on data from meteorological stations, which has been in operation at the site and a given layout of turbines. The purpose of this report is to form a synopsis of the wind resource based on the wind measurement campaign on the site and correlated to long-term reference stations, with the aim to provide a robust prediction of the expected energy production over the projects lifetime. The methodology follows the Measure, Correlate Predict (MCP) procedure.

1. Conclusions and Recommendations:

Measured on-site wind data of relatively good quality is available for a period of 5 years for prediction of energy calculations. Three met masts, two at one side of the site and one at the other, forms the basis for the wind assessment.
Up to 5 years of data from November 1st 2006 up to November 14th 2011 is recorded at two locations at the centre of the site, with measurement levels up to 35m and 27month of data from 12/8 2009 up to 14/11 2011 is recorded south of the site, Identified as Molinara met mast, with a measurement level up to 50m.
As the proposed hub height is 80m or 88m, some uncertainty is induced through extrapolation between the heights.
It is our recommendation to measure at hub height for longer period to minimize uncertainty on the wind shear.
In order to compensate for missing long term on site measurements, we have correlated the data with long term data found from NCAR/NCEP,
Using the long term reference data decreases the annual wind energy by 3-5%, as the long term predictions compared to the measured data alone.
The measured wind speed at San Marco met mast is 5,95m/s at 50m level, and the and the predicted long term wind speed at same level is 5,9m/s. The predicted long term wind speed at hub height (80m) is 6,8m/s at the San Marco met mast.
The measured wind speed at Molinara met mast is 6,07m/s at 50m level, and the predicted long term wind speed at same level is 6,4m/s. The predicted long term wind speed at hub height (80m) is 7,0m/s at the Molinara met mast.

Together for the 48MW project returns an annual average production for the following turbines as:

Wind Turbine	P(50)	P(75)	P(90)	Full load hours P(50)
WinWinD 3MW 80m Hub height	105.519	97.788	90.829	2198
WinWinD 3MW 88m Hub height	109.950	101.894	94.644	2291
Vestas V90 3MW 80m Hub height	99.718	92.412	85.836	2077
Vestas V90 3MW 90m Hub height	104.966	97.275	90.353	2187

Technical losses, estimated to 5,1%, are not considered into the energy calculations.

In the region a large number of existing wind turbines are found. Those wind turbines will have a shading effect on the present project as well as the new project will have negative influences on the existing turbines.
We have included into the calculations a number of 50 existing turbines, which together is reducing the San Marco project with 3,2%.
The new San Marco project is reducing the existing wind turbines in common with 1,3%. There are great deviations between the effected existing turbines. From 0% up to 4% reduction. In the Appendix WindPRO Park calculations the detailed reductions are presented per turbine.

Further details in the document text and appendices.

2. The Site

The site is located approximately 5 km west of the village of San Marco, as shown in Figure 1. The village of San Marco is located approximately 90 km west of Napoli and 48km southwest of Foggia.
The proposed wind farm lies on a smooth hilly farmland area with elevation of 650-900 m above sea level. The general terrain at the site can be described as semi-complex with agriculture fields surrounding the site.

The site situation in central Italy.

3. The Wind Turbines

The total numbers of turbines are 16 units. The coordinates of each individual turbine is presented in Annex 1.

Alternative 1a:	**Wind turbine type:**	**Vestas V90**
	Generator:	**3MW**
	Rotor:	**90m**
	Hub Height:	**80m**
Alternative 1b:	**Wind turbine type:**	**Vestas V90**
	Generator:	**3MW**
	Rotor:	**90m**
	Hub Height:	**88m**
Alternative 2a:	**Wind turbine type:**	**WinWinD WWD3**
	Generator:	**3MW**
	Rotor:	**90m**
	Hub Height:	**80m**
Alternative 2b:	**Wind turbine type:**	**WinWinD WWD3**
	Generator:	**3MW**
	Rotor:	**90m**
	Hub Height:	**88m**

The turbines are thus giving the total facility an installed capacity 48MW.

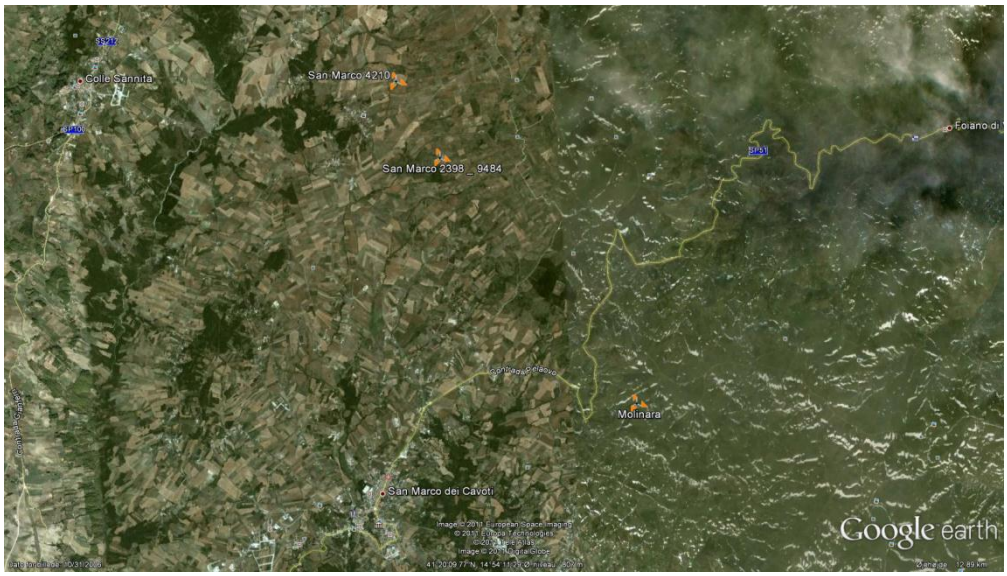
The basic parameters of this turbine are presented in Annex 5. Vestas and WinWinD have supplied the power curve for the turbines for an air density of 1.225 kg/m3.

Using historical pressure and temperature records from nearby meteorological station at Campobasso and standard lapse rate assumptions, KenTec has estimated the long-term mean air density at the site to be from 895,5hPa to 926,1hPa at a hub elevation of 700m to 1000 above sea level. The supplied power curves used in this analysis have been adjusted to the predicted site air density, in accordance with the recommendations of IEC [2]. This has been undertaken on an individual turbine basis.

4. The Wind Regime

4.1. On site measurement:

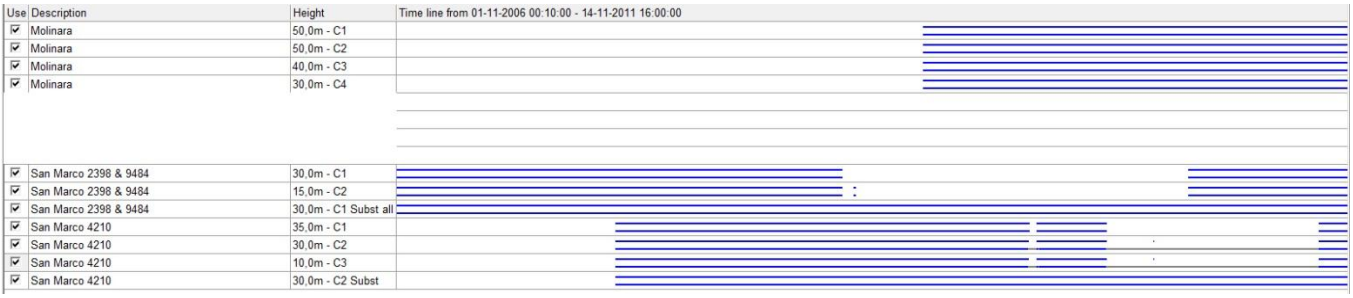
Wind data from 3 met masts forms the basis for the wind assessment.
At the site centre, wind data from November 1st 2006 up to November 14th 2011 is recorded on a met mast, identified as SM1 (San Marco 2398 9484), with measurement levels up to 30m and at a second mast, identified as SM2 (San Marco 4210) 3 years 11 months of data from 27/12 2007 up to 14/11 2011 is recorded.
South of the site the 3rd mast, Identified as Molinara met mast, with a measurement level up to 50m has measured wind data 2 years 3 months from 12/8 2009 to 14/11 2011.



At the masts SM1 and SM2 a period of missing data is observed. The following matrix presents the wind measurements from all the masts:

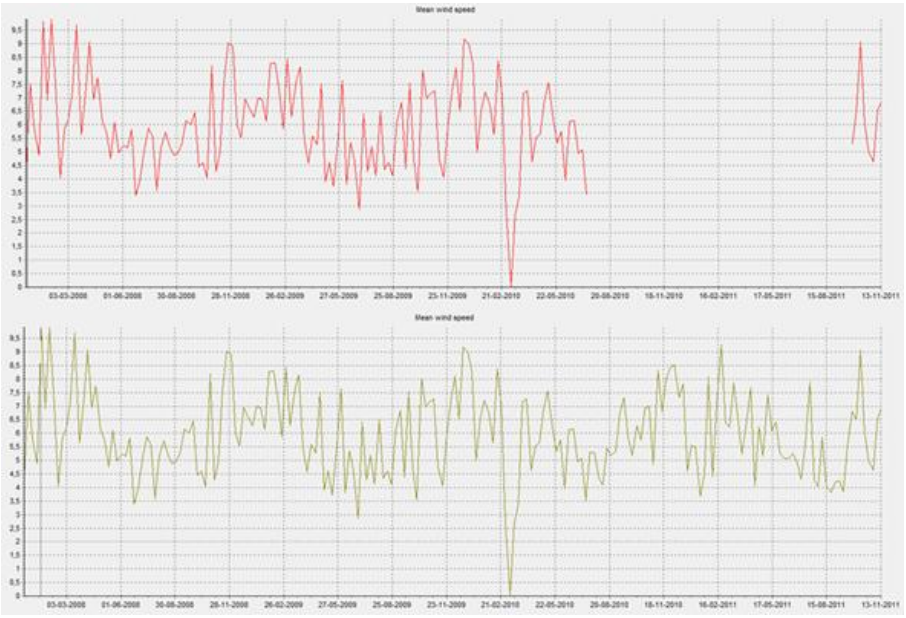
Met mast ID	Height	Start day	Stop day	Availability
SM1	30	1/11 2006	14/11 2011	64%
SM2	30	27/12 2007	14/11 2011	70%
Molinara	50	12/8 2009	14/11 2011	100%

The periods of recording is however overlapping each other so that it is possible to substitute missing or faulty data with data from the other masts. The meteodology for this operation is to correlate the data between the selected instruments from the different masts, thus obtaining the scale offset between the two. With the offset multiplied to the instrument with the missing period, the merged data set is obtained.
The time line graph below indicates the periods from which the various data is available from the masts.



The merged data set is named “Subst.” and due to the very good correlation between the masts, represents a full period of measurements at the masts location.

The graph below presents the data before and after the merged repair.



San Marco data flow before and after the repair

The San Marco meteorological stations are located at geographical positions as presented in the table below according to UTM datum ED50 zone 33. The altitude is 806m above sea level.

Mast ID	North	East	Height above sea level
SM1 2398/9484	4578121	0491222	879
SM2 4210	4579229	0490670	823
Molinara	4574570	0493741	900

The wind data have been recorded using Second Wind Nomad2 data logger, NRG Maximum #40 anemometers and NRG 200 P wind vanes. The data logger has been programmed to record, at ten-minute intervals, mean and standard deviation wind speed and direction, and maximum and minimum wind speed.
The anemometers were individually calibrated and we have observed that the results of the individual calibrations were coded in the relevant channel set-up's of the data logger. Therefore, the individual calibrations were not applied by KenTec to the recorded wind speed data.

Instruments mounted on the San Marco on-site mast are all boom-mounted with orientation as presented in the table below:

Mast ID	Instrument	Boom height	Boom length	Pin height	Direction
SM1	An	30m	NA	NA	WNW
SM1	An	15m	NA	NA	WNW
SM1	Vane	27m	NA	NA	NE
SM2	An	35m	NA	NA	SSW
SM2	An	30m	NA	NA	SSW
SM2	An	10m	NA	NA	SSW
SM2	Vane	35m	NA	NA	SSW
Molinara	An	50m	NA	NA	S
Molinara	An	50m	NA	NA	N
Molinara	An	40m	NA	NA	N
Molinara	An	30m	NA	NA	N
Molinara	Vane	45m	NA	NA	N
Molinara	Vane	25m	NA	NA	N

We have not been informed of the boom length, the pin height (instrument height above the boon), the tower diameter or the boom diameter. We have therefore not been able to verify if the mounting arrangements are consistent with the recommendations of the IEC [2].

Including the repaired period the recorded wind speeds at individual heights are presented in the table below:

Mast ID	Instrument height	Wind speed
SM1	30m	6,20 m/s
SM2	35m	5,54m/s
Molinara	50m	6,07m/s

Short term measured wind speeds.

1.1. Long term reference:

Long term reference:
Due to potential inter-annual variations it is essential to know how the wind speed, during the measuring period, deviates from the long term average. A correlation based on simultaneous measurements between a long-term dataset and the on-site measurements has been carried out to perform the best adjustments.
We have analysed the measured data against a number of available wind data records near the site and found that the dataset with the highest correlation factor is the NCAR/NCEP data.
The correlations between the repaired data and the NCAR data are 0,83 to 0,84.

1.2. MCP result:

The MCP correlation between the measured data at the two San Marco masts and NCAR/NCEP return an energy level correction factor of :

Mast ID	Energy correction factor
SM1	0,97
SM2	0,94
Molinara	0,97

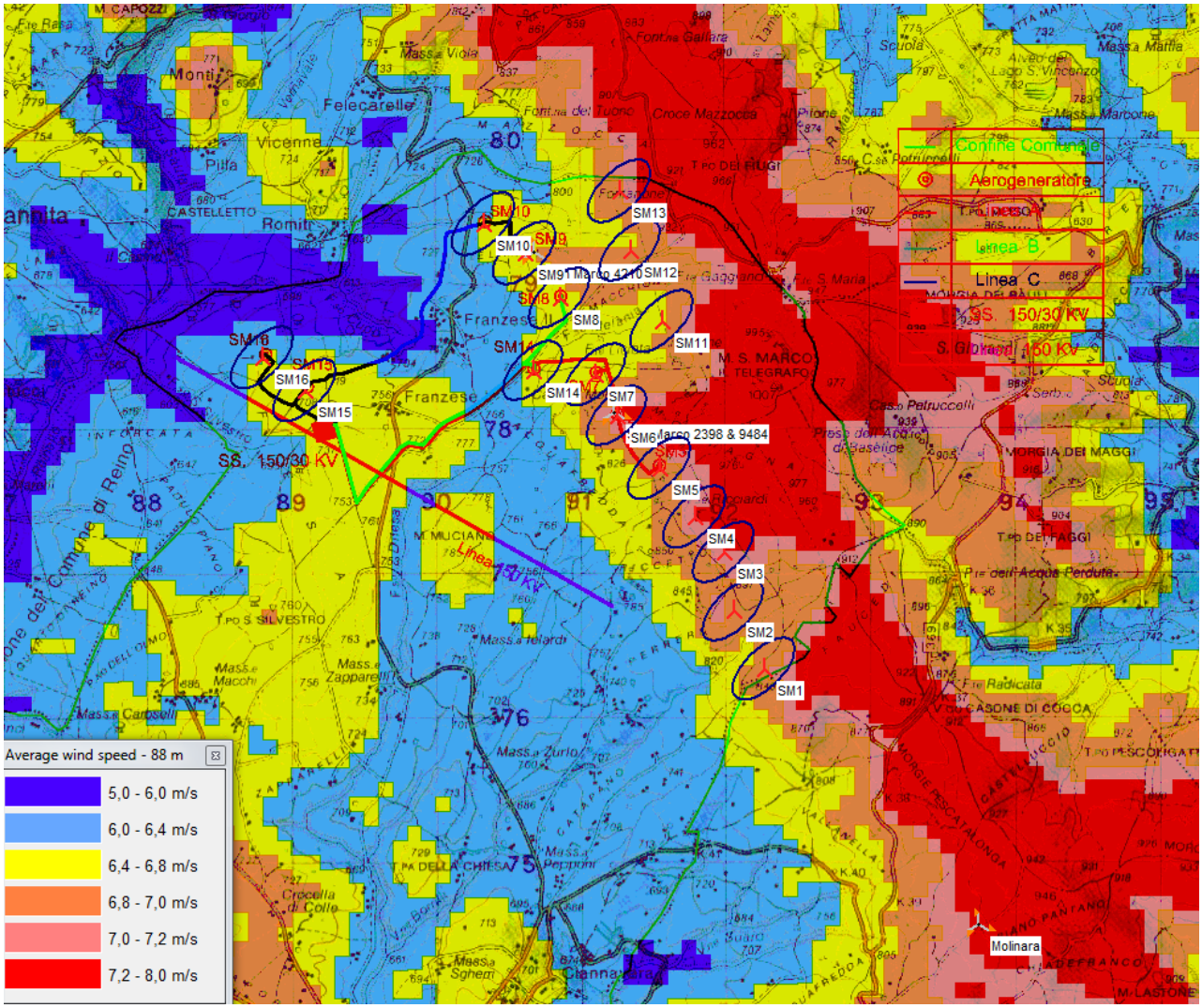
I.e. the measured wind energy at the site shall be subtracted 3% for the turbines near to the SM1 mast and 6% for the turbines near the SM2 mast, in order to match the 31-year long term average, which is used as best source to predict the future average wind speed.

The nearest wind data, based on SM1, SM2 and Molinara data, is used for the energy calculations on individual wind turbines. The wind resources are generated from the synthetic wind statistics that is generated at the 3 met stations by WAsP modelling and thus forming the basis for the long term predictions through the MCP Index method.
The predicted wind data at measurement height and hub height is presented in the table below:

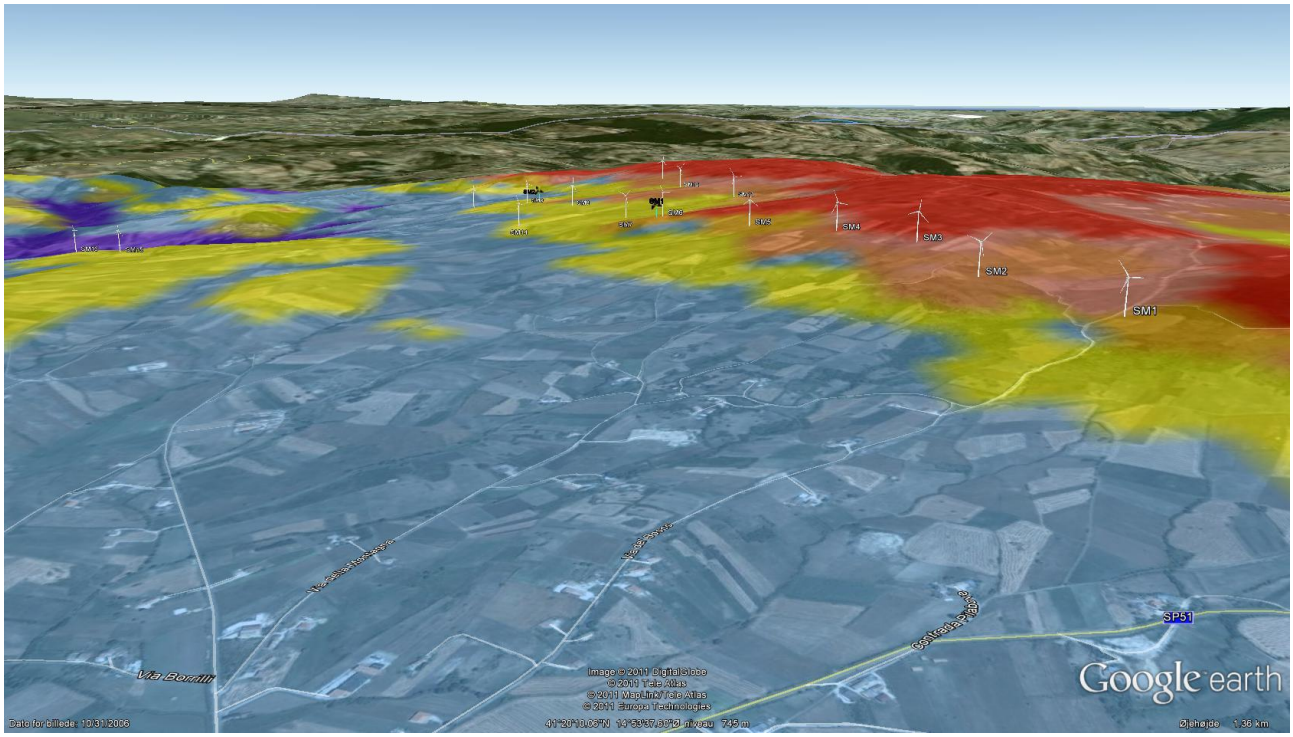
Mast ID	Instrument height	Wind speed at measure height	Wind speed at 88m height
SM1	30m	5,98m/s	7,13
SM2	35m	5,63m/s	6,72
Molinara	50m	6,45m/s	7,26

Long term predicted wind speeds.

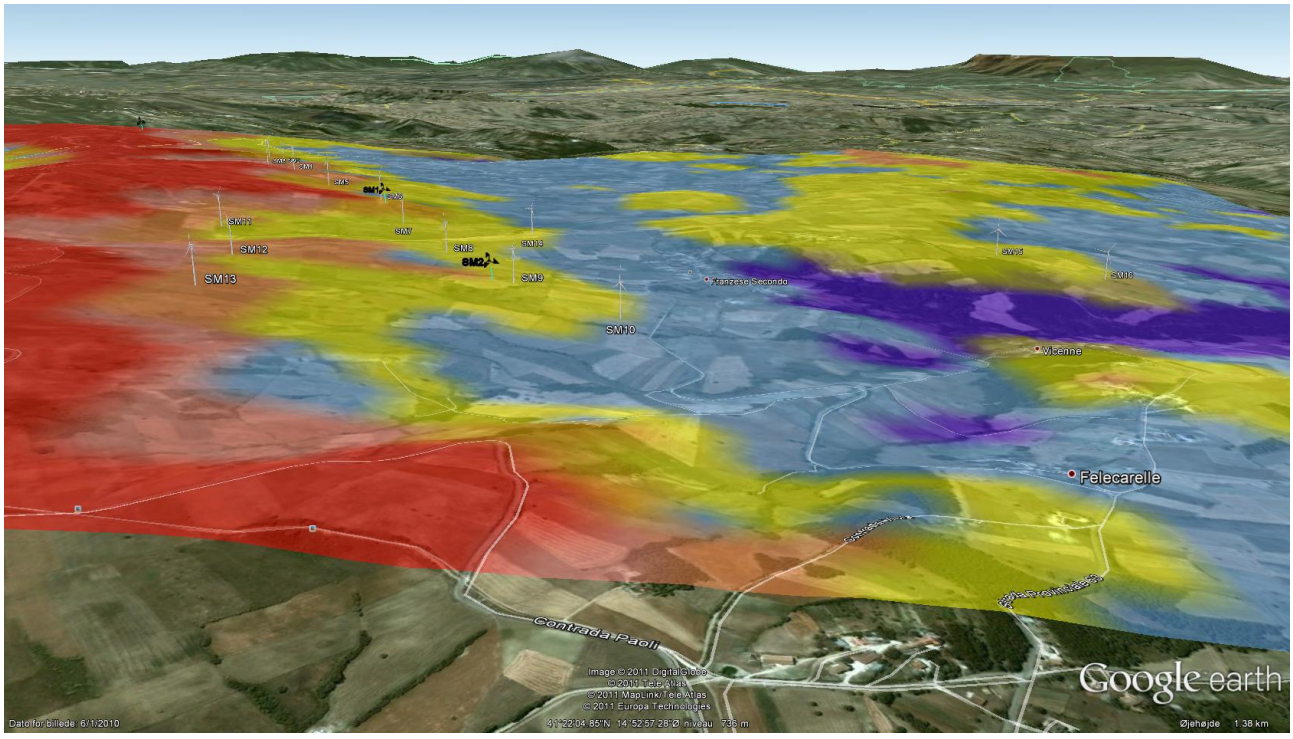
1.3. The projected energy resource map.



Wind resource at 88m height



Wind resource on Google Earth with wind turbines. North view.



Wind resource on Google Earth with wind turbines. South view.

1.4. The projected energy production.

Following the long term average wind speed, the annual predicted energy output is as follows for the selected type of turbines. The tables below indicate the 50%, 75% and 90% probability of exceeding the calculated energy P(50), P(75) and P(90).
Further the equivalent full load hours are calculated for each P() factor. Technical losses are not considered in the calculation values but discussed later.
(Details in the following pages)

Uncertainty evaluation:

Uncertainty in general technical matters:		
Measuring equipment:	5%	
Terrain evaluation:	5%	
Wind profile evaluation:	3%	
Power curve of the wind turbine:	3%	
Calculation methodology:	5%	
Uncertainty in general technical matters:	9,6%	(Rt-S-Sq)

Uncertainty in long term mean wind speed:		
Reference anemometer accuracy:	2%	
Variability of the campaign period:	2%	
Correlation accuracy:	2%	
Total uncertainty in long term mean wind speed:	3,5%	(Rt-S-Sq)

Uncertainties in future mean wind speed:		
Wake, roughness and topographic estimation:	3%	
Future wind variation (long term):	2%	
Total uncertainties in future mean wind speed:	3,6%	(Rt-S-Sq)

The summarized uncertainty is then:	**10,9%**	(Rt-S-Sq)

All uncertainties are summarized on Root-Sum-Square basis.

Wind Turbine Generator: WinWinD WWD
Generator size: 3 MW
Hub Height: 80 m
Number of turbines: 16 units
Base value: 105.519 MWh
Uncertainty: 10,9% (Standard Deviation)

			Reduction		Equivalent
Probability	SD	MWh	MWh	%	full load hours
50%	11.462	105.519	-	0%	2.198
75%	11.462	97.788	7.731	7%	2.037
90%	11.462	90.829	14.690	14%	1.892

Wind Turbine Generator: WinWinD WWD
Generator size: 3 MW
Hub Height: 88 m
Number of turbines: 16 units
Base value: 109.950 MWh
Uncertainty: 10,9% (Standard Deviation)

			Reduction		Equivalent
Probability	SD	MWh	MWh	%	full load hours
50%	11.944	109.950	-	0%	2.291
75%	11.944	101.894	8.056	7%	2.123
90%	11.944	94.644	15.306	14%	1.972

Wind Turbine Generator: Vestas V90
Generator size: 3 MW
Hub Height: 80 m
Number of turbines: 16 units
Base value: 99.718 MWh
Uncertainty: 10,9% (Standard Deviation)

			Reduction		Equivalent
Probability	SD	MWh	MWh	%	full load hours
50%	10.832	99.718	-	0%	2.077
75%	10.832	92.412	7.306	7%	1.925
90%	10.832	85.836	13.882	14%	1.788

Wind Turbine Generator: Vestas V90
Generator size: 3 MW
Hub Height: 90 m
Number of turbines: 16 units
Base value: 104.966 MWh
Uncertainty: 10,9% (Standard Deviation)

			Reduction		Equivalent
Probability	SD	MWh	MWh	%	full load hours
50%	11.402	104.966	-	0%	2.187
75%	11.402	97.275	7.691	7%	2.027
90%	11.402	90.353	14.613	14%	1.882

1.4.1. **Technical loses:**

The following technical losses will affect the energy available for sales.

Sources of loss:			
Electrical transmission	:	2,5 %	*1)
Availability of the wind turbines	:	2,0 %	*2)
Substation maintenance	:	0,2 %	Typical value
Utility downtime	:	0,2 %	Typical value
Blade fouling	:	0,2 %	
High Wind Hysteresis	:	0,0 %	
Total estimated technical losses:	**:**	**5,1 %**	

*1) The electrical transmission efficiency is the losses from the transformer stations in the individual wind turbines up to the metering point. The value is considered as a typical value and a formal calculation of the electrical losses should be undertaken when the electrical system has been defined.
*2) The availability is assumed based on data from modern wind farms. However, availability may be a matter of warranty between the owner and the turbine supplier and the assumed figure should be reviewed when the terms of that warranty are clear.
A detailed description of the various sources of losses is presented in the following “Data Analysis Procedures”.

2. Data Analysis Procedures

Correlation of wind speed and direction at the site and at the reference meteorological site:

The method used to determine the long-term mean wind speed at the proposed site was based on a Measure-Correlate-Predict (MCP) approach that is outlined below.

The first stage in the approach is to measure concurrent wind data from the site and one or more reference meteorological station(s). For the analysis reported here we use the meteorological station at the San Marco site. The data from NCAR/NCEP, returns in average the long term reference to yield the future estimated wind resource.
Concurrent wind data were used to establish the correlation between the winds at the locations. Finally, the correlation was used to adjust data recorded at the projects meteorological site to calculate the wind speed that would be expected at the project site.

The concurrent data were correlated by comparing wind speeds at the two locations in turn for each of twelve 30-degree direction sectors, based on the wind direction recorded at site station. This correlation involves two steps:

- Wind directions recorded at the two locations are compared to determine whether there are any local features influencing the directional results.
- Wind speed ratios are determined for each of the direction sectors using a principal component analysis.

The result of the MCP analysis is a table of wind energy ratios, each corresponding to one of twelve direction sectors, these ratios are used to factor the long-term wind speed and direction frequency table at the reference location to obtain the long-term wind speed at the target location.

Site wind speed variations:
To calculate the variation of mean wind speed over the site, the computer wind flow model, WAsP is used. Details of the model and its validation are given by Troen and Petersen Danish National Laboratory Riso.

Wind flow is affected by the roughness of the ground. For the site and its surrounding areas, the surface roughness was assumed to be 1,7 to 2,3 for the areas with scattered plantation, 1,5 for open farmland and areas of water were assigned a value of Class 0.

The wind flow calculations were carried out for 30-degree steps in wind direction corresponding to the measured wind rose and results were produced as factors relative to the mast location encompassing the site area.
To determine the long-term mean wind speed at any location, the factor for each wind direction was weighted with the measured probability previously derived for the mast location. All directions were then summed to obtain the long-term mean wind speed at the required location.

Projected energy production:

The components of the derivation of the wind turbine net energy output prediction are listed and described below:

Topographic and wake effect calculations:

The first step in modelling flow through an array of wind turbines is the calculation of the flow in the wake of a single machine. Immediately downstream of the rotor, there is a momentum deficit with respect to free stream conditions, which is equal to the thrust force on the machine. As the flow proceeds downstream, there is a spreading of the wake and recovery to free stream conditions.

The WAsP model is employed in a scheme which, taking each wind speed and direction in turn, calculates the power production of the wind farm. The important parameters used in this process are:

- Array layout
- Upstream mean wind speed
- Terrain roughness of the surrounding area
- Wind turbine thrust characteristic
- Wind turbine power characteristic
- Topographical speed-up factors from site wind flow calculations

The array model is used to calculate the wind speed in the turbine wakes.

Turbine availability:

A figure of 98 % has been assumed for turbine availability based on data from modern operational wind farms. However, availability may be a matter of warranty between the owner and the turbine supplier and the assumed figure should be reviewed when the terms of that warranty are clear.

Electrical transmission losses:

The electrical transmission losses have been assumed to be 2,5 %. A formal calculation of the electrical loss should be undertaken when the electrical system has been defined.

Blade fouling:

Accretion of dirt and insects on the blades, particularly during the summer months, may have a detrimental effect on the energy production. Due to this effect and the turbine being pitch controlled with variable RPM, an allowance of only 0,2% lost production has been included.

High wind hysteresis:

High wind hysteresis is caused by the turbine cut in and cut out control criteria for high wind speeds. The magnitude of this loss is influenced by three factors.

- The turbine will cut out when the maximum mean wind speed is exceeded and it will not cut in again until this mean wind speed is below a mean wind speed level lower than the cut out mean wind speed.
- The turbine will cut out if the instantaneous gust wind speed exceeds a maximum level and the turbine will not cut in until the wind speed drops to a lower value.
- The accuracy of the calibration of the instruments that are determining the wind characteristics at the turbine.

These three affects will normally cause the turbine to possibly lose production for some proportion of high mean wind speed occurrences.

Substation maintenance:

Net wind farm production may be reduced due to the electrical output not being transferred to the grid network while the substation is shutdown for maintenance. An assumption of approximately one working day of down time is made here.

Utility downtime:

Net wind farm production will be reduced if the grid is not available for the wind farm to output electricity to it. However, as central Italy is well covered with high-class generation and transmission systems, the losses to expect here is set to 0 %.

Power curve adjustment:

Adjustment to the energy prediction in order to account for variations in the actual turbine performance compared to the supplied power curve. In this report a 2% adjustment has been assumed. However, a power curve guarantee is normally a matter of agreement between the owner and the turbine supplier and the assumed figure should be reviewed when the terms of that guarantee are clear.
The figure also account for the turbines own consumption of energy.

Confidence analysis:

There are a number of categories of uncertainty associated with the site wind speed predictions. The considered factors are listed below:

1.
There is an uncertainty associated with the measurement accuracy of the anemometers. Normal calibrated anemometers are considered an uncertainty to account for calibration accuracy and mast effect as well as other second order effects such as over speeding, degradation and air density variations etc.

2.
The wind regime at the San Marco station was derived from correlation analysis, using external reference data as a long-term reference. The uncertainty associated with correlating and extrapolating between masts is evaluated from the statistical scatter in the correlation plots.

3.
There is an uncertainty associated with the assumption made here that the historical period for which data were available from the meteorological site is representative of the future climate over longer periods. A figure is used to define the uncertainty in assuming the long-term mean wind speed is defined by a period of 30 years in length. It is also assumed to include uncertainty associated with possible minor inconsistencies in the measured data over this long period.

4.
For a finite number of future years, the mean wind speed may differ from the long-term mean due to the natural variability of a random process. It is generally considered that the deviation between a normal year and one individual year follows a normal distribution scatter with a standard deviation of 6%.

5.
It is assumed that the time series of wind speed is random with no systematic trends. Care is taken to ensure that consistency of the meteorological station measurement system and exposure has been maintained over the historical period and no allowance is made for uncertainties arising due to changes in either.

Uncertainties from above are added as independent errors on a root-sum-square basis to give the total uncertainty in the site wind speed prediction for the historical period considered.

Uncertainties above are added as independent errors on a root-sum-square basis to give the total uncertainty in the site wind speed prediction for the historical period considered.

It is considered here that there are three categories of uncertainty in the energy output projection:

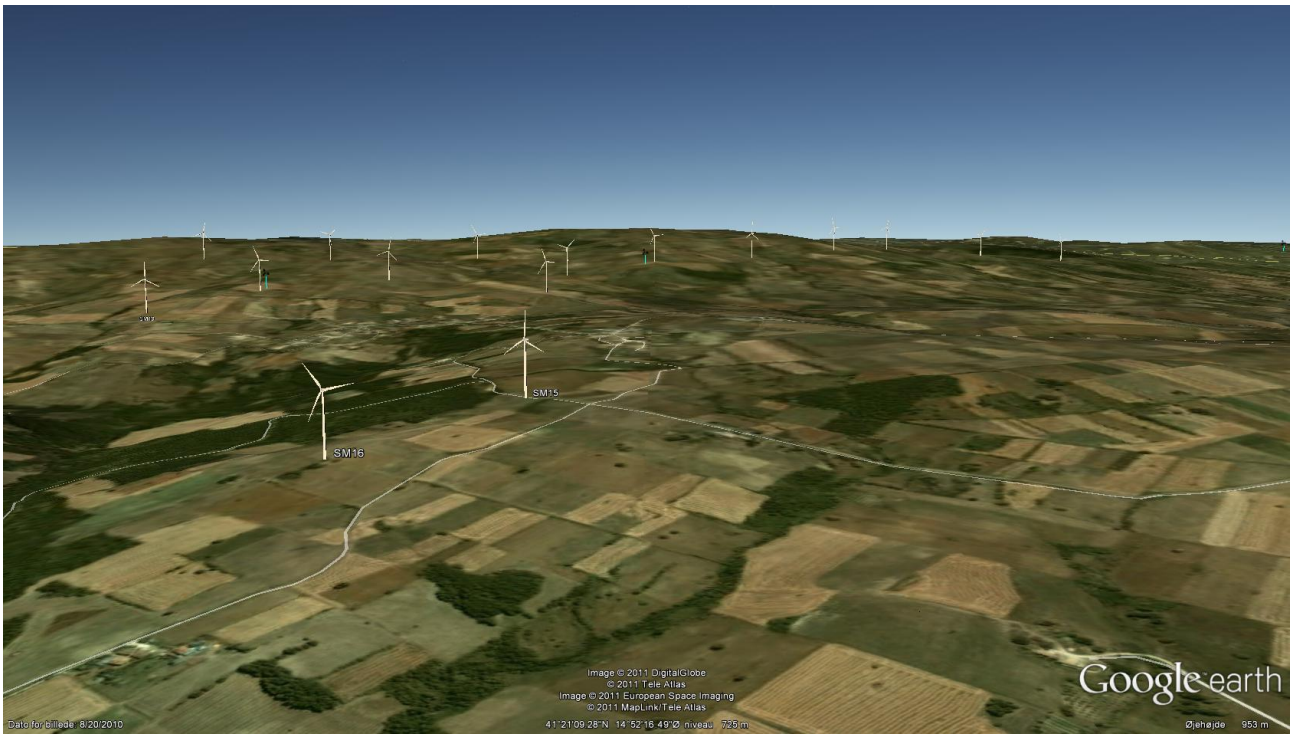
- Wind speed dependent uncertainty is derived from the total wind speed uncertainty using a factor for the sensitivity of the annual energy output to changes in annual mean wind speed.

- Wake, roughness and topographic modelling uncertainties.
  The uncertainty related to roughness and topography evaluations are together with the uncertainty in the wake modelling assumed 5%.

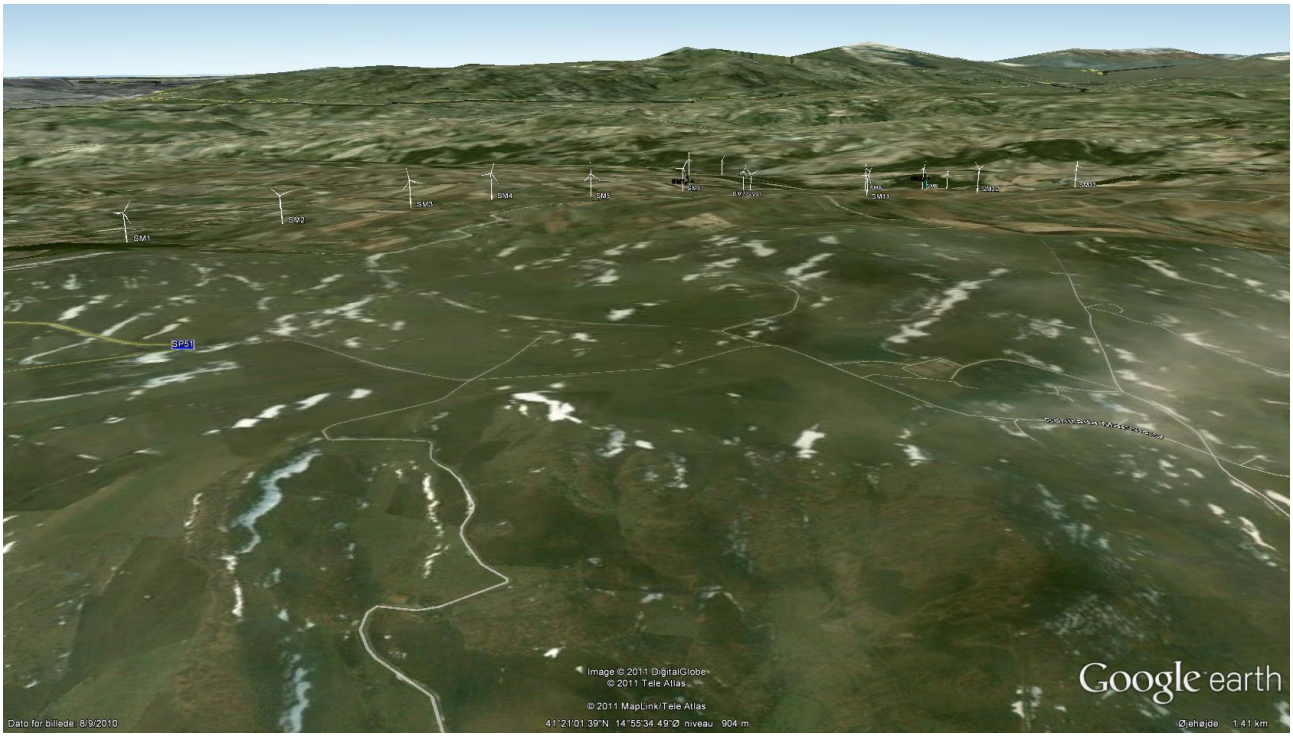
- Wind Turbine uncertainties, except for power curve adjustments, are generally the subject of contract between the developer and turbine supplier and in this report there have therefore been made no allowance referred to this factor.

Those uncertainties that are considered are added as independent errors on a root-sum-square basis to give the total uncertainty in the projected energy output.

3. The site layout with wind turbines.

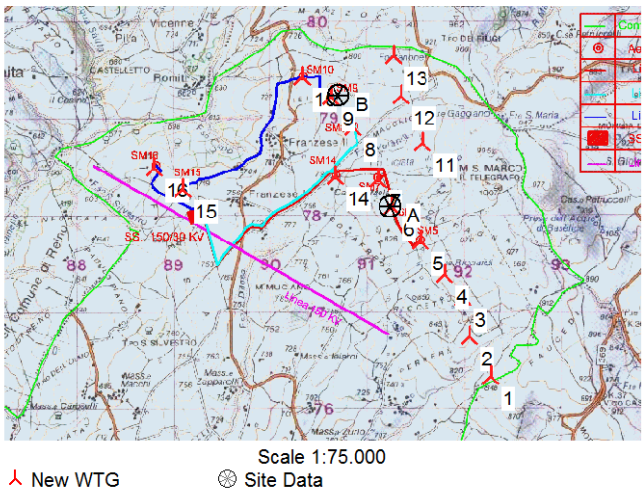


Seen against east



1 Seen against West

	Z	Nearest WTG	Z	Horizontal distance	Distance in rotor diameters
	[m]		[m]	[m]	
1	848,8	2	869,6	461	5,1
2	869,6	3	907,6	407	4,5
3	907,6	4	910,3	314	3,5
4	910,3	3	907,6	314	3,5
5	877,5	4	910,3	418	4,6
6	867,7	7	825,0	323	3,6
7	825,0	6	867,7	323	3,6
8	818,7	9	799,0	396	4,4
9	799,0	10	752,1	351	3,9
10	752,1	9	799,0	351	3,9
11	873,8	12	873,6	532	5,9
12	873,6	13	877,4	424	4,7
13	877,4	12	873,6	424	4,7
14	792,7	7	825,0	436	4,8
15	707,3	16	671,3	367	4,1
16	671,3	15	707,3	367	4,1



Tabel. 2.2: The distances between the individual turbines.

ANNEX 1 Wind turbine positions.

UTM ED50

	East	North
SM 1	492264	4576339
SM 2	492050	4576747
SM 3	491982	4577148
SM 4	491785	4577393
SM 5	491540	4577732
SM 6	491245	4578091
SM 7	491099	4578379
SM 8	490850	4578910
SM 9	490613	4579227
SM 10	490325	4579428
SM 11	491563	4578750
SM 12	491344	4579235
SM 13	491267	4579652
SM 14	490664	4578404
SM 15	489086	4578279
SM 16	488795	4578503

ANNEX 2 Detailed wind report from San Marco meteorological stations.

San Marco met mast SM1

San Marco met mast SM2

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Meteo data report - Main results

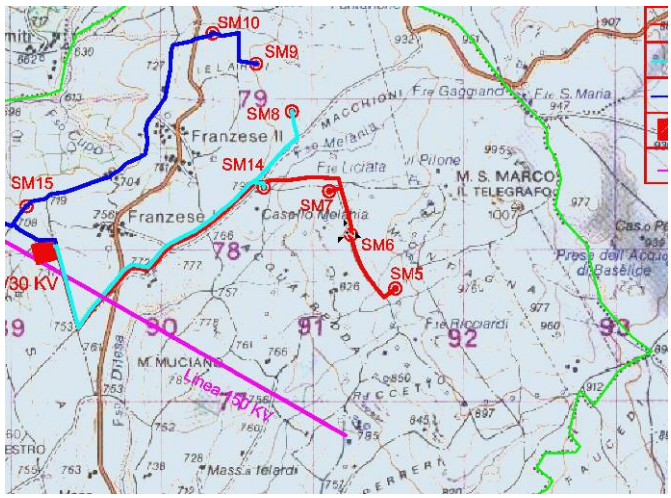
Mast: San Marco 2398 & 9484; San Marco 2398 & 9484 **Period:** Full period: 01-11-2006 - 14-11-2011 (60,4 months)

Mast position: UTM ED50 Zone: 33 East: 491.222 North: 4.578.121

Measurement heights and wind speeds (in this report)
Disabled data not included in overview table below

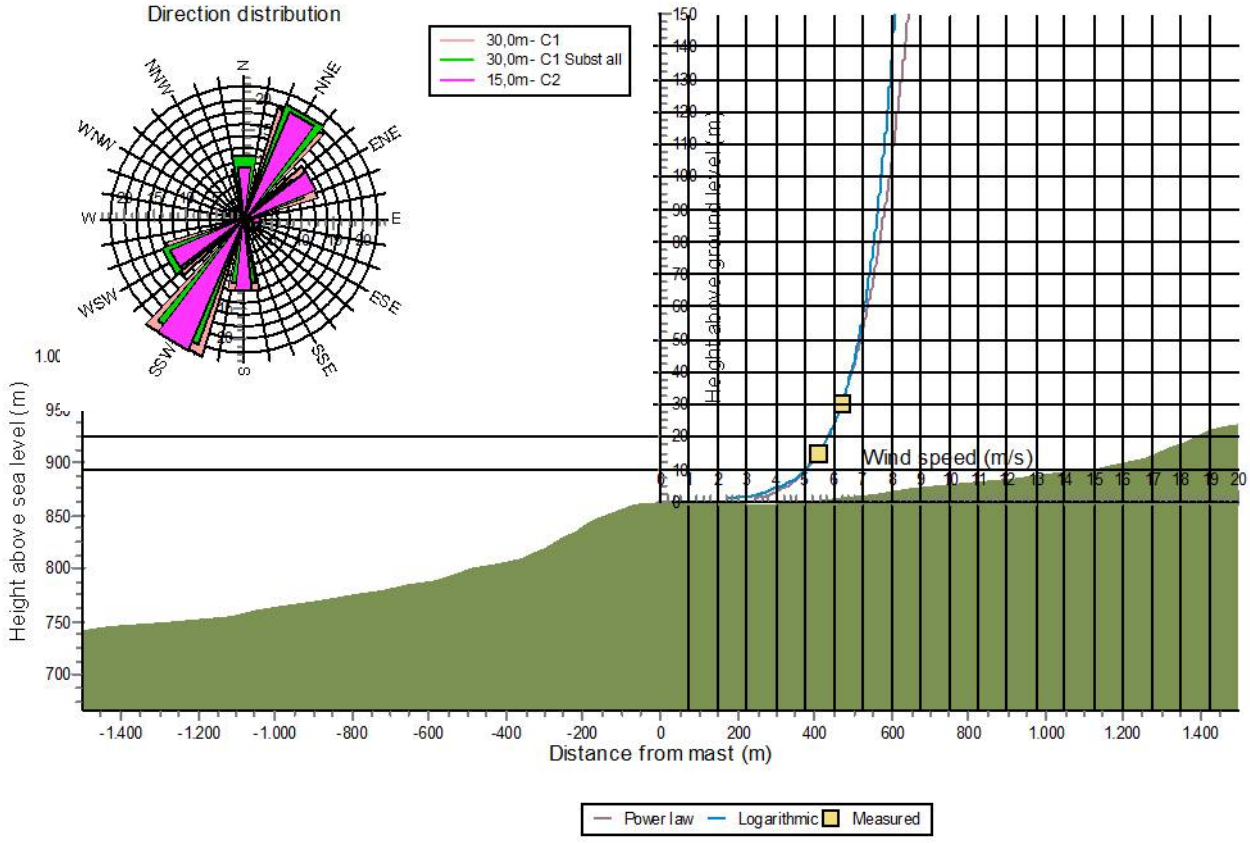
ID	Height [m]	Data recovery [%]	Records	U_max [m/s]	U_mean *) [m/s]
30,0m - C1	30,0	63,6	168579	25,4	6,2
30,0m - C1 Subst all	30,0	100,0	264882	25,4	6,2
15,0m - C2	15,0	63,9	169139	22,9	5,4

*) *U_mean is simple arithmetic average*



Scale: 50.000

Mean w ind profile for all concurrent data and terrain profile for the most frequent sector of height: 30,0m - C1: SSW (left side)



Profile characteristics for best curve fit through all data (Note: Values are only fully valid in flat terrain)
Shear exponent 0,1949 (Power law profile)
Roughness lenght 0,1243 m class 2,16 (Equivalent roughness for logarithmic profile)

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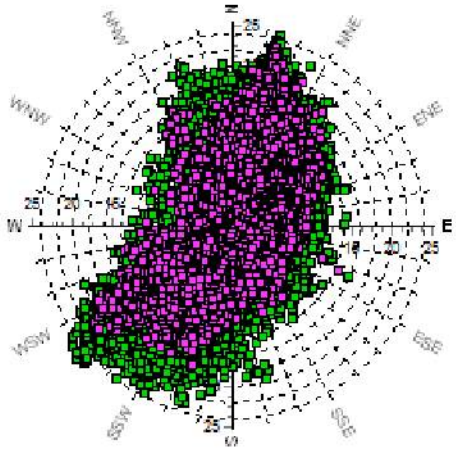
Meteo data report - Main results

Mast: San Marco 2398 & 9484; San Marco 2398 & 9484**Period:** Full period: 01-11-2006 - 14-11-2011 (60,4 months)

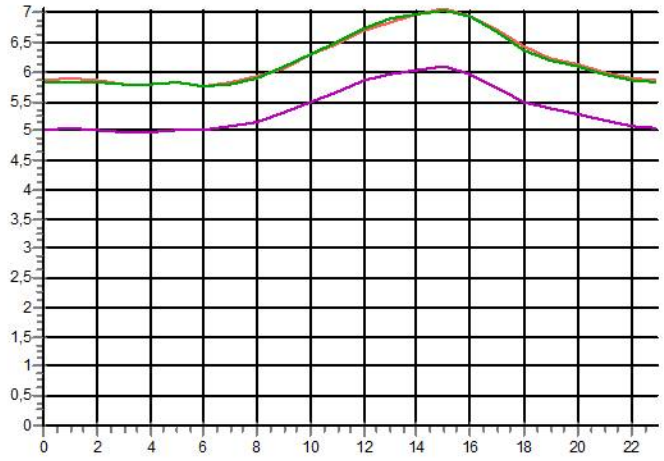
Wind speed/direction



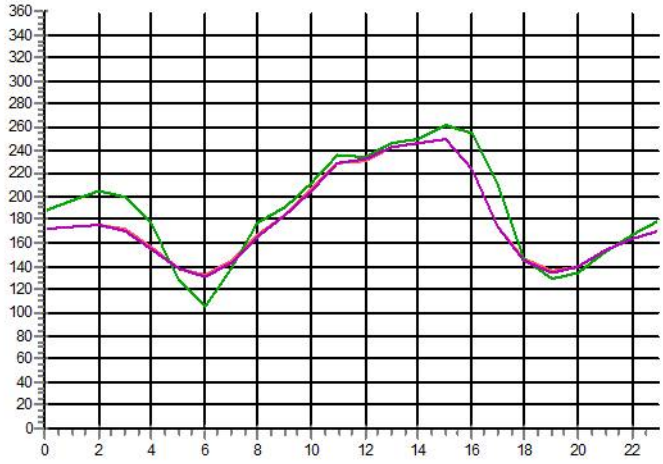
Statistics

	Signal	Unit	Count	Of period [%]	Mean	Weibull mean	Weibull A	Weibull k
30,0m - C1	Mean wind speed, all	m/s	168579	100,0	6,21	6,27	7,07	1,94
30,0m - C1	Wind direction, all	Degrees	168579	100,0	175,12			
30,0m - C1	Turbulence intensity, all		167252	99,2	0,14			
30,0m - C1	Turbulence intensity, enabled		123980	73,5	0,11			
30,0m - C1 Subst all	Mean wind speed, all	m/s	264882	100,0	6,20	6,24	7,03	1,92
30,0m - C1 Subst all	Wind direction, all	Degrees	264882	100,0	196,38			
30,0m - C1 Subst all	Turbulence intensity, all		263868	99,6	0,15			
30,0m - C1 Subst all	Turbulence intensity, enabled		197426	74,5	0,12			
15,0m - C2	Mean wind speed, all	m/s	169139	100,0	5,37	5,47	6,17	1,96
15,0m - C2	Wind direction, all	Degrees	169139	100,0	174,48			
15,0m - C2	Turbulence intensity, all		167802	99,2	0,17			
15,0m - C2	Turbulence intensity, enabled		112171	66,3	0,14			

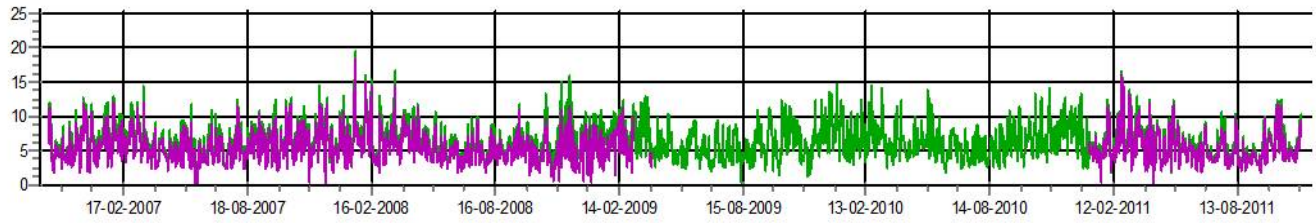
Hourly mean w ind speed



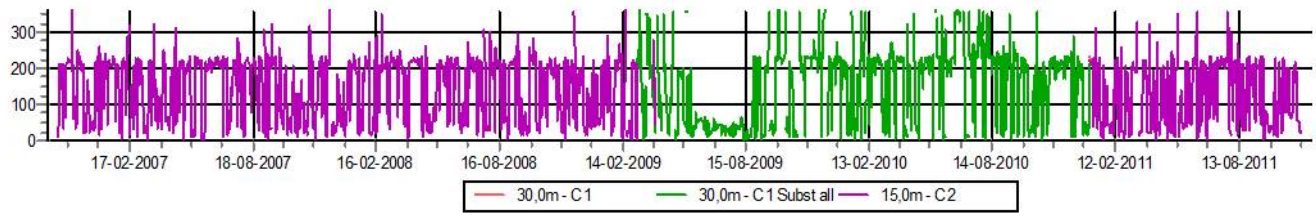
Hourly mean w ind direction



Wind speed, Averaging: Day



Wind direction, Averaging: Day



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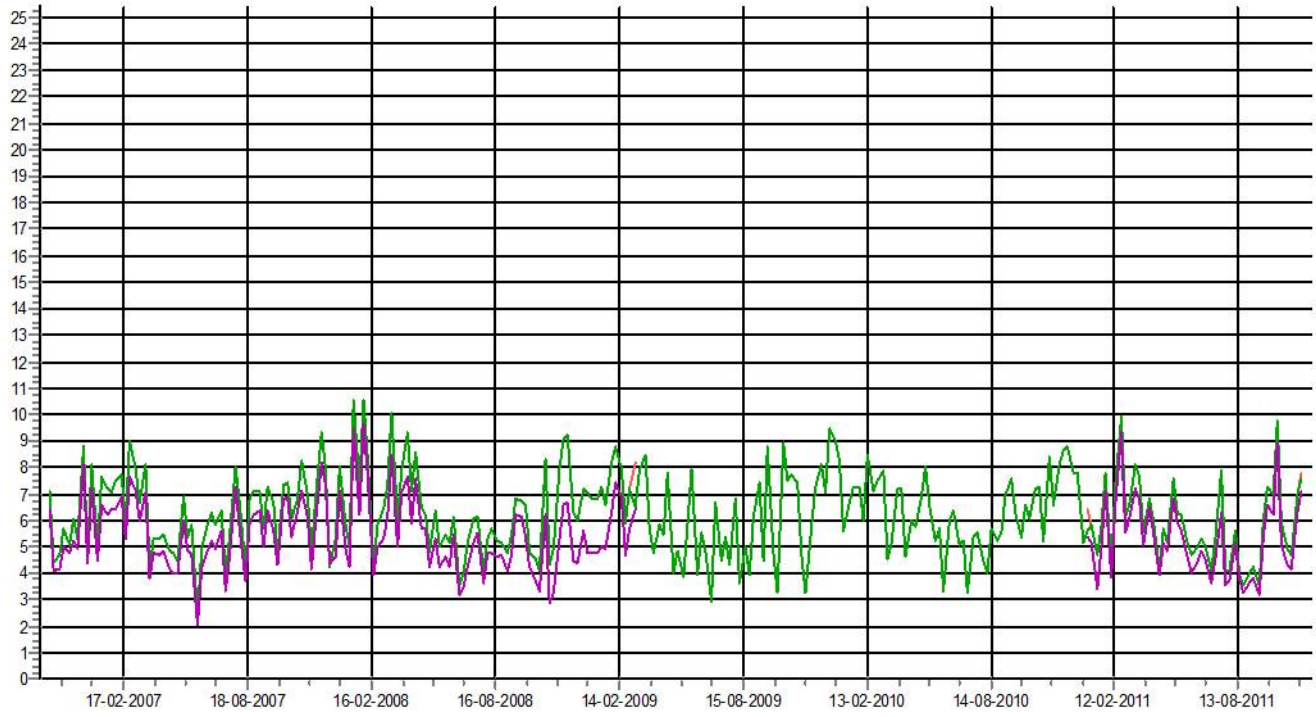
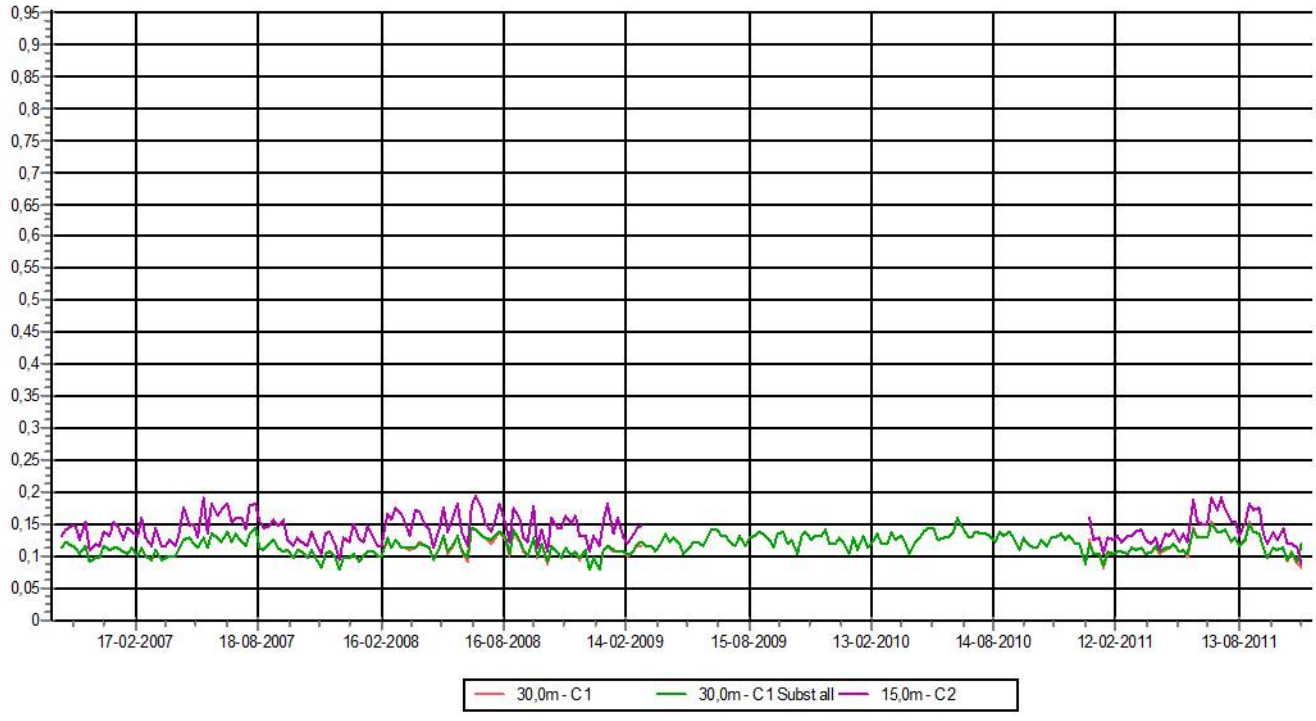
Meteo data report - Time series graphs

Mast: San Marco 2398 & 9484; San Marco 2398 & 9484**Period:** Full period: 01-11-2006 - 14-11-2011 (60,4 months)

Mean wind speed, Averaging: Week



Turbulence intensity, Averaging: Week



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Meteo data report - Monthly wind speeds

Mast: San Marco 2398 & 9484; San Marco 2398 & 9484**Period:** Full period: 01-11-2006 - 14-11-2011 (60,4 months)

Monthly wind speeds

30,0m - C1

Month	2006	2007	2008	2009	2010	2011	Mean	Mean of month
January		6,81	7,39	7,02		5,51	6,74	6,68
February		7,39	7,01	7,72		7,29	7,35	7,35
March		7,18	7,57	6,99		6,98	7,22	7,18
April		5,16	8,11			5,72	6,33	6,33
May		5,60	5,85			6,12	5,86	5,86
June		4,85	4,95			5,17	4,99	4,99
July		5,38	5,41			5,25	5,35	5,35
August		6,49	5,05			4,29	5,28	5,28
September		6,70	5,86			4,99	5,85	5,85
October		6,28	5,60			6,82	6,23	6,23
November	5,43	6,89	6,66			5,94	6,28	6,23
December	5,96	6,65	7,07				6,56	6,56
mean, all data	5,70	6,28	6,37	7,31		5,82		
mean of months	5,70	6,28	6,38	7,24		5,83		6,16

Monthly wind speeds

30,0m - C1 Subst all

Month	2006	2007	2008	2009	2010	2011	Mean	Mean of month
January		6,81	7,39	7,02	7,28	5,30	6,76	6,76
February		7,39	7,01	7,72	7,20	7,29	7,32	7,32
March		7,18	7,57	7,44	6,52	6,98	7,14	7,14
April		5,16	8,11	5,76	5,89	5,72	6,13	6,13
May		5,60	5,85	4,83	6,71	6,12	5,82	5,82
June		4,85	4,95	5,35	5,26	5,17	5,12	5,12
July		5,38	5,41	4,94	4,81	5,25	5,16	5,16
August		6,49	5,05	4,81	5,06	4,29	5,14	5,14
September		6,70	5,86	6,48	6,51	4,99	6,11	6,11
October		6,28	5,60	6,70	6,43	6,82	6,36	6,37
November	5,43	6,89	6,66	5,54	7,23	5,97	6,32	6,29
December	5,96	6,65	7,07	7,84	7,79		7,06	7,06
mean, all data	5,70	6,28	6,37	6,19	6,39	5,79		
mean of months	5,70	6,28	6,38	6,20	6,39	5,81		6,20

Monthly wind speeds

15,0m - C2

Month	2006	2007	2008	2009	2010	2011	Mean	Mean of month
January		5,95	6,48	4,96		4,61	5,54	5,50
February		6,56	6,33	6,31		6,70	6,47	6,47
March		6,31	6,33	5,45		6,26	6,23	6,09
April		4,54	6,95	3,58		5,34	5,53	5,10
May		4,85	5,09			5,61	5,18	5,18
June		4,05	4,26			4,63	4,31	4,31
July		4,67	4,66			4,45	4,59	4,59
August		5,67	4,46			3,93	4,69	4,69
September		5,89	5,17			4,50	5,19	5,19
October		5,79	4,56			6,11	5,49	5,49
November	4,93	6,09	4,59			5,33	5,22	5,23
December	5,45	6,03	5,17				5,55	5,55
mean, all data	5,20	5,53	5,33	5,48		5,22		
mean of months	5,19	5,53	5,34	5,07		5,22		5,28

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Meteo data report - Main results

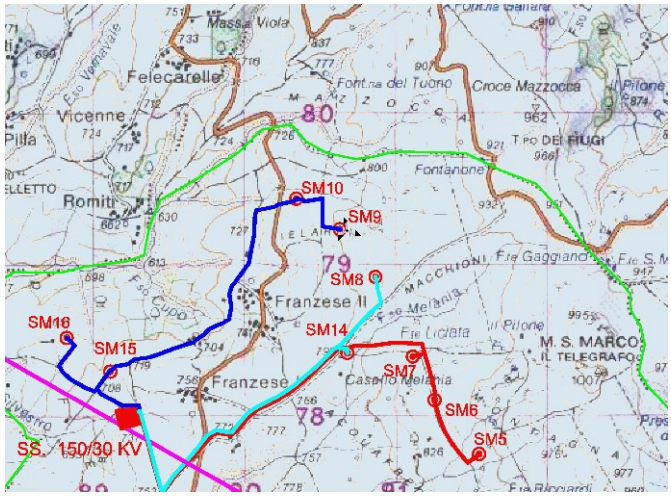
Mast: San Marco 4210; San Marco 4210**Period:** Full period: 27-12-2007 - 14-11-2011 (46,6 months)

Mast position: UTM ED50 Zone: 33 East: 490.670 North: 4.579.229

Measurement heights and wind speeds (in this report)
Disabled data not included in overview table below

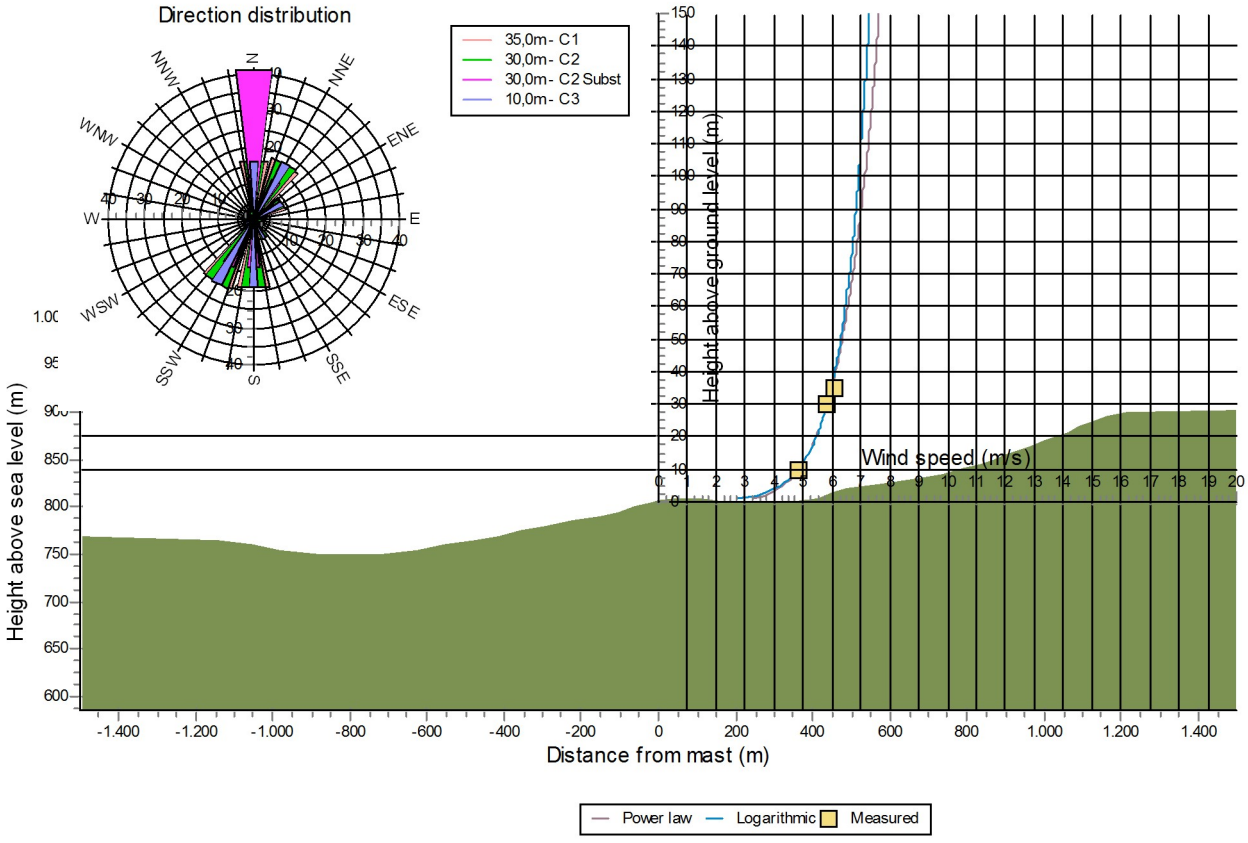
ID	Height [m]	Data recovery [%]	Records	U_max [m/s]	U_mean *) [m/s]
35,0m - C1	35,0	69,8	142568	24,1	6,0
30,0m - C2	30,0	69,8	142553	23,5	5,7
30,0m - C2 Subst	30,0	100,0	204164	23,5	5,5
10,0m - C3	10,0	69,8	142553	20,5	4,8

*) *U_mean is simple arithmetic average*



Scale: 50.000

Mean w ind profile for all concurrent data and terrain profile for the most frequent sector of height: 35,0m - C1: SSW (left side)



Profile characteristics for best curve fit through all data (Note: Values are only fully valid in flat terrain)
Shear exponent 0,1683 (Power law profile)
Roughness lenght 0,0473 m class 1,38 (Equivalent roughness for logarithmic profile)

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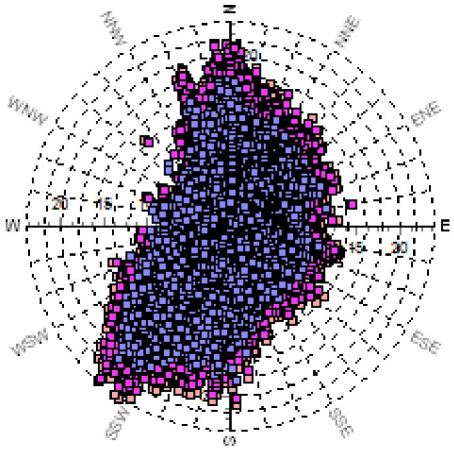
Meteo data report - Main results

Mast: San Marco 4210; San Marco 4210**Period:** Full period: 27-12-2007 - 14-11-2011 (46,6 months)

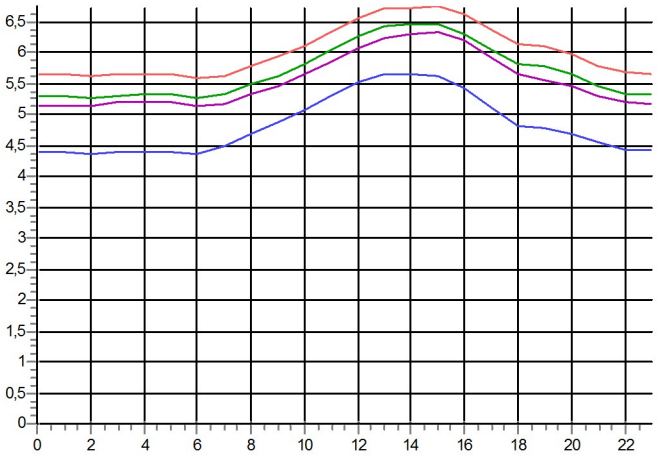
Wind speed/direction



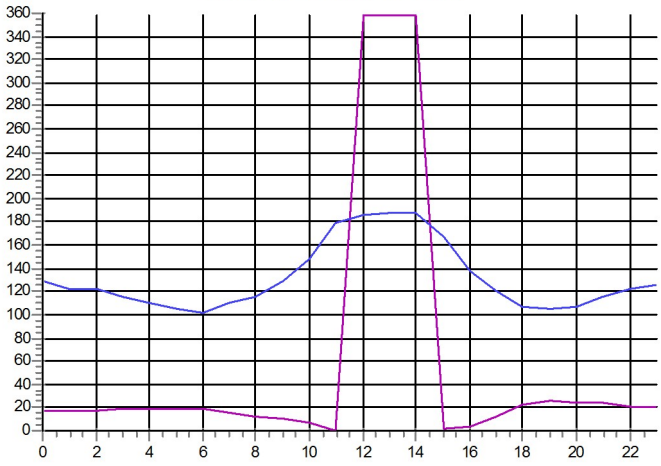
Statistics

	Signal	Unit	Count	Of period [%]	Mean	Weibull mean	Weibull A	Weibull k
35,0m - C1	Mean wind speed, all	m/s	142568	100,0	6,01	6,07	6,85	1,97
35,0m - C1	Wind direction, all	Degrees	142568	100,0	121,80			
35,0m - C1	Turbulence intensity, all		142568	100,0	0,15			
35,0m - C1	Turbulence intensity, enabled		103178	72,4	0,12			
30,0m - C2	Mean wind speed, all	m/s	142553	100,0	5,69	5,78	6,52	1,94
30,0m - C2	Wind direction, all	Degrees	142553	100,0	121,85			
30,0m - C2	Turbulence intensity, all		142553	100,0	0,17			
30,0m - C2	Turbulence intensity, enabled		98693	69,2	0,13			
30,0m - C2 Subst	Mean wind speed, all	m/s	204164	100,0	5,54	5,63	6,34	1,93
30,0m - C2 Subst	Wind direction, all	Degrees	204164	100,0	13,62			
30,0m - C2 Subst	Turbulence intensity, all		184084	90,2	0,16			
30,0m - C2 Subst	Turbulence intensity, enabled		144612	70,8	0,13			
10,0m - C3	Mean wind speed, all	m/s	142553	100,0	4,82	4,86	5,48	1,93
10,0m - C3	Wind direction, all	Degrees	142553	100,0	121,85			
10,0m - C3	Turbulence intensity, all		142553	100,0	0,20			
10,0m - C3	Turbulence intensity, enabled		84128	59,0	0,17			

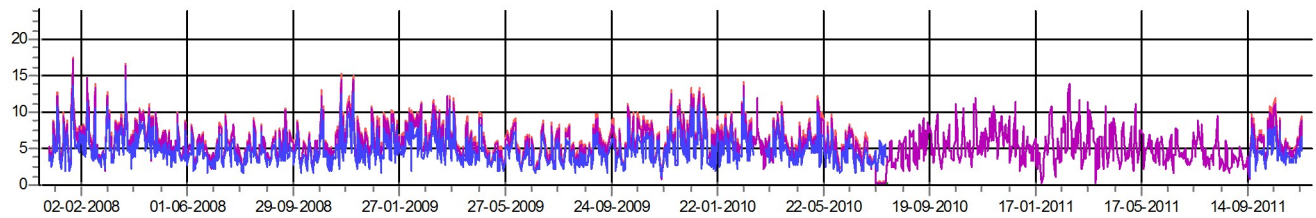
Hourly mean w ind speed



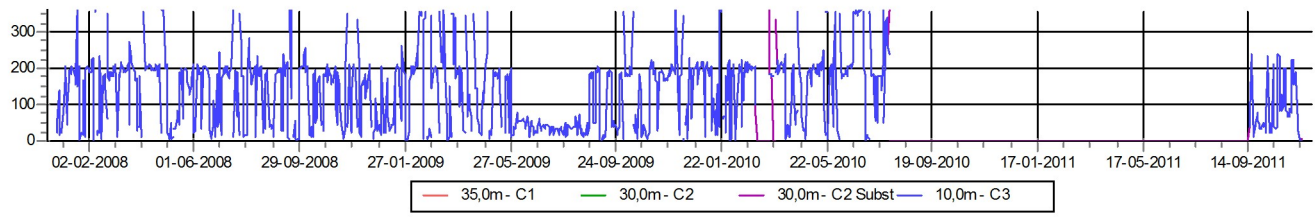
Hourly mean w ind direction



Wind speed, Averaging: Day



Wind direction, Averaging: Day



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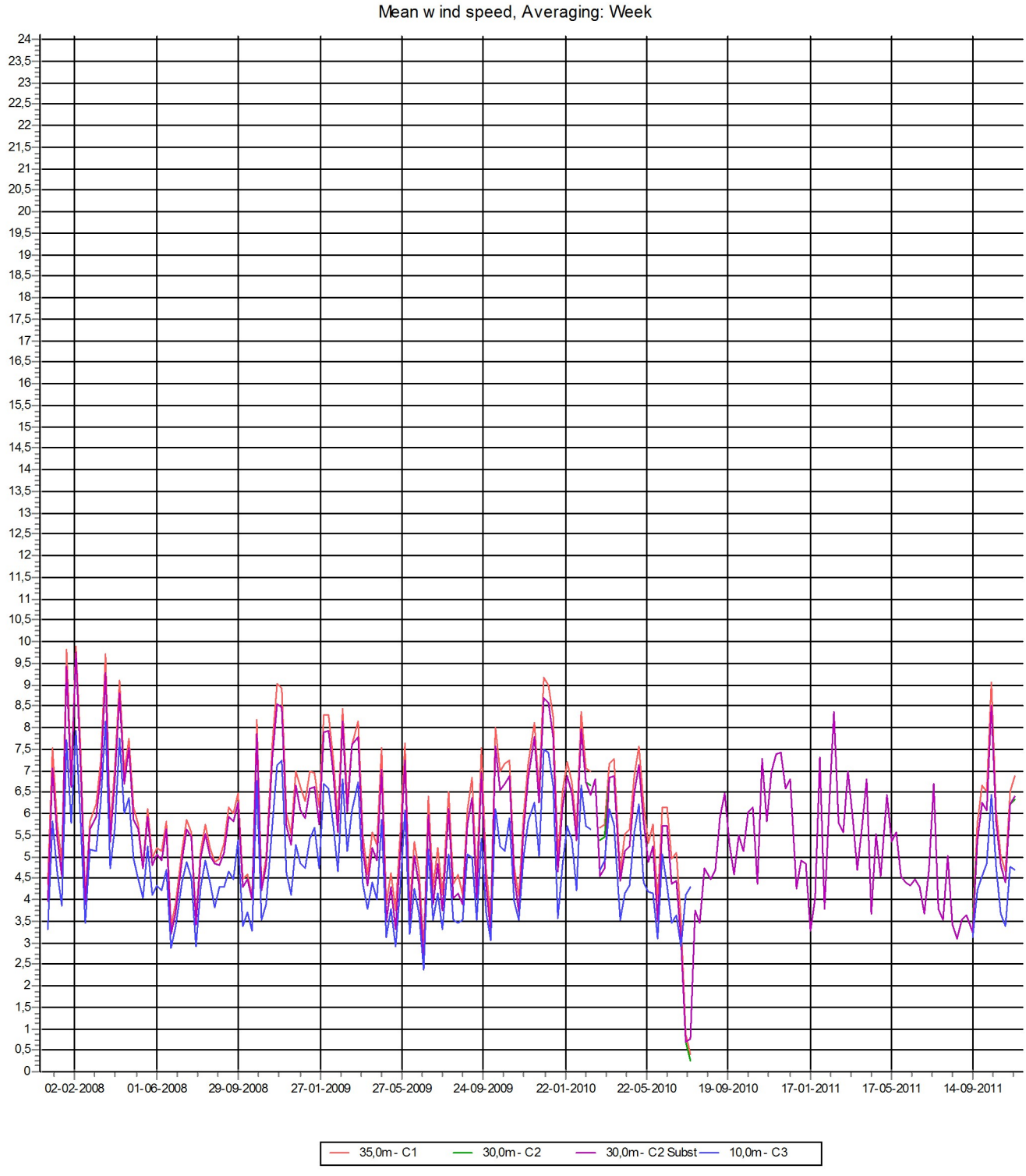
Meteo data report - Time series graphs

Mast: San Marco 4210; San Marco 4210**Period:** Full period: 27-12-2007 - 14-11-2011 (46,6 months)



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Meteo data report - Main results

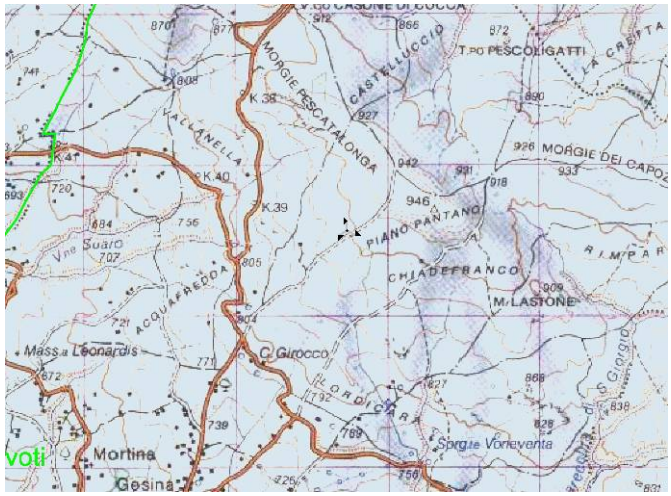
Mast: Molinara; Molinara**Period:** Full period: 12-08-2009 - 14-11-2011 (27,1 months)

Mast position: UTM ED50 Zone: 33 East: 493.741 North: 4.574.570

Measurement heights and wind speeds (in this report)
Disabled data not included in overview table below

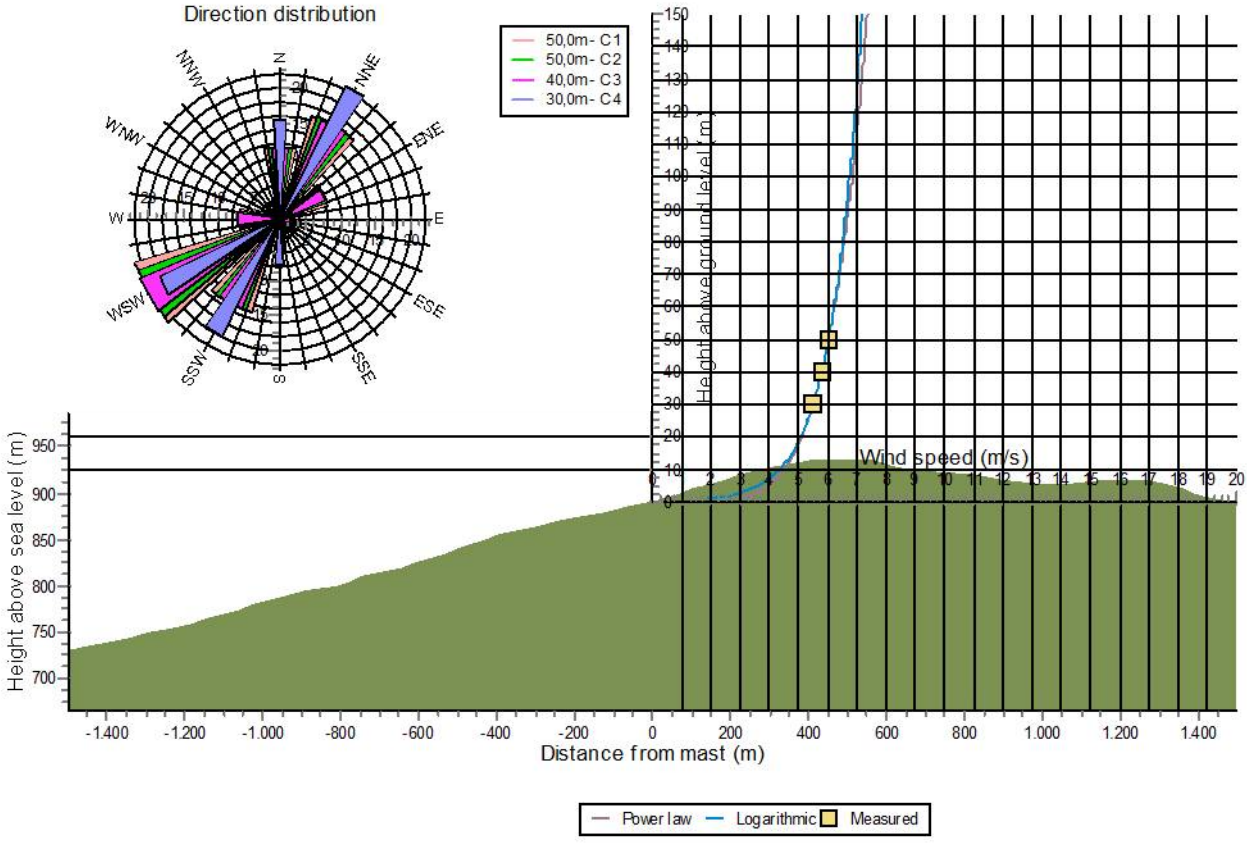
ID	Height [m]	Data recovery [%]	Records	U_max [m/s]	U_mean *) [m/s]
50,0m - C1	50,0	100,0	118677	23,0	6,1
50,0m - C2	50,0	100,0	118677	23,0	6,1
40,0m - C3	40,0	100,0	118677	22,4	5,9
30,0m - C4	30,0	100,0	118677	20,9	5,5

*) *U_mean is simple arithmetic average*



Scale: 50.000

Mean wind profile for all concurrent data and terrain profile for the most frequent sector of height: 50,0m - C1: WSW (left side)



Profile characteristics for best curve fit through all data (Note: Values are only fully valid in flat terrain)
Shear exponent 0,1817 (Power law profile)
Roughness lenght 0,1553 m class 2,32 (Equivalent roughness for logarithmic profile)

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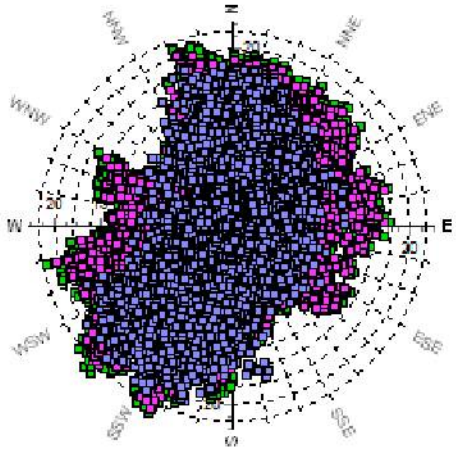
Meteo data report - Main results

Mast: Molinara; Molinara**Period:** Full period: 12-08-2009 - 14-11-2011 (27,1 months)

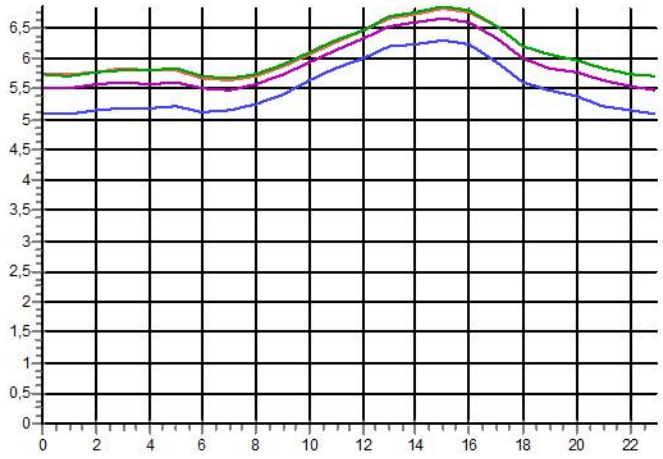
Wind speed/direction



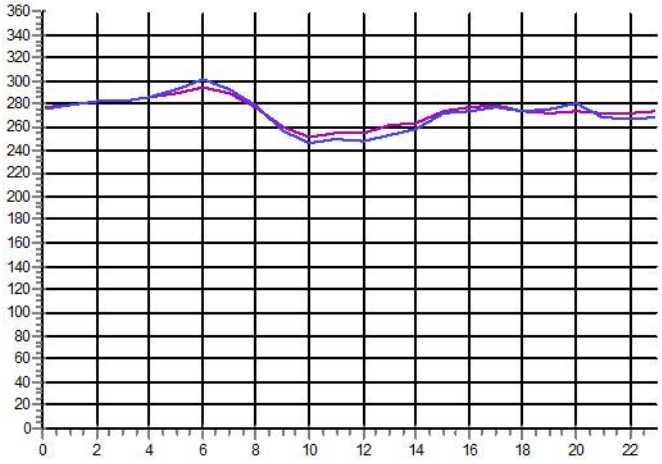
Statistics

	Signal	Unit	Count	Of period [%]	Mean	Weibull mean	Weibull A	Weibull k
50,0m - C1	Mean wind speed, all	m/s	118677	100,0	6,06	6,02	6,78	1,85
50,0m - C1	Wind direction, all	Degrees	118677	100,0	273,95			
50,0m - C1	Turbulence intensity, all		118528	99,9	0,14			
50,0m - C1	Turbulence intensity, enabled		84798	71,4	0,11			
50,0m - C2	Mean wind speed, all	m/s	118677	100,0	6,07	6,01	6,76	1,81
50,0m - C2	Wind direction, all	Degrees	118677	100,0	273,95			
50,0m - C2	Turbulence intensity, all		118528	99,9	0,15			
50,0m - C2	Turbulence intensity, enabled		84568	71,3	0,11			
40,0m - C3	Mean wind speed, all	m/s	118677	100,0	5,88	5,85	6,59	1,86
40,0m - C3	Wind direction, all	Degrees	118677	100,0	273,95			
40,0m - C3	Turbulence intensity, all		118528	99,9	0,15			
40,0m - C3	Turbulence intensity, enabled		82638	69,6	0,12			
30,0m - C4	Mean wind speed, all	m/s	118677	100,0	5,51	5,47	6,16	1,83
30,0m - C4	Wind direction, all	Degrees	118677	100,0	271,79			
30,0m - C4	Turbulence intensity, all		118528	99,9	0,16			
30,0m - C4	Turbulence intensity, enabled		78847	66,4	0,13			

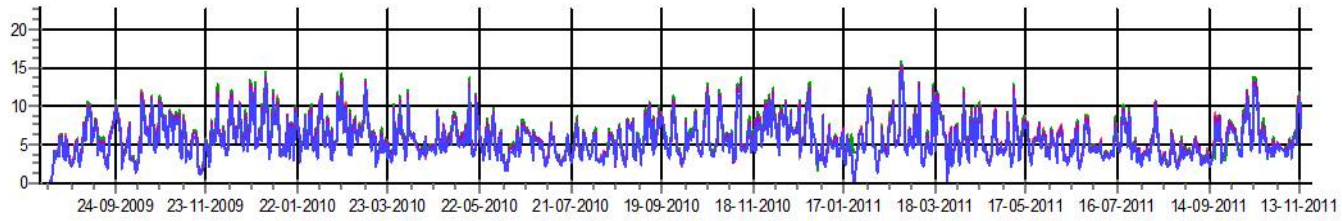
Hourly mean w ind speed



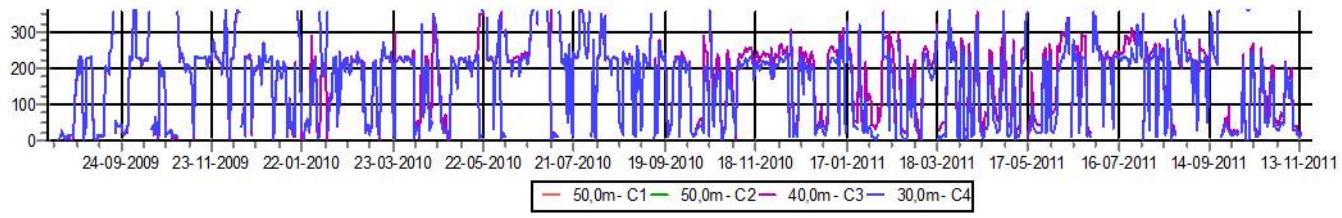
Hourly mean w ind direction



Wind speed, Averaging: Day



Wind direction, Averaging: Day



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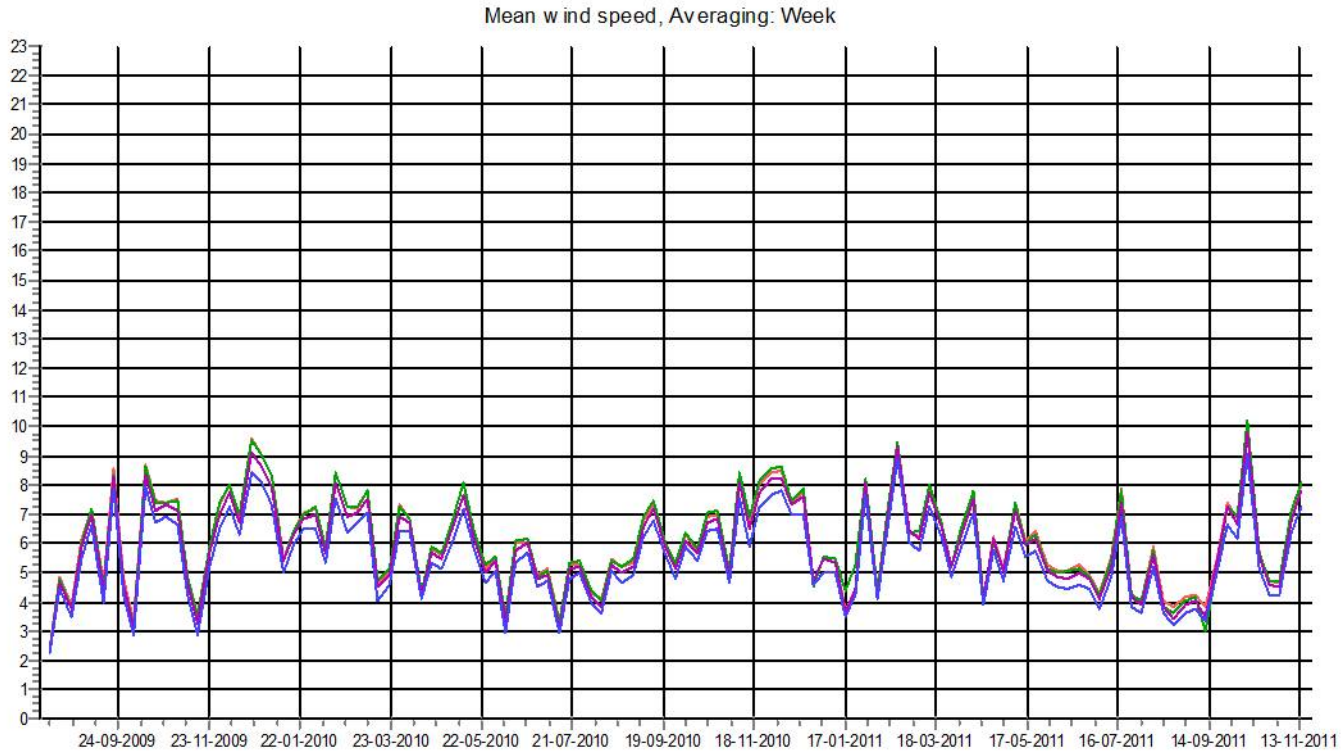
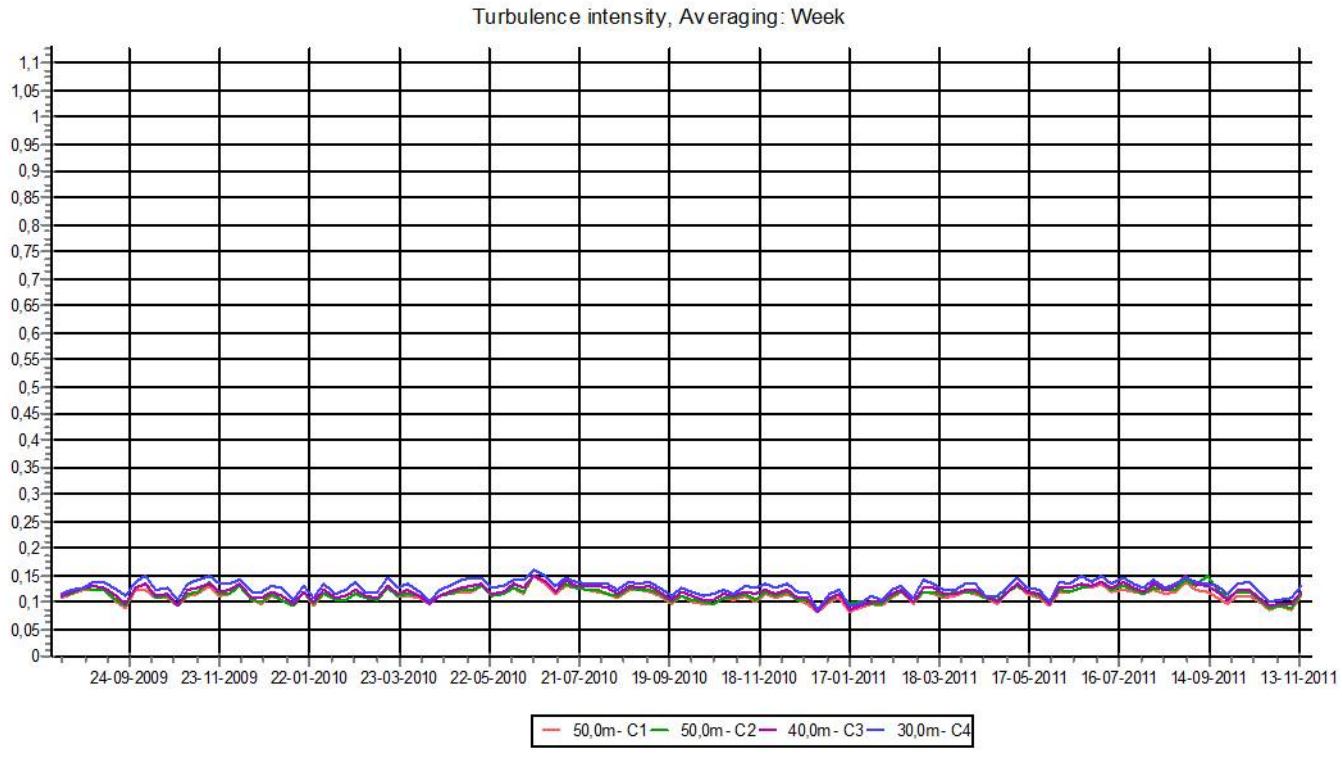
29-11-2011 12:33

Meteo data report - Time series graphs

Mast: Molinara; Molinara**Period:** Full period: 12-08-2009 - 14-11-2011 (27,1 months)





ANNEX 3 Production reports from the WindPRO programme

Project: **San Marco**

Description: PRELIMINARY

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PARK - Main Result

Calculation: WWD 3MW 80m HH with ex wtgs

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1,098 kg/m³ to 1,129 kg/m³
Air density relative to standard	91,5 %
Hub altitude above sea level (asl)	751,3 m to 1.039,3 m
Annual mean temperature at hub alt.	11,1 °C to 13,0 °C
Pressure at WTGs	895,5 hPa to 927,0 hPa

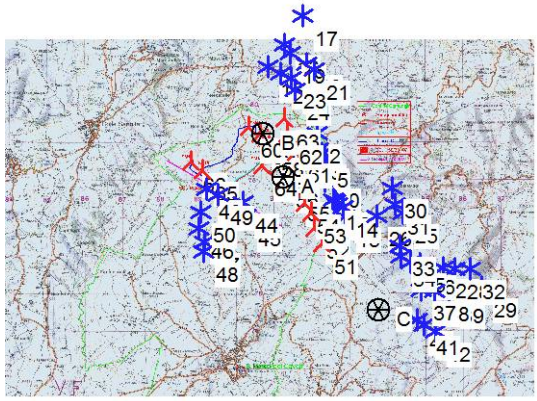
Wake Model Parameters

Wake Decay Constant 0,075 Open farmland

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0,5	360,0	1,0	0,5	30,5	1,0

WAsP version WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13



Scale 1:200.000

New WTG Existing WTG Site Data

Key results for height 50,0 m above ground level

Terrain UTM ED50 Zone: 33

	East	North	Name of wind distribution	Type	Wind energy	Mean wind speed	Equivalent roughness
					[kWh/m²]	[m/s]	
A	491.230	4.578.093	SM1	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.906	6,9	0,5
B	490.693	4.579.239	SM2	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.117	6,1	0,9
C	493.741	4.574.577	Molinara	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.145	6,0	0,5

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK	Result-10,0%	GROSS (no loss)|Free WTGs	Park efficiency	Specific results¤) Capacity factor	Mean WTG result	Full load hours	Mean wind speed|@hub height
	[MWh/y]	[MWh]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]
Wind farm	331.937,4	298.743,6	357.281,5	92,9	24,0	4.526,4	2.104	7,0
New WTGs only	105.519,3	94.967,4	114.089,0	92,5	22,6	5.935,5	1.978	7,0
Existing park WTGs only	226.418,1	203.776,3	243.192,5	93,1	24,7	4.075,5	2.168	7,0
Existing park WTGs without new WTGs	229.533,1	206.579,8	243.192,5	94,4		4.131,6		0,0
Reduction for existing park WTGs caused by new	3.115,0	2.803,5						

¤) *Based on Result-10,0%*

Calculated Annual Energy for each of 16 new WTGs with total 48,0 MW rated power

	WTG type							Power curve		Annual Energy		Park	
Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10,0%	Efficiency	Mean wind speed
				[kW]	[m]	[m]			[MWh]	[MWh]	[%]	[m/s]
51 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	7.629,8	6.867	96,4	7,32
52 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	7.611,6	6.850	95,2	7,36
53 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	7.991,1	7.192	95,4	7,55
54 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	8.097,9	7.288	95,7	7,59
55 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	7.295,4	6.566	94,7	7,24
56 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	7.645,6	6.881	92,6	7,48
57 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	6.479,7	5.832	90,7	6,98
58 B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.472,0	4.925	87,9	6,62
59 B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.910,0	5.319	91,7	6,71
60 B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.295,0	4.765	93,8	6,34
61 A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	6.977,3	6.280	91,0	7,21
62 B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.470,9	4.924	84,6	6,74
63 B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.958,3	5.363	87,6	6,89

To be continued on next page...

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Calculated:
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PARK - Main Result

Calculation: WWD 3MW 80m HH with ex wtgs

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	Terrain	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Result [MWh]	Result-10,0% [MWh]	Park Efficiency [%]	Mean wind speed [m/s]
64	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.670,5	5.103	87,1	6,71
65	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	6.227,8	5.605	95,5	6,72
66	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	80,0	EMD	Level 0 - calculated - 0 - 11-2009	5.786,5	5.208	97,3	6,44

Calculated Annual Energy for each of 50 existing park WTGs with total 94,0 MW rated power

	Terrain	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Calculated prod. without new WTGs [MWh]	After New WTGs [MWh]	Decrease due to new WTGs [MWh %]	Park Efficiency [%]
1	A	No	VESTAS	V42-600	600	42,0	40,0	EMD	Manufacturer 24-08-00 1.225 25.00 0.00	1.533,8	1.471,7	62,1 4,1	94,0
2	B	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.123,5	1.085,9	37,6 3,3	92,5
3	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.587,6	1.530,0	57,6 3,6	93,9
4	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.611,7	1.559,1	52,6 3,3	94,0
5	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.612,3	1.565,5	46,8 2,9	93,3
6	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.569,1	1.523,2	45,9 2,9	90,5
7	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.453,8	1.416,6	37,2 2,6	86,9
8	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.508,3	1.467,2	41,1 2,7	85,9
9	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.528,8	1.471,8	56,9 3,7	87,0
10	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.519,6	1.464,0	55,7 3,7	89,7
11	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.511,2	1.444,6	66,6 4,4	89,1
12	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.574,2	1.510,7	63,4 4,0	93,2
13	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.503,4	1.441,5	61,9 4,1	92,5
14	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.452,3	1.410,9	41,4 2,9	94,8
15	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.437,3	1.393,1	44,2 3,1	94,0
16	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.180,1	7.065,6	114,4 1,6	94,8
17	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.407,9	6.392,0	15,9 0,2	96,6
18	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.010,0	5.966,5	43,5 0,7	92,8
19	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.781,4	5.731,9	49,5 0,9	90,3
20	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.498,6	6.416,8	81,8 1,3	92,7
21	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.130,4	6.028,6	101,8 1,7	94,3
22	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.076,3	6.928,6	147,7 2,1	90,2
23	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.855,4	6.713,8	141,6 2,1	88,0
24	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.014,3	6.810,3	204,0 2,9	87,3
25	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.237,6	5.201,4	36,2 0,7	96,9
26	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.730,1	4.664,3	65,8 1,4	94,2
27	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.687,9	4.686,3	1,6 0,0	93,8
28	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.837,1	4.835,6	1,5 0,0	92,9
29	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.075,1	5.074,3	0,8 0,0	97,0
30	A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	8.511,9	8.444,9	67,0 0,8	96,8
31	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.306,7	6.252,0	54,7 0,9	93,3
32	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.228,2	6.226,3	1,9 0,0	94,3
33	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.453,9	4.439,2	14,7 0,3	96,4
34	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.711,4	4.700,7	10,7 0,2	94,9
35	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.664,4	4.661,6	2,8 0,1	97,1
36	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.899,0	4.896,8	2,3 0,0	96,5
37	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.703,0	6.698,1	4,9 0,1	95,0
38	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.663,9	6.660,8	3,1 0,0	92,1
39	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.110,3	7.108,8	1,5 0,0	92,4
40	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.676,5	6.671,9	4,5 0,1	94,2
41	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.410,7	6.409,5	1,2 0,0	93,6
42	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.033,0	6.032,3	0,7 0,0	95,5
43	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.480,2	5.267,9	212,3 3,9	92,9
44	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.380,9	5.163,2	217,6 4,0	91,7
45	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.495,9	5.301,4	194,5 3,5	92,2
46	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.593,9	5.500,6	93,2 1,7	92,4
47	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.572,6	5.492,6	79,9 1,4	92,1
48	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.688,5	5.619,9	68,6 1,2	92,6
49	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.347,8	5.176,0	171,8 3,2	91,7
50	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.551,4	5.421,5	129,9 2,3	90,7

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Calculated:
29-11-2011 11:29/2.7.486

PARK - Main Result

Calculation: WWD 3MW 80m HH with ex wtgs

WTG siting

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
1	Exist	492.557	4.577.491	953,4	VESTAS V42 600 42.0 !O! hub: 40,0 m (51)
2	Exist	492.125	4.579.251	940,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (52)
3	Exist	492.160	4.578.831	962,6	VESTAS V44 600 44.0 !O! hub: 40,0 m (53)
4	Exist	492.248	4.578.713	974,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (54)
5	Exist	492.330	4.578.613	984,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (55)
6	Exist	492.349	4.578.519	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (56)
7	Exist	492.360	4.578.416	992,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (57)
8	Exist	492.312	4.578.293	999,3	VESTAS V44 600 44.0 !O! hub: 40,0 m (58)
9	Exist	492.294	4.578.186	995,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (59)
10	Exist	492.323	4.578.075	991,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (60)
11	Exist	492.335	4.577.994	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (61)
12	Exist	492.614	4.577.441	950,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (62)
13	Exist	492.648	4.577.364	936,8	VESTAS V44 600 44.0 !O! hub: 40,0 m (63)
14	Exist	492.809	4.577.287	920,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (64)
15	Exist	492.854	4.577.048	913,2	VESTAS V44 600 44.0 !O! hub: 40,0 m (65)
16	Exist	490.819	4.581.018	847,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (66)
17	Exist	491.740	4.582.376	819,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (67)
18	Exist	491.277	4.581.598	830,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (68)
19	Exist	491.419	4.581.367	838,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (69)
20	Exist	491.852	4.581.105	869,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (70)
21	Exist	492.064	4.580.937	849,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (71)
22	Exist	491.170	4.580.839	870,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (72)
23	Exist	491.444	4.580.723	894,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (73)
24	Exist	491.553	4.580.415	916,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (74)
25	Exist	494.397	4.577.141	860,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (75)
26	Exist	493.702	4.577.067	881,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (76)
27	Exist	495.455	4.575.687	849,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (77)
28	Exist	495.757	4.575.656	862,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (78)
29	Exist	496.471	4.575.175	864,8	VESTAS V90 1800 90.0 !O! hub: 80,0 m (79)
30	Exist	494.103	4.577.807	905,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (80)
31	Exist	494.189	4.577.359	890,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (81)
32	Exist	496.171	4.575.648	865,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (82)
33	Exist	494.303	4.576.268	826,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (83)
34	Exist	494.337	4.575.979	844,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (84)
35	Exist	494.591	4.575.842	835,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (85)
36	Exist	494.857	4.575.787	857,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (86)
37	Exist	494.879	4.575.096	918,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (87)
38	Exist	495.228	4.575.079	921,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (88)
39	Exist	495.613	4.575.009	936,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (89)
40	Exist	494.768	4.574.308	905,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (90)
41	Exist	494.955	4.574.190	894,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (91)
42	Exist	495.243	4.573.991	867,4	VESTAS V90 3000 90.0 !O! hub: 90,0 m (92)
43	Exist	489.205	4.577.783	730,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (93)
44	Exist	490.159	4.577.428	770,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (94)
45	Exist	490.247	4.577.061	766,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (95)
46	Exist	488.981	4.576.750	745,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (96)
47	Exist	489.134	4.576.400	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (97)
48	Exist	489.121	4.576.131	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (98)
49	Exist	489.494	4.577.635	745,9	VESTAS V90 2000 90.0 !O! hub: 80,0 m (99)
50	Exist	489.054	4.577.188	740,1	VESTAS V90 2000 90.0 !O! hub: 80,0 m (100)
51	New	492.264	4.576.339	848,8	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (65)
52	New	492.050	4.576.747	869,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (66)
53	New	491.982	4.577.148	907,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (67)
54	New	491.785	4.577.393	910,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (68)
55	New	491.540	4.577.732	877,5	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (69)
56	New	491.245	4.578.091	867,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (70)
57	New	491.099	4.578.379	825,0	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (71)
58	New	490.850	4.578.910	818,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (72)
59	New	490.613	4.579.227	799,0	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (73)
60	New	490.325	4.579.428	752,1	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (74)

To be continued on next page...

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PARK - Main Result

Calculation: WWD 3MW 80m HH with ex wtgs

...continued from previous page

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
61	New	491.563	4.578.750	873,8	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (75)
62	New	491.344	4.579.235	873,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (76)
63	New	491.267	4.579.652	877,4	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (77)
64	New	490.664	4.578.404	792,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (78)
65	New	489.086	4.578.279	707,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (79)
66	New	488.795	4.578.503	671,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 80,0 m (80)

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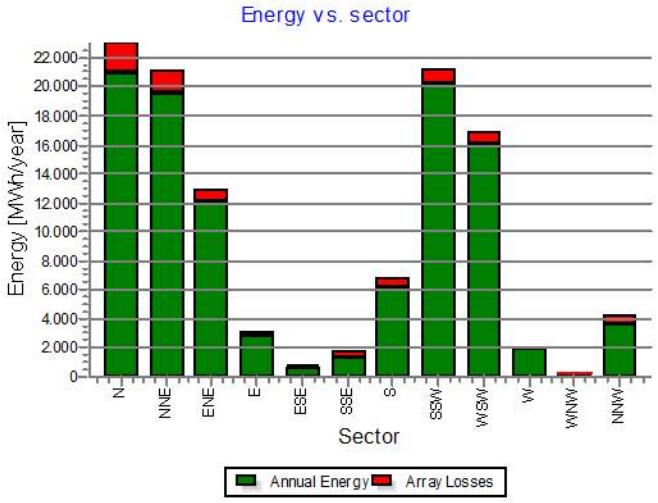
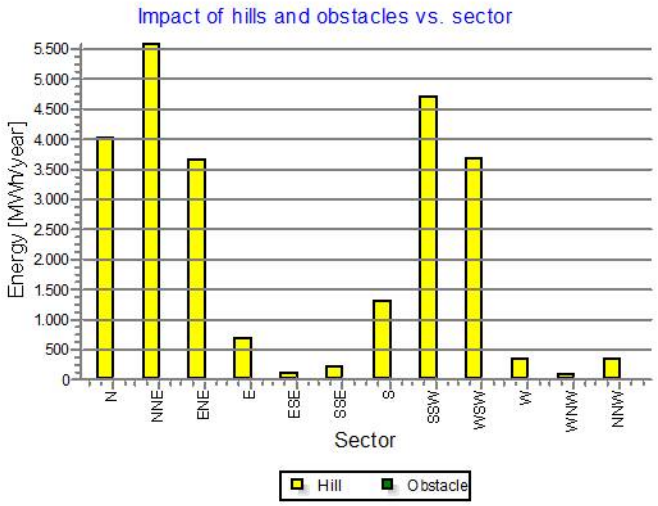
PARK - Production Analysis

Calculation: WWD 3MW 80m HH with ex wtgs **WTG:** All new WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,129 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	18.990,4	15.478,0	9.240,3	2.422,6	694,6	1.566,5	5.504,3	16.546,1	13.215,4	1.709,6	182,2	3.844,5	89.394,4
+Increase due to hills	[MWh]	4.013,9	5.578,7	3.644,6	688,1	111,3	206,7	1.323,6	4.692,9	3.662,2	333,7	102,9	336,0	24.694,5
-Decrease due to array losses	[MWh]	2.068,9	1.576,9	847,5	300,4	118,2	461,4	699,2	1.018,3	800,4	136,2	21,0	521,2	8.569,7
Resulting energy	**[MWh]**	**20.935,4**	**19.479,8**	**12.037,4**	**2.810,4**	**687,7**	**1.311,7**	**6.128,7**	**20.220,6**	**16.077,2**	**1.907,1**	**264,1**	**3.659,2**	**105.519,3**
Specific energy	[kWh/m²]													1.037
Specific energy	[kWh/kW]													2.198
Increase due to hills	[%]	21,1	36,0	39,4	28,4	16,0	13,2	24,0	28,4	27,7	19,5	56,5	8,7	27,62
Decrease due to array losses	[%]	9,0	7,5	6,6	9,7	14,7	26,0	10,2	4,8	4,7	6,7	7,4	12,5	7,51
Utilization	[%]	35,9	36,8	38,7	39,3	37,1	32,1	37,5	34,7	30,4	28,3	34,0	33,6	35,0
Operational	[Hours/year]	1.594	1.246	779	256	118	307	822	1.302	805	148	62	312	7.751
Full Load Equivalent	[Hours/year]	436	406	251	59	14	27	128	421	335	40	6	76	2.198





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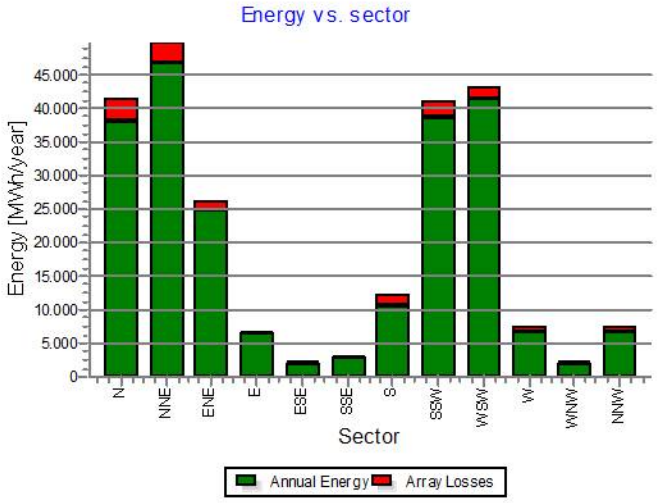
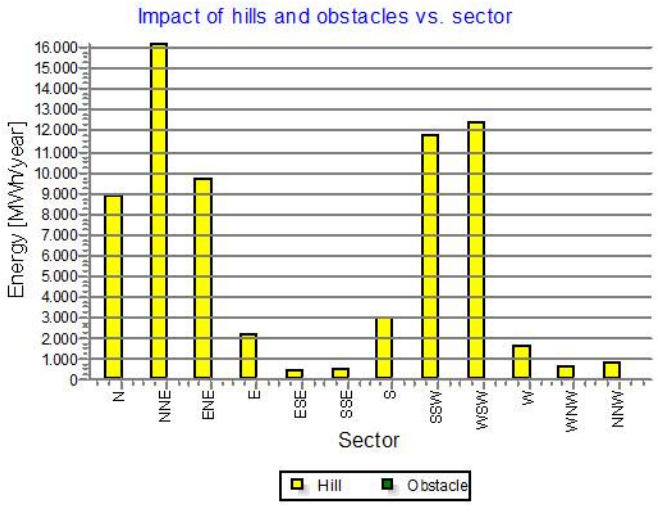
PARK - Production Analysis

Calculation: WWD 3MW 80m HH with ex wtgs **WTG:** All existing WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,129 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	32.480,1	33.508,8	16.289,3	4.616,0	1.938,9	2.560,0	9.208,5	29.474,4	30.707,3	5.890,8	1.661,9	6.683,2	175.019,5
+Increase due to hills	[MWh]	8.843,2	16.209,4	9.697,5	2.150,0	419,4	559,5	2.973,2	11.768,4	12.450,8	1.644,3	617,0	840,5	68.173,1
-Decrease due to array losses	[MWh]	3.324,0	3.009,8	1.249,8	511,3	333,2	445,6	1.661,4	2.707,8	1.639,6	774,2	367,8	750,0	16.774,4
Resulting energy	**[MWh]**	**37.999,4**	**46.708,4**	**24.737,0**	**6.254,7**	**2.025,1**	**2.673,9**	**10.520,4**	**38.535,0**	**41.518,5**	**6.761,0**	**1.911,0**	**6.773,7**	**226.417,9**
Specific energy	[kWh/m²]													923
Specific energy	[kWh/kW]													2.409
Increase due to hills	[%]	27,2	48,4	59,5	46,6	21,6	21,9	32,3	39,9	40,5	27,9	37,1	12,6	38,95
Decrease due to array losses	[%]	8,0	6,1	4,8	7,6	14,1	14,3	13,6	6,6	3,8	10,3	16,1	10,0	6,90
Utilization	[%]	31,5	32,4	34,5	35,4	34,1	33,9	31,5	29,0	27,0	26,4	29,0	31,1	30,5
Operational	[Hours/year]	1.049	1.245	792	251	135	225	597	1.211	1.193	297	134	242	7.370
Full Load Equivalent	[Hours/year]	404	497	263	67	22	28	112	410	442	72	20	72	2.409





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PARK - Park power curve

Calculation: WWD 3MW 80m HH with ex wtgs

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,5	1.027	618	536	620	670	599	518	433	589	673	672	640	558	465
4,5	6.670	5.502	5.188	5.639	5.847	5.468	4.909	4.876	5.173	5.609	5.796	5.454	4.928	4.841
5,5	13.746	11.830	11.308	12.030	12.339	11.761	10.909	10.799	11.307	12.021	12.291	11.759	10.910	10.776
6,5	23.657	20.626	19.737	20.955	21.445	20.560	19.204	18.932	19.741	20.931	21.358	20.536	19.209	18.894
7,5	36.952	32.444	31.109	32.941	33.683	32.372	30.344	29.851	31.080	32.901	33.559	32.343	30.318	29.809
8,5	53.708	47.593	45.779	48.280	49.320	47.538	44.676	43.976	45.743	48.200	49.144	47.472	44.635	43.910
9,5	72.950	65.641	63.516	66.488	67.762	65.616	62.034	61.103	63.446	66.336	67.547	65.494	61.894	61.026
10,5	92.913	85.295	83.187	86.217	87.534	85.306	81.316	80.160	83.152	86.008	87.275	85.124	81.145	80.090
11,5	111.309	104.459	102.671	105.176	106.450	104.648	100.684	99.204	102.941	105.119	106.211	104.612	100.928	99.271
12,5	125.446	120.537	119.392	121.034	122.065	121.087	117.641	116.035	119.654	120.978	121.812	120.932	117.974	116.277
13,5	135.505	132.504	131.847	132.830	133.503	133.002	130.534	129.890	131.915	132.731	133.312	132.756	130.695	129.972
14,5	140.777	139.614	139.312	139.786	140.026	139.781	138.593	138.666	139.336	139.738	139.947	139.659	138.640	138.680
15,5	142.611	142.339	142.230	142.406	142.456	142.380	142.032	142.119	142.226	142.374	142.424	142.331	142.035	142.105
16,5	143.027	142.972	142.934	142.991	143.001	142.986	142.919	142.927	142.932	142.980	142.991	142.972	142.914	142.920
17,5	143.106	143.093	143.081	143.099	143.101	143.098	143.086	143.082	143.082	143.095	143.097	143.093	143.084	143.080
18,5	143.120	143.119	143.114	143.119	143.120	143.120	143.119	143.115	143.114	143.119	143.120	143.120	143.118	143.115
19,5	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120	143.120
20,5	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720
21,5	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720
22,5	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720
23,5	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720
24,5	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720	134.720
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes array losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in WindPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in WindPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

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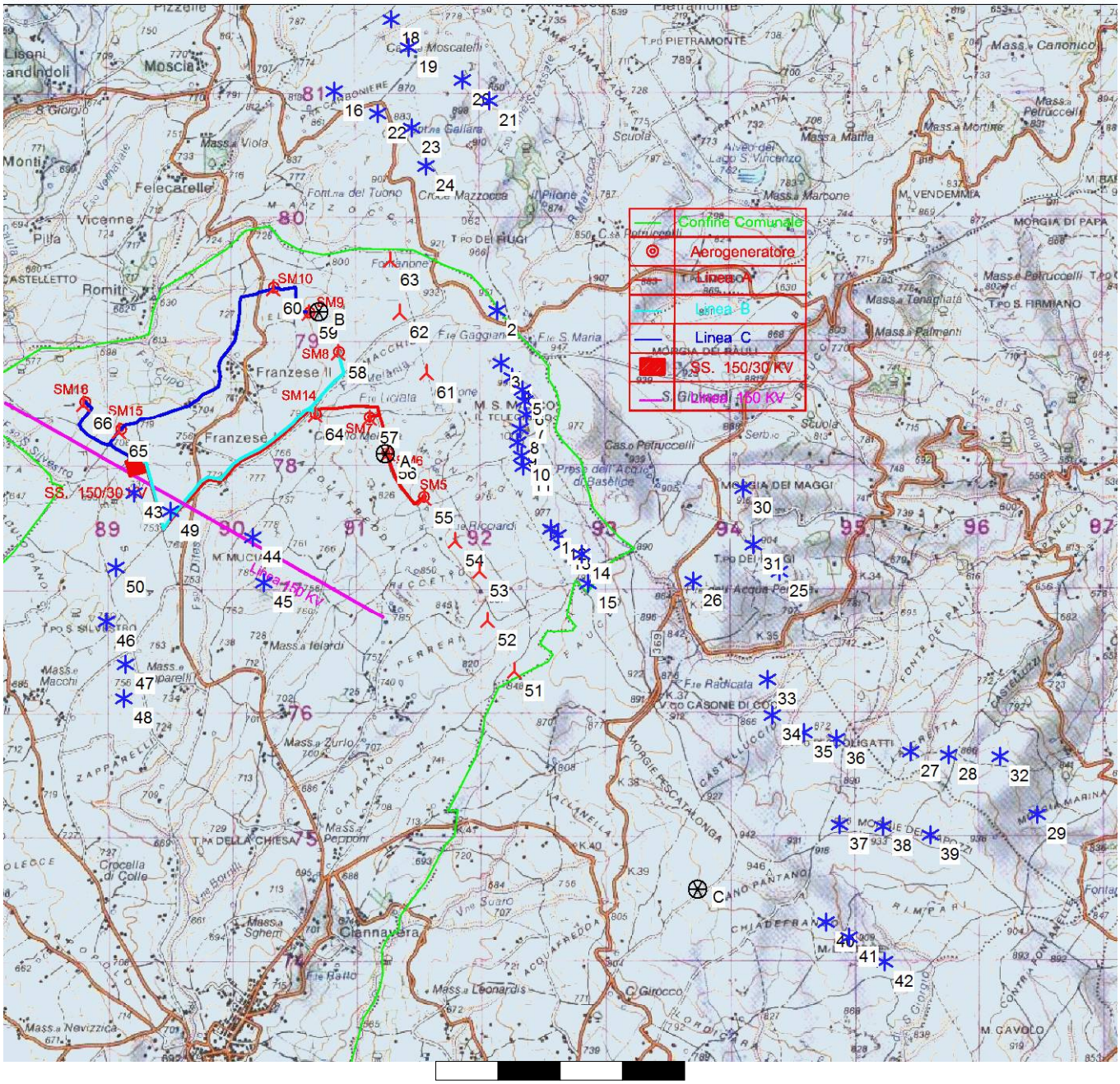
PARK - Map

Calculation: WWD 3MW 80m HH with ex wtgs



Map: Corografia , Print scale 1:50.000, Map center UTM ED50 Zone: 33 East: 492.705 North: 4.578.293

New WTG Existing WTG Site Data

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PARK - Main Result

Calculation: WWD 3MW 88m HH without ex wtgs

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1,102 kg/m³ to 1,128 kg/m³
Air density relative to standard	92,1 %
Hub altitude above sea level (asl)	759,3 m to 998,3 m
Annual mean temperature at hub alt.	11,4 °C to 12,9 °C
Pressure at WTGs	900,0 hPa to 926,1 hPa

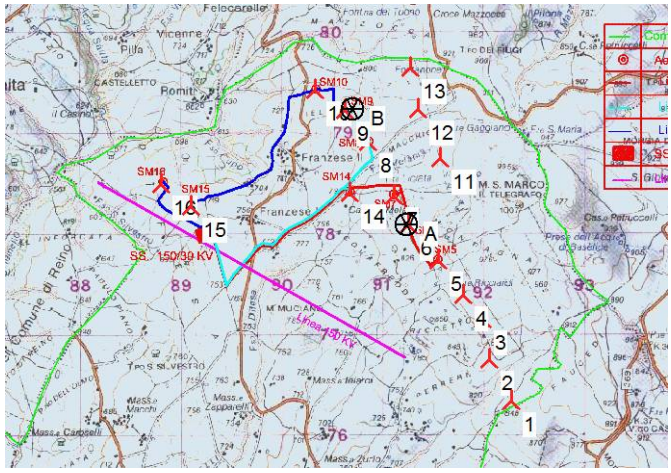
Wake Model Parameters

Wake Decay Constant	0,075 Open farmland

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0,5	360,0	1,0	0,5	30,5	1,0

WAsP version WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13



Key results for height 50,0 m above ground level

Terrain **UTM ED50 Zone: 33**

	East	North	Name of wind distribution	Type	Wind energy [kWh/m²]	Mean wind speed [m/s]	Equivalent roughness
A	491.230	4.578.093	SM1	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.894	6,8	0,5
B	490.693	4.579.239	SM2	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.104	6,1	0,9

Calculated Annual Energy for Wind Farm

					Specific results¤)			
WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	113.553,6	102.198,2	118.142,2	96,1	24,3	6.387,4	2.129	7,1

¤) Based on Result-10,0%

Calculated Annual Energy for each of 16 new WTGs with total 48,0 MW rated power

	Terrain	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Result [MWh]	Result-10,0% [MWh]	Park Efficiency [%]	Mean wind speed [m/s]
1	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	8.113,2	7.302	99,3	7,44
2	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	8.070,8	7.264	97,7	7,49
3	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	8.483,6	7.635	98,2	7,67
4	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	8.544,5	7.690	98,3	7,70
5	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	7.811,6	7.030	98,0	7,37
6	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	8.132,0	7.319	95,7	7,59
7	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	7.032,1	6.329	94,6	7,11
8	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	5.989,7	5.391	92,4	6,75
9	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.448,1	5.803	96,7	6,82
10	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	5.797,3	5.218	98,3	6,46
11	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	7.442,8	6.699	93,6	7,35
12	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.009,0	5.408	89,4	6,87
13	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.725,6	6.053	95,3	7,01
14	A	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.205,5	5.585	91,3	6,85
15	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.648,9	5.984	98,7	6,82
16	B	Yes	WINWIND	WWD-3-D90-3.000	3.000	90,0	88,0	EMD	Level 0 - calculated - 0 - 11-2009	6.098,7	5.489	99,0	6,55

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PARK - Main Result

Calculation: WWD 3MW 88m HH without ex wtgs

WTG siting

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
1	New	492.264	4.576.339	848,8	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (81)
2	New	492.050	4.576.747	869,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (82)
3	New	491.982	4.577.148	907,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (83)
4	New	491.785	4.577.393	910,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (84)
5	New	491.540	4.577.732	877,5	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (85)
6	New	491.245	4.578.091	867,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (86)
7	New	491.099	4.578.379	825,0	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (87)
8	New	490.850	4.578.910	818,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (88)
9	New	490.613	4.579.227	799,0	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (89)
10	New	490.325	4.579.428	752,1	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (90)
11	New	491.563	4.578.750	873,8	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (91)
12	New	491.344	4.579.235	873,6	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (92)
13	New	491.267	4.579.652	877,4	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (93)
14	New	490.664	4.578.404	792,7	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (94)
15	New	489.086	4.578.279	707,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (95)
16	New	488.795	4.578.503	671,3	WINWIND WWD-3-D90 3000 90.0 !-! hub: 88,0 m (96)

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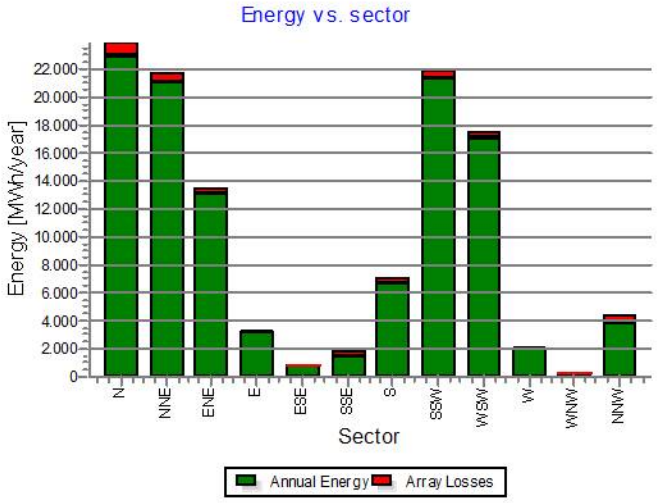
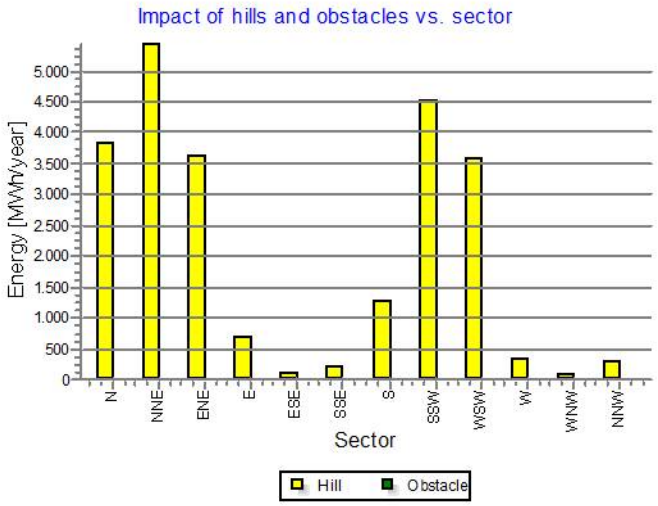
PARK - Production Analysis

Calculation: WWD 3MW 88m HH without ex wtgs **WTG:** All new WTGs, Air density varies with WTG position 1,102 kg/m³ - 1,128 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	19.970,0	16.289,1	9.830,8	2.585,0	743,6	1.667,4	5.813,5	17.324,8	13.806,5	1.783,5	192,4	4.046,2	94.052,8
+Increase due to hills	[MWh]	3.839,6	5.442,2	3.633,1	701,0	112,1	198,9	1.277,4	4.539,1	3.590,1	332,7	105,7	317,6	24.089,3
-Decrease due to array losses	[MWh]	957,6	678,7	407,1	124,5	62,6	395,3	477,2	536,6	338,6	75,4	19,6	515,4	4.588,6
Resulting energy	**[MWh]**	**22.852,0**	**21.052,7**	**13.056,7**	**3.161,5**	**793,2**	**1.471,0**	**6.613,7**	**21.327,2**	**17.058,0**	**2.040,9**	**278,5**	**3.848,3**	**113.553,6**
Specific energy	[kWh/m²]													1.116
Specific energy	[kWh/kW]													2.366
Increase due to hills	[%]	19,2	33,4	37,0	27,1	15,1	11,9	22,0	26,2	26,0	18,7	54,9	7,8	25,61
Decrease due to array losses	[%]	4,0	3,1	3,0	3,8	7,3	21,2	6,7	2,5	1,9	3,6	6,6	11,8	3,88
Utilization	[%]	37,7	38,3	39,9	41,7	40,2	34,2	38,9	35,3	31,0	29,1	34,2	33,7	36,2
Operational	[Hours/year]	1.608	1.251	786	259	120	310	827	1.309	813	149	62	315	7.810
Full Load Equivalent	[Hours/year]	476	439	272	66	17	31	138	444	355	43	6	80	2.366





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PARK - Wind Data Analysis

Calculation: WWD 3MW 88m HH without ex wtgs **Wind data:** A - SM1; Hub height: 50,0

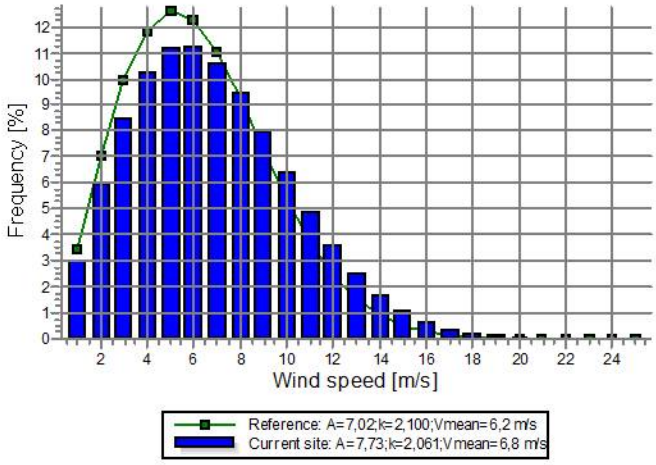
Site Coordinates
UTM ED50 Zone: 33 East: 491.230 North: 4.578.093

Wind statistics
IT San Marco 2398 & 9484 (Wind Index MCP using NCAR_BASIC_N40.0_E15.0).wws

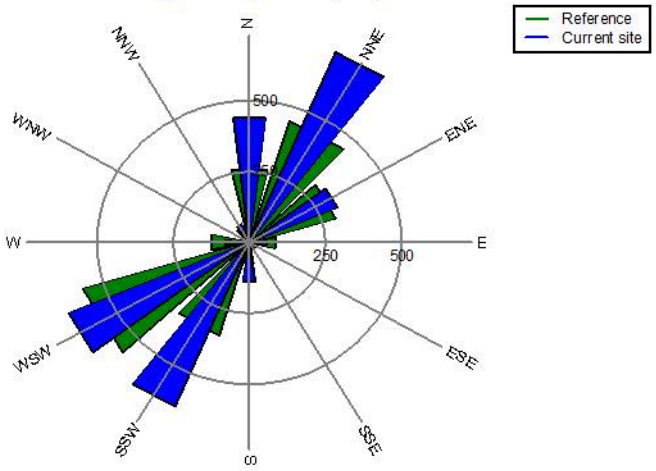
Weibull Data

	Current site				Reference: Roughness class 1		
Sector	A-parameter [m/s]	Wind speed [m/s]	k-parameter	Frequency [%]	A-parameter [m/s]	k-parameter	Frequency [%]
0 N	8,89	7,87	2,307	10,3	7,79	2,351	9,0
1 NNE	8,79	7,81	2,607	18,9	7,76	2,651	17,1
2 ENE	7,95	7,08	2,830	11,4	7,53	2,861	12,9
3 E	6,72	5,99	2,869	3,7	6,96	2,891	4,9
4 ESE	5,35	4,74	2,146	1,7	5,58	2,281	2,0
5 SSE	5,05	4,48	1,893	3,0	4,65	1,910	2,9
6 S	5,48	4,88	1,775	10,2	4,68	1,830	8,9
7 SSW	7,52	6,67	1,975	20,7	6,41	2,001	18,4
8 WSW	8,69	7,69	2,084	14,4	8,05	2,111	16,4
9 W	6,77	6,07	1,584	2,6	7,28	1,761	4,1
10 WNW	3,56	3,37	1,174	0,9	3,97	1,190	1,1
11 NNW	7,13	6,35	1,783	2,4	6,70	1,851	2,3
All	7,73	6,85	2,061	100,0	7,02	2,100	100,0

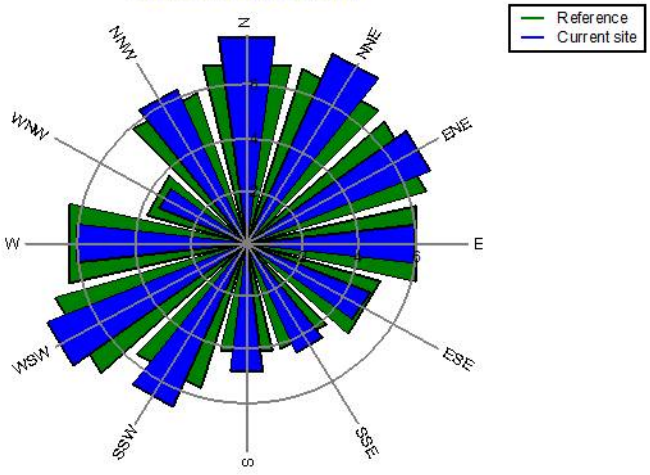
Weibull Distribution



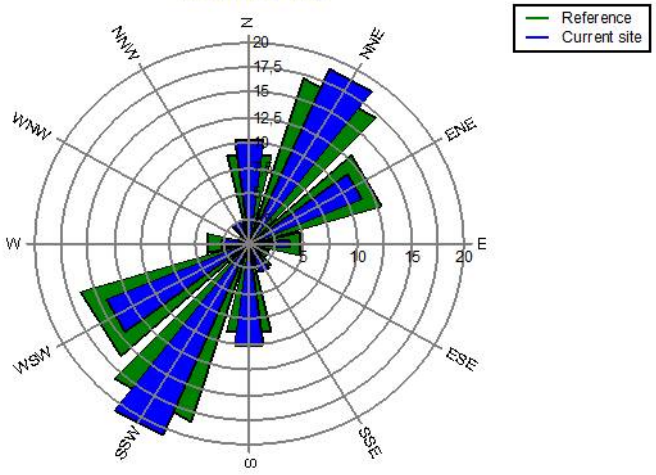
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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PARK - Wind Data Analysis

Calculation: WWD 3MW 88m HH without ex wtgs **Wind data:** B - SM2; Hub height: 50,0

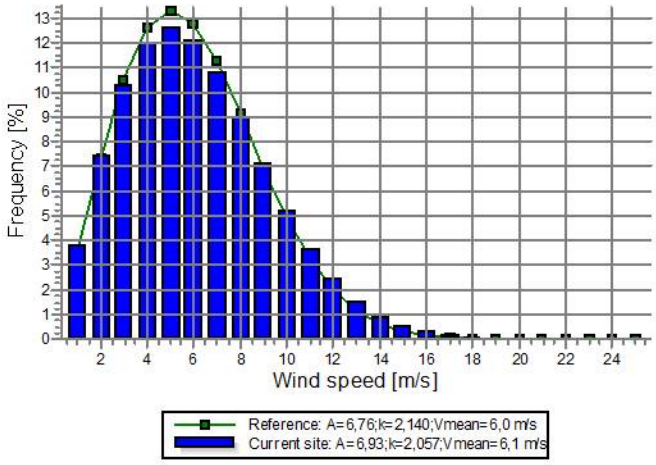
Site Coordinates
UTM ED50 Zone: 33 East: 490.693 North: 4.579.239

Wind statistics
IT San Marco 4210 (Wind Index MCP using NCAR_BASIC_N40.0_E15.0).wws

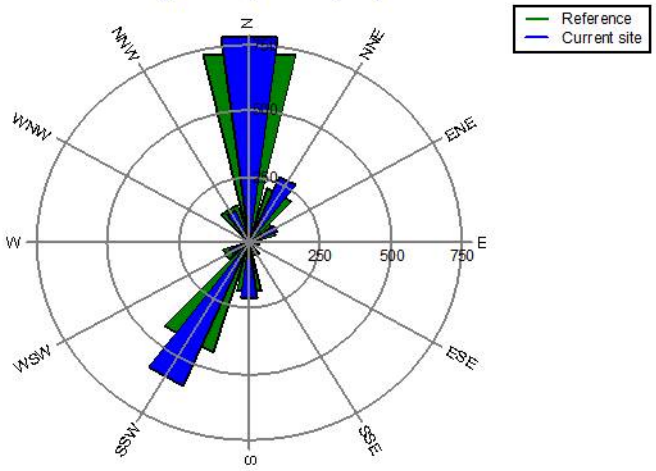
Weibull Data

	Current site				Reference: Roughness class 1		
Sector	A-parameter [m/s]	Wind speed [m/s]	k-parameter	Frequency [%]	A-parameter [m/s]	k-parameter	Frequency [%]
0 N	6,93	6,14	2,107	35,3	6,85	2,171	35,0
1 NNE	6,95	6,17	2,549	14,1	6,55	2,581	13,4
2 ENE	6,84	6,09	2,783	6,2	6,56	2,871	6,5
3 E	6,15	5,46	2,541	2,3	6,35	2,661	2,7
4 ESE	5,18	4,59	2,014	1,1	5,64	2,121	1,3
5 SSE	5,12	4,54	2,025	5,2	5,33	2,091	5,3
6 S	6,21	5,51	1,967	12,6	6,03	2,001	12,3
7 SSW	8,78	7,78	2,232	13,7	8,19	2,282	12,9
8 WSW	7,47	6,64	1,834	2,3	7,54	2,012	3,1
9 W	3,87	3,70	1,139	0,6	4,86	1,321	0,8
10 WNW	2,50	2,47	1,033	0,5	2,58	1,021	0,5
11 NNW	6,78	6,01	2,014	6,0	7,09	2,062	6,0
All	6,93	6,14	2,057	100,0	6,76	2,140	100,0

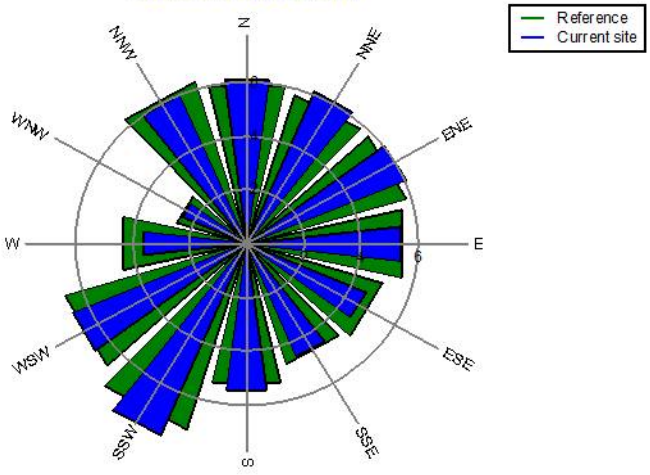
Weibull Distribution



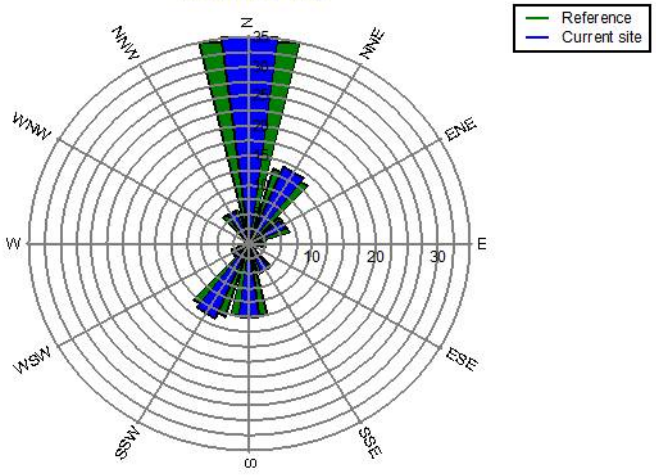
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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PARK - Park power curve

Calculation: WWD 3MW 88m HH without ex wtgs

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,5	588	482	452	505	480	475	439	290	462	503	481	479	428	304
4,5	2.188	1.996	1.946	2.051	2.011	1.997	1.902	1.530	1.958	2.049	2.012	2.002	1.888	1.547
5,5	4.290	3.980	3.898	4.066	3.999	3.976	3.830	3.250	3.918	4.065	4.002	3.986	3.808	3.278
6,5	7.212	6.717	6.588	6.856	6.744	6.709	6.477	5.561	6.620	6.853	6.749	6.724	6.440	5.609
7,5	11.170	10.423	10.234	10.631	10.466	10.413	10.060	8.668	10.283	10.628	10.472	10.435	10.004	8.740
8,5	16.213	15.168	14.912	15.461	15.238	15.167	14.660	12.676	14.979	15.455	15.246	15.197	14.585	12.777
9,5	22.208	20.846	20.522	21.231	20.948	20.856	20.182	17.557	20.605	21.223	20.961	20.897	20.092	17.695
10,5	28.952	27.318	26.946	27.779	27.462	27.348	26.520	23.313	27.039	27.774	27.478	27.391	26.441	23.441
11,5	36.431	34.731	34.383	35.221	34.935	34.816	33.933	30.283	34.478	35.218	34.943	34.843	33.878	30.321
12,5	42.622	41.356	41.171	41.745	41.567	41.473	40.850	37.564	41.229	41.744	41.575	41.494	40.808	37.625
13,5	46.602	45.965	45.900	46.166	46.093	46.051	45.749	43.977	45.915	46.168	46.094	46.048	45.740	43.915
14,5	48.506	48.307	48.294	48.364	48.342	48.333	48.258	47.731	48.296	48.363	48.343	48.334	48.254	47.692
15,5	49.055	49.031	49.031	49.039	49.036	49.036	49.029	48.954	49.031	49.039	49.037	49.036	49.027	48.941
16,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.115	49.120	49.120	49.120	49.120	49.120	49.113
17,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
18,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
19,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
20,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
21,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
22,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
23,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
24,5	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120	49.120
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes array losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in WindPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in WindPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

Project:
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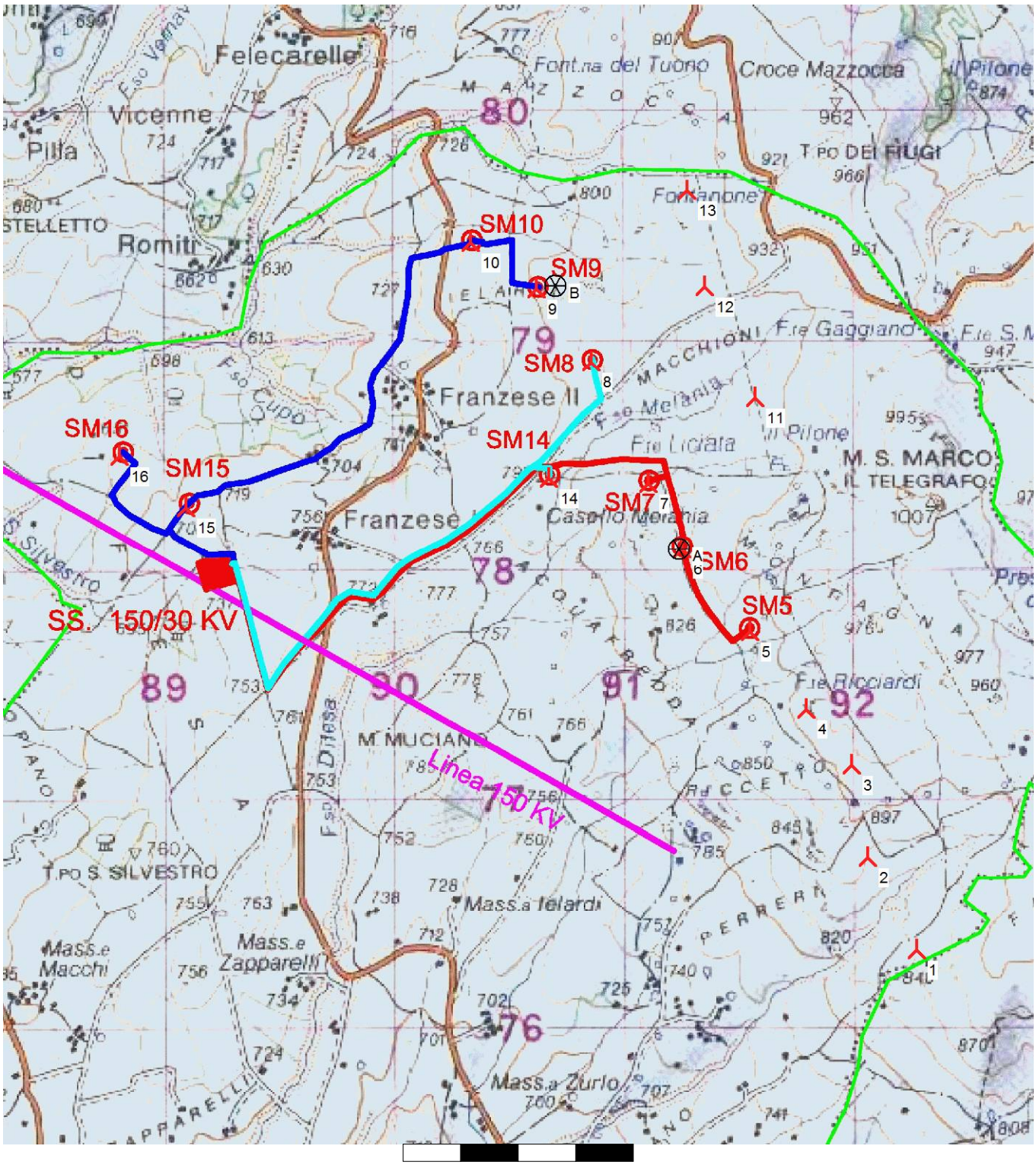
29-11-2011 10:59/2.7.486

PARK - Map

Calculation: WWD 3MW 88m HH without ex wtgs



Map: Corografia , Print scale 1:25.000, Map center UTM ED50 Zone: 33 East: 490.602 North: 4.578.105

New WTG Site Data

Project: **San Marco**

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PARK - Main Result

Calculation: V90 3MW 80m HH with ex wtgs

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1,098 kg/m³ to 1,129 kg/m³
Air density relative to standard	91,5 %
Hub altitude above sea level (asl)	751,3 m to 1.039,3 m
Annual mean temperature at hub alt.	11,1 °C to 13,0 °C
Pressure at WTGs	895,5 hPa to 927,0 hPa

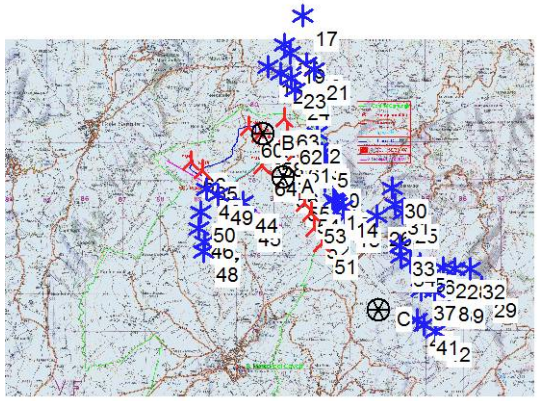
Wake Model Parameters

Wake Decay Constant 0,075 Open farmland

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0,5	360,0	1,0	0,5	30,5	1,0

WAsP version WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13



Scale 1:200.000

New WTG Existing WTG Site Data

Key results for height 50,0 m above ground level

Terrain UTM ED50 Zone: 33

	East	North	Name of wind distribution	Type	Wind energy [kWh/m²]	Mean wind speed [m/s]	Equivalent roughness
A	491.230	4.578.093	SM1	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.906	6,9	0,5
B	490.693	4.579.239	SM2	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.117	6,1	0,9
C	493.741	4.574.577	Molinara	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.145	6,0	0,5

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK	Result-10,0%	GROSS (no loss)|Free WTGs	Park efficiency	Specific results¤) Capacity factor	Mean WTG result	Full load hours	Mean wind speed|@hub height
	[MWh/y]	[MWh]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]
Wind farm	326.055,4	293.449,9	351.158,1	92,9	23,6	4.446,2	2.067	7,0
New WTGs only	99.718,3	89.746,5	107.965,6	92,4	21,3	5.609,2	1.870	7,0
Existing park WTGs only	226.337,2	203.703,4	243.192,5	93,1	24,7	4.074,1	2.167	7,0
Existing park WTGs without new WTGs	229.533,1	206.579,8	243.192,5	94,4		4.131,6		0,0
Reduction for existing park WTGs caused by new	3.195,9	2.876,3						

¤) *Based on Result-10,0%*

Calculated Annual Energy for each of 16 new WTGs with total 48,0 MW rated power

	WTG type						Power curve		Annual Energy		Park	
Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10,0%	Efficiency	Mean wind speed
				[kW]	[m]	[m]			[MWh]	[MWh]	[%]	[m/s]
51 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.226,9	6.504	96,3	7,32
52 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.207,7	6.487	95,1	7,36
53 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.572,4	6.815	95,3	7,55
54 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.674,8	6.907	95,6	7,59
55 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.904,8	6.214	94,6	7,24
56 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.239,6	6.516	92,5	7,48
57 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.121,5	5.509	90,6	6,98
58 B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.150,7	4.636	87,6	6,62
59 B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.576,9	5.019	91,5	6,71
60 B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	4.987,5	4.489	93,7	6,34
61 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.596,5	5.937	90,9	7,21
62 B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.150,0	4.635	84,3	6,74
63 B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.625,0	5.062	87,4	6,89
64 A	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.343,7	4.809	86,9	6,71

To be continued on next page...

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PARK - Main Result

Calculation: V90 3MW 80m HH with ex wtgs

...continued from previous page

	WTG type							Power curve		Annual Energy		Park	
	Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10,0%	Efficiency	Mean wind speed
					[kW]	[m]	[m]			[MWh]	[MWh]	[%]	[m/s]
65	B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.882,0	5.294	95,4	6,72
66	B	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.458,3	4.913	97,2	6,44

Calculated Annual Energy for each of 50 existing park WTGs with total 94,0 MW rated power

	WTG type							Power curve		Annual Energy			Park
	Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Calculated prod. without new WTGs	After New WTGs	Decrease due to new WTGs	Efficiency
					[kW]	[m]	[m]			[MWh]	[MWh]	[MWh %]	[%]
1	A	No	VESTAS	V42-600	600	42,0	40,0	EMD	Manufacturer 24-08-00 1.225 25.00 0.00	1.533,8	1.470,1	63,7 4,2	93,9
2	B	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.123,5	1.084,8	38,7 3,4	92,4
3	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.587,6	1.528,5	59,1 3,7	93,8
4	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.611,7	1.557,7	54,0 3,3	93,9
5	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.612,3	1.564,4	48,0 3,0	93,2
6	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.569,1	1.522,0	47,0 3,0	90,4
7	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.453,8	1.415,6	38,2 2,6	86,9
8	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.508,3	1.466,0	42,3 2,8	85,9
9	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.528,8	1.470,3	58,4 3,8	86,9
10	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.519,6	1.462,4	57,2 3,8	89,6
11	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.511,2	1.442,9	68,3 4,5	89,0
12	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.574,2	1.509,1	65,0 4,1	93,1
13	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.503,4	1.439,9	63,4 4,2	92,4
14	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.452,3	1.409,9	42,4 2,9	94,7
15	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.437,3	1.392,0	45,3 3,2	94,0
16	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.180,1	7.062,4	117,7 1,6	94,7
17	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.407,9	6.391,4	16,5 0,3	96,6
18	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.010,0	5.965,0	44,9 0,7	92,8
19	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.781,4	5.730,0	51,4 0,9	90,2
20	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.498,6	6.413,8	84,8 1,3	92,6
21	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.130,4	6.025,8	104,7 1,7	94,3
22	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.076,3	6.924,2	152,1 2,1	90,2
23	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.855,4	6.709,7	145,7 2,1	87,9
24	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.014,3	6.804,3	210,1 3,0	87,2
25	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.237,6	5.200,3	37,2 0,7	96,9
26	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.730,1	4.662,6	67,6 1,4	94,2
27	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.687,9	4.686,3	1,7 0,0	93,8
28	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.837,1	4.835,6	1,5 0,0	92,9
29	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.075,1	5.074,2	0,9 0,0	97,0
30	A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	8.511,9	8.442,6	69,2 0,8	96,8
31	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.306,7	6.250,4	56,4 0,9	93,3
32	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.228,2	6.226,2	2,0 0,0	94,3
33	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.453,9	4.438,5	15,4 0,3	96,3
34	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.711,4	4.700,1	11,2 0,2	94,9
35	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.664,4	4.661,5	2,9 0,1	97,1
36	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.899,0	4.896,7	2,3 0,0	96,5
37	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.703,0	6.698,0	5,1 0,1	95,0
38	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.663,9	6.660,7	3,3 0,0	92,1
39	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.110,3	7.108,7	1,6 0,0	92,4
40	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.676,5	6.671,8	4,7 0,1	94,2
41	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.410,7	6.409,4	1,3 0,0	93,6
42	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.033,0	6.032,2	0,8 0,0	95,5
43	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.480,2	5.263,8	216,4 3,9	92,8
44	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.380,9	5.157,8	223,1 4,1	91,6
45	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.495,9	5.297,2	198,7 3,6	92,2
46	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.593,9	5.498,9	95,0 1,7	92,4
47	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.572,6	5.490,9	81,6 1,5	92,1
48	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.688,5	5.618,5	70,0 1,2	92,6
49	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.347,8	5.172,5	175,3 3,3	91,6
50	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.551,4	5.419,5	132,0 2,4	90,7

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Calculated:
29-11-2011 11:33/2.7.486

PARK - Main Result

Calculation: V90 3MW 80m HH with ex wtgs

WTG siting

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
1	Exist	492.557	4.577.491	953,4	VESTAS V42 600 42.0 !O! hub: 40,0 m (51)
2	Exist	492.125	4.579.251	940,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (52)
3	Exist	492.160	4.578.831	962,6	VESTAS V44 600 44.0 !O! hub: 40,0 m (53)
4	Exist	492.248	4.578.713	974,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (54)
5	Exist	492.330	4.578.613	984,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (55)
6	Exist	492.349	4.578.519	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (56)
7	Exist	492.360	4.578.416	992,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (57)
8	Exist	492.312	4.578.293	999,3	VESTAS V44 600 44.0 !O! hub: 40,0 m (58)
9	Exist	492.294	4.578.186	995,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (59)
10	Exist	492.323	4.578.075	991,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (60)
11	Exist	492.335	4.577.994	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (61)
12	Exist	492.614	4.577.441	950,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (62)
13	Exist	492.648	4.577.364	936,8	VESTAS V44 600 44.0 !O! hub: 40,0 m (63)
14	Exist	492.809	4.577.287	920,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (64)
15	Exist	492.854	4.577.048	913,2	VESTAS V44 600 44.0 !O! hub: 40,0 m (65)
16	Exist	490.819	4.581.018	847,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (66)
17	Exist	491.740	4.582.376	819,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (67)
18	Exist	491.277	4.581.598	830,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (68)
19	Exist	491.419	4.581.367	838,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (69)
20	Exist	491.852	4.581.105	869,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (70)
21	Exist	492.064	4.580.937	849,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (71)
22	Exist	491.170	4.580.839	870,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (72)
23	Exist	491.444	4.580.723	894,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (73)
24	Exist	491.553	4.580.415	916,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (74)
25	Exist	494.397	4.577.141	860,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (75)
26	Exist	493.702	4.577.067	881,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (76)
27	Exist	495.455	4.575.687	849,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (77)
28	Exist	495.757	4.575.656	862,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (78)
29	Exist	496.471	4.575.175	864,8	VESTAS V90 1800 90.0 !O! hub: 80,0 m (79)
30	Exist	494.103	4.577.807	905,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (80)
31	Exist	494.189	4.577.359	890,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (81)
32	Exist	496.171	4.575.648	865,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (82)
33	Exist	494.303	4.576.268	826,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (83)
34	Exist	494.337	4.575.979	844,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (84)
35	Exist	494.591	4.575.842	835,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (85)
36	Exist	494.857	4.575.787	857,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (86)
37	Exist	494.879	4.575.096	918,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (87)
38	Exist	495.228	4.575.079	921,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (88)
39	Exist	495.613	4.575.009	936,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (89)
40	Exist	494.768	4.574.308	905,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (90)
41	Exist	494.955	4.574.190	894,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (91)
42	Exist	495.243	4.573.991	867,4	VESTAS V90 3000 90.0 !O! hub: 90,0 m (92)
43	Exist	489.205	4.577.783	730,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (93)
44	Exist	490.159	4.577.428	770,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (94)
45	Exist	490.247	4.577.061	766,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (95)
46	Exist	488.981	4.576.750	745,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (96)
47	Exist	489.134	4.576.400	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (97)
48	Exist	489.121	4.576.131	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (98)
49	Exist	489.494	4.577.635	745,9	VESTAS V90 2000 90.0 !O! hub: 80,0 m (99)
50	Exist	489.054	4.577.188	740,1	VESTAS V90 2000 90.0 !O! hub: 80,0 m (100)
51	New	492.264	4.576.339	848,8	VESTAS V90 3000 90.0 !O! hub: 80,0 m (49)
52	New	492.050	4.576.747	869,6	VESTAS V90 3000 90.0 !O! hub: 80,0 m (50)
53	New	491.982	4.577.148	907,6	VESTAS V90 3000 90.0 !O! hub: 80,0 m (51)
54	New	491.785	4.577.393	910,3	VESTAS V90 3000 90.0 !O! hub: 80,0 m (52)
55	New	491.540	4.577.732	877,5	VESTAS V90 3000 90.0 !O! hub: 80,0 m (53)
56	New	491.245	4.578.091	867,7	VESTAS V90 3000 90.0 !O! hub: 80,0 m (54)
57	New	491.099	4.578.379	825,0	VESTAS V90 3000 90.0 !O! hub: 80,0 m (55)
58	New	490.850	4.578.910	818,7	VESTAS V90 3000 90.0 !O! hub: 80,0 m (56)
59	New	490.613	4.579.227	799,0	VESTAS V90 3000 90.0 !O! hub: 80,0 m (57)
60	New	490.325	4.579.428	752,1	VESTAS V90 3000 90.0 !O! hub: 80,0 m (58)

To be continued on next page...

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PARK - Main Result

Calculation: V90 3MW 80m HH with ex wtgs

...continued from previous page

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
61	New	491.563	4.578.750	873,8	VESTAS V90 3000 90.0 !O! hub: 80,0 m (59)
62	New	491.344	4.579.235	873,6	VESTAS V90 3000 90.0 !O! hub: 80,0 m (60)
63	New	491.267	4.579.652	877,4	VESTAS V90 3000 90.0 !O! hub: 80,0 m (61)
64	New	490.664	4.578.404	792,7	VESTAS V90 3000 90.0 !O! hub: 80,0 m (62)
65	New	489.086	4.578.279	707,3	VESTAS V90 3000 90.0 !O! hub: 80,0 m (63)
66	New	488.795	4.578.503	671,3	VESTAS V90 3000 90.0 !O! hub: 80,0 m (64)

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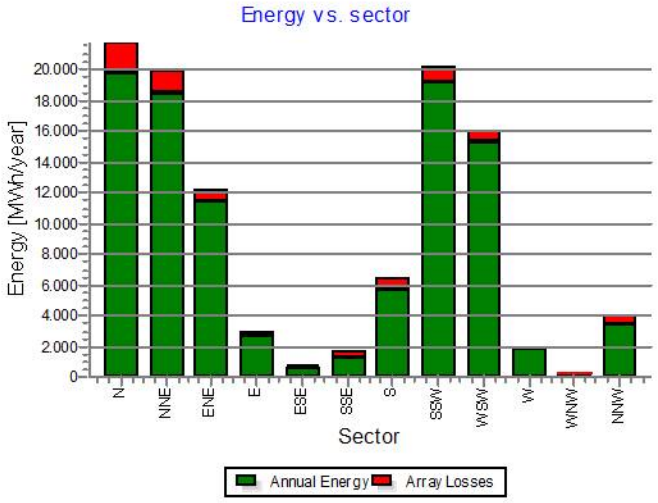
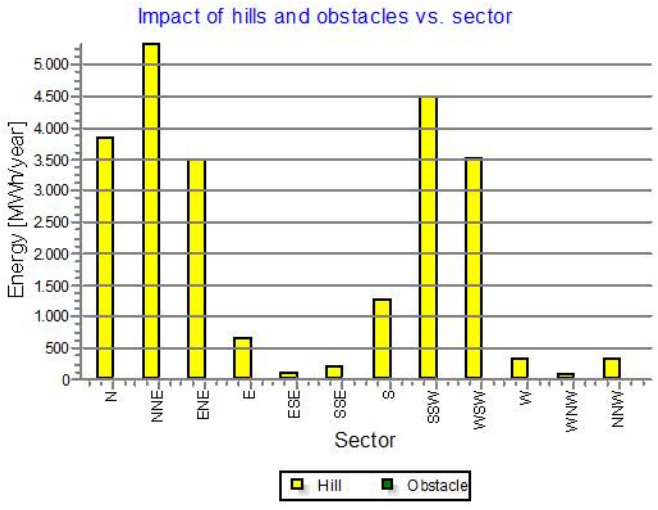
PARK - Production Analysis

Calculation: V90 3MW 80m HH with ex wtgs**WTG:** All new WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,129 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	17.905,2	14.613,8	8.727,4	2.278,3	643,5	1.444,2	5.126,7	15.619,0	12.522,2	1.615,6	167,3	3.627,3	84.290,3
+Increase due to hills	[MWh]	3.845,5	5.336,9	3.481,7	659,6	107,0	198,4	1.268,3	4.504,6	3.530,8	321,8	98,1	322,6	23.675,3
-Decrease due to array losses	[MWh]	1.983,3	1.512,8	815,9	290,9	114,0	449,1	672,5	978,0	769,9	131,1	20,1	509,7	8.247,3
Resulting energy	**[MWh]**	**19.767,4**	**18.438,0**	**11.393,2**	**2.647,1**	**636,5**	**1.193,4**	**5.722,5**	**19.145,5**	**15.283,0**	**1.806,2**	**245,3**	**3.440,1**	**99.718,3**
Specific energy	[kWh/m²]													980
Specific energy	[kWh/kW]													2.077
Increase due to hills	[%]	21,5	36,5	39,9	29,0	16,6	13,7	24,7	28,8	28,2	19,9	58,7	8,9	28,09
Decrease due to array losses	[%]	9,1	7,6	6,7	9,9	15,2	27,3	10,5	4,9	4,8	6,8	7,6	12,9	7,64
Utilization	[%]	33,9	34,9	36,6	37,0	34,3	29,2	35,0	32,9	28,9	26,8	31,6	31,6	33,1
Operational	[Hours/year]	1.594	1.246	779	256	118	307	822	1.302	805	148	62	312	7.751
Full Load Equivalent	[Hours/year]	412	384	237	55	13	25	119	399	318	38	5	72	2.077





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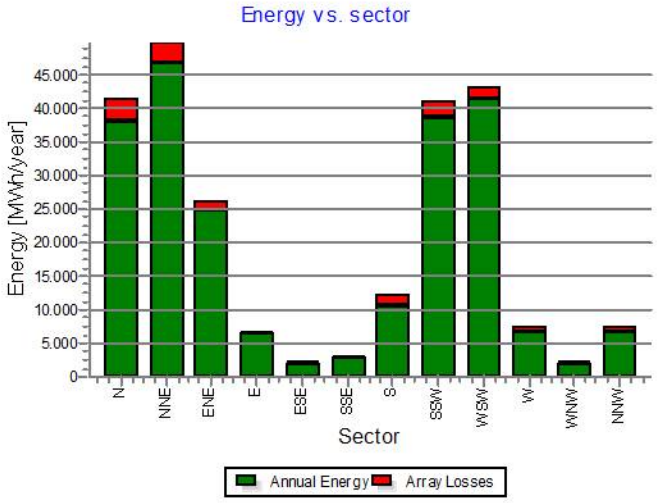
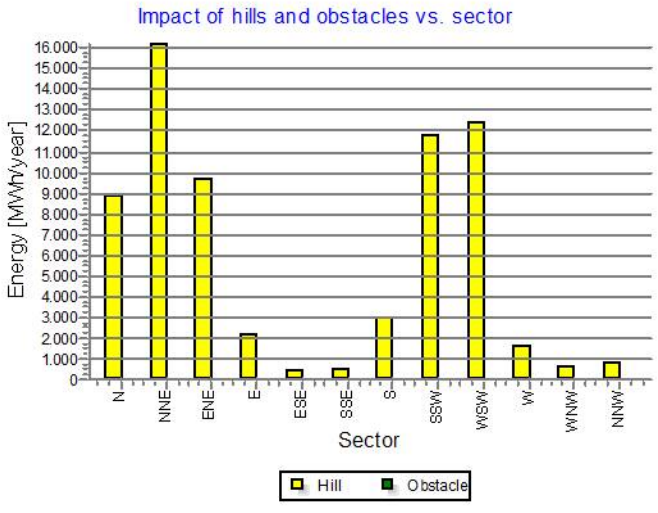
PARK - Production Analysis

Calculation: V90 3MW 80m HH with ex wtgs**WTG:** All existing WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,129 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	32.480,1	33.508,8	16.289,3	4.616,0	1.938,9	2.560,0	9.208,5	29.474,4	30.707,3	5.890,8	1.661,9	6.683,2	175.019,5
+Increase due to hills	[MWh]	8.843,2	16.209,4	9.697,5	2.150,0	419,4	559,5	2.973,2	11.768,4	12.450,8	1.644,3	617,0	840,5	68.173,1
-Decrease due to array losses	[MWh]	3.326,1	3.019,3	1.258,3	514,3	333,5	446,0	1.673,3	2.730,3	1.653,9	778,7	370,3	751,3	16.855,4
Resulting energy	**[MWh]**	**37.997,2**	**46.698,9**	**24.728,5**	**6.251,7**	**2.024,8**	**2.673,4**	**10.508,5**	**38.512,5**	**41.504,2**	**6.756,5**	**1.908,6**	**6.772,4**	**226.336,9**
Specific energy	[kWh/m²]													923
Specific energy	[kWh/kW]													2.408
Increase due to hills	[%]	27,2	48,4	59,5	46,6	21,6	21,9	32,3	39,9	40,5	27,9	37,1	12,6	38,95
Decrease due to array losses	[%]	8,0	6,1	4,8	7,6	14,1	14,3	13,7	6,6	3,8	10,3	16,2	10,0	6,93
Utilization	[%]	31,5	32,4	34,5	35,4	34,1	33,9	31,5	29,0	27,0	26,4	28,9	31,1	30,5
Operational	[Hours/year]	1.049	1.245	792	251	135	225	597	1.211	1.193	297	134	242	7.370
Full Load Equivalent	[Hours/year]	404	497	263	67	22	28	112	410	442	72	20	72	2.408





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PARK - Park power curve

Calculation: V90 3MW 80m HH with ex wtgs

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,5	570	279	246	271	288	232	202	231	247	312	326	279	203	215
4,5	6.363	5.157	4.842	5.304	5.504	5.130	4.569	4.473	4.810	5.269	5.465	5.115	4.550	4.442
5,5	13.351	11.422	10.908	11.629	11.930	11.357	10.514	10.370	10.891	11.606	11.883	11.341	10.480	10.328
6,5	23.176	20.146	19.268	20.483	20.964	20.086	18.743	18.447	19.254	20.443	20.878	20.047	18.706	18.397
7,5	36.371	31.855	30.533	32.361	33.087	31.788	29.776	29.271	30.478	32.300	32.965	31.739	29.697	29.210
8,5	53.068	46.904	45.101	47.605	48.624	46.853	44.004	43.287	45.034	47.498	48.450	46.764	43.901	43.194
9,5	72.255	64.965	62.836	65.808	67.112	64.951	61.356	60.422	62.774	65.652	66.880	64.820	61.238	60.317
10,5	91.824	84.529	82.447	85.409	86.776	84.553	80.609	79.504	82.449	85.239	86.520	84.386	80.488	79.428
11,5	108.857	102.547	100.948	103.274	104.454	102.735	99.007	97.836	101.010	103.090	104.219	102.612	99.017	97.862
12,5	122.428	117.572	116.506	118.134	119.068	118.128	114.741	113.525	116.550	117.879	118.750	117.854	114.865	113.702
13,5	133.116	129.700	128.993	130.111	130.783	130.249	127.619	126.613	129.002	129.925	130.528	129.959	127.735	126.765
14,5	139.074	137.632	137.317	137.888	138.152	137.871	136.544	135.999	137.309	137.791	138.025	137.709	136.577	136.019
15,5	141.300	140.927	140.811	141.024	141.086	140.998	140.599	140.457	140.806	140.983	141.037	140.930	140.604	140.417
16,5	141.873	141.797	141.757	141.821	141.834	141.817	141.741	141.704	141.756	141.809	141.820	141.797	141.734	141.690
17,5	141.986	141.972	141.960	141.978	141.981	141.977	141.965	141.956	141.960	141.973	141.975	141.970	141.961	141.952
18,5	142.000	141.998	141.994	141.999	142.000	142.000	141.999	141.995	141.994	141.999	142.000	141.999	141.998	141.995
19,5	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000
20,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
21,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
22,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
23,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
24,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes array losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in WindPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in WindPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

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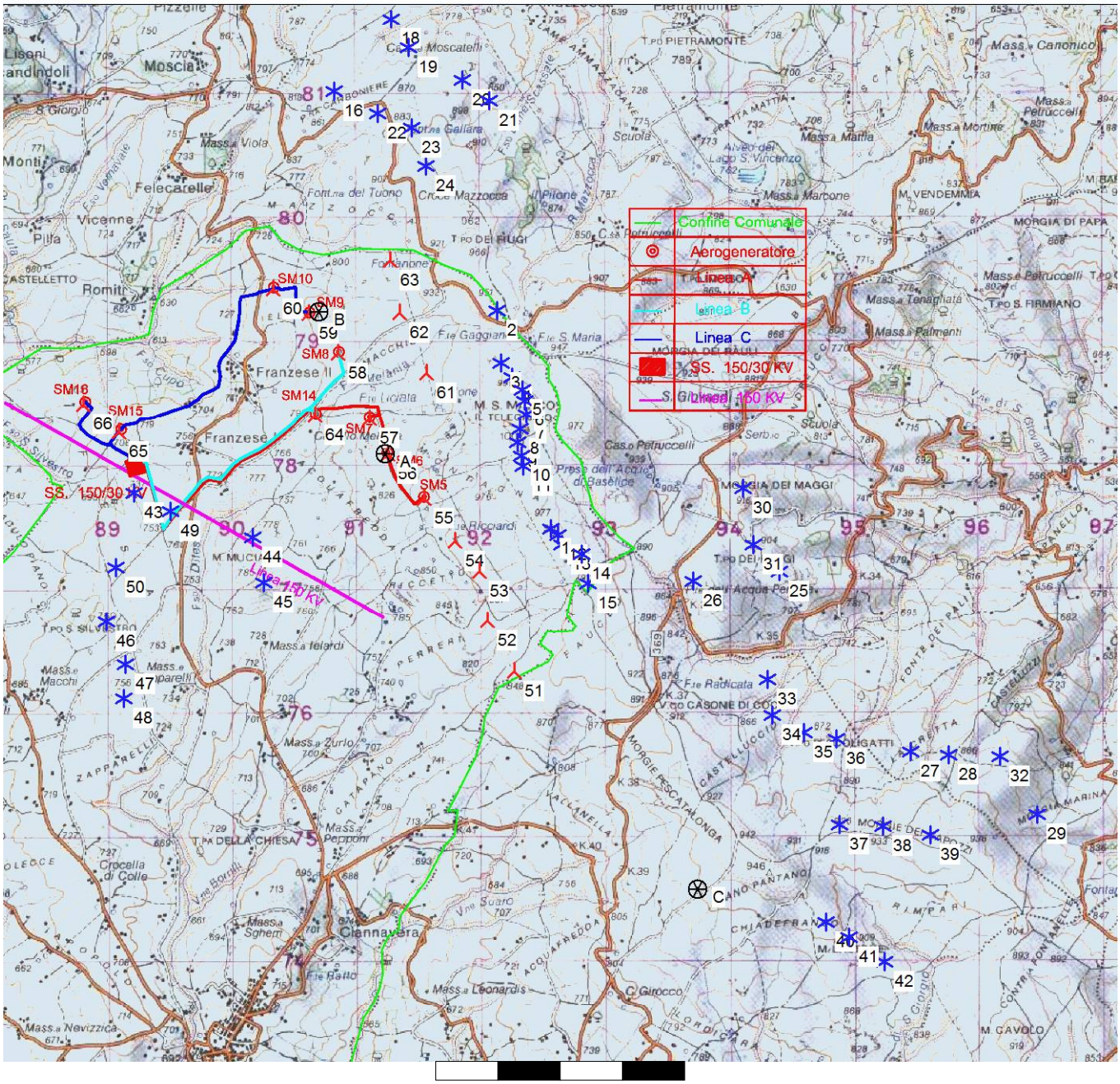
PARK - Map

Calculation: V90 3MW 80m HH with ex wtgs



Map: Corografia , Print scale 1:50.000, Map center UTM ED50 Zone: 33 East: 492.705 North: 4.578.293

New WTG Existing WTG Site Data

Project: **San Marco**

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PARK - Main Result

Calculation: V90 3MW 90m HH with ex wtgs

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1,098 kg/m³ to 1,128 kg/m³
Air density relative to standard	91,5 %
Hub altitude above sea level (asl)	761,3 m to 1.039,3 m
Annual mean temperature at hub alt.	11,1 °C to 12,9 °C
Pressure at WTGs	895,5 hPa to 925,9 hPa

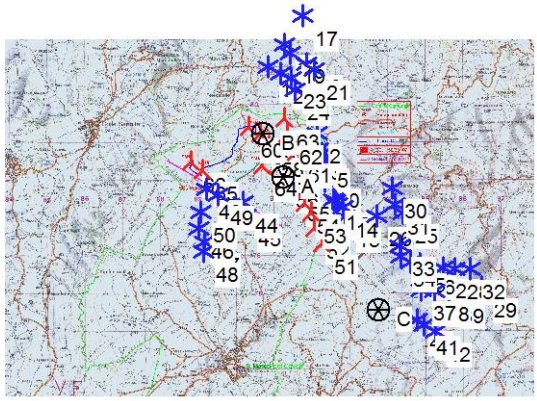
Wake Model Parameters

Wake Decay Constant 0,075 Open farmland

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0,5	360,0	1,0	0,5	30,5	1,0

WAsP version WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13



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New WTG Existing WTG Site Data

Key results for height 50,0 m above ground level

Terrain UTM ED50 Zone: 33

	East	North	Name of wind distribution	Type	Wind energy	Mean wind speed	Equivalent roughness
					[kWh/m²]	[m/s]	
A	491.230	4.578.093	SM1	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.906	6,9	0,5
B	490.693	4.579.239	SM2	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.117	6,1	0,9
C	493.741	4.574.577	Molinara	WAsP (WAsP 6-9 for Windows RVEA0011 1, 0, 0, 13)	2.145	6,0	0,5

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK	Result-10,0%	GROSS (no loss)|Free WTGs	Park efficiency	Specific results¤) Capacity factor	Mean WTG result	Full load hours	Mean wind speed|@hub height
	[MWh/y]	[MWh]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]
Wind farm	331.468,3	298.321,5	356.467,2	93,0	24,0	4.520,0	2.101	7,1
New WTGs only	104.966,2	94.469,6	113.274,7	92,7	22,5	5.904,3	1.968	7,2
Existing park WTGs only	226.502,1	203.851,9	243.192,5	93,1	24,7	4.077,0	2.169	7,0
Existing park WTGs without new WTGs	229.533,1	206.579,8	243.192,5	94,4		4.131,6		0,0
Reduction for existing park WTGs caused by new	3.030,9	2.727,8						

¤) *Based on Result-10,0%*

Calculated Annual Energy for each of 16 new WTGs with total 48,0 MW rated power

	WTG type						Power curve		Annual Energy		Park	
Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10,0%	Efficiency	Mean wind speed
				[kW]	[m]	[m]			[MWh]	[MWh]	[%]	[m/s]
51 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.581,9	6.824	96,6	7,49
52 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.551,8	6.797	95,3	7,53
53 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.920,3	7.128	95,5	7,72
54 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.991,6	7.192	95,8	7,74
55 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.277,3	6.550	95,0	7,42
56 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.552,0	6.797	92,8	7,63
57 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.486,2	5.838	91,0	7,16
58 B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.473,6	4.926	88,1	6,79
59 B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.870,8	5.284	91,9	6,86
60 B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.308,2	4.777	94,0	6,51
61 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.954,1	6.259	91,2	7,39
62 B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.464,8	4.918	84,8	6,91
63 B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.928,5	5.336	87,8	7,05
64 A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.686,4	5.118	87,3	6,89

To be continued on next page...

Project:
San Marco

Description:
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Calculated:
29-11-2011 11:36/2.7.486

PARK - Main Result

Calculation: V90 3MW 90m HH with ex wtgs

...continued from previous page

	WTG type							Power curve		Annual Energy		Park	
	Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10,0%	Efficiency	Mean wind speed
					[kW]	[m]	[m]			[MWh]	[MWh]	[%]	[m/s]
65	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.177,3	5.560	95,6	6,87
66	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.741,4	5.167	97,3	6,59

Calculated Annual Energy for each of 50 existing park WTGs with total 94,0 MW rated power

	WTG type							Power curve		Annual Energy			Park
	Terrain	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Calculated prod. without new WTGs	After New WTGs	Decrease due to new WTGs	Efficiency
					[kW]	[m]	[m]			[MWh]	[MWh]	[MWh %]	[%]
1	A	No	VESTAS	V42-600	600	42,0	40,0	EMD	Manufacturer 24-08-00 1.225 25.00 0.00	1.533,8	1.478,7	55,1 3,6	94,5
2	B	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.123,5	1.088,9	34,5 3,1	92,7
3	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.587,6	1.534,3	53,3 3,4	94,1
4	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.611,7	1.562,7	49,0 3,0	94,2
5	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.612,3	1.568,8	43,5 2,7	93,5
6	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.569,1	1.526,2	42,9 2,7	90,6
7	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.453,8	1.418,9	34,9 2,4	87,1
8	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.508,3	1.470,2	38,1 2,5	86,1
9	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.528,8	1.476,2	52,6 3,4	87,2
10	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.519,6	1.469,2	50,5 3,3	90,0
11	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.511,2	1.450,7	60,5 4,0	89,5
12	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.574,2	1.517,4	56,7 3,6	93,6
13	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.503,4	1.447,9	55,5 3,7	92,9
14	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.452,3	1.413,9	38,4 2,6	95,0
15	A	No	VESTAS	V44-600	600	44,0	40,0	EMD	Manufactor 24/8-2000 1.225 20.00 0.00	1.437,3	1.396,9	40,3 2,8	94,3
16	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.180,1	7.066,7	113,4 1,6	94,8
17	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.407,9	6.391,6	16,3 0,3	96,6
18	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.010,0	5.965,3	44,7 0,7	92,8
19	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	5.781,4	5.731,7	49,7 0,9	90,3
20	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.498,6	6.417,0	81,6 1,3	92,7
21	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.130,4	6.029,2	101,2 1,7	94,3
22	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.076,3	6.929,9	146,4 2,1	90,2
23	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.855,4	6.715,0	140,4 2,0	88,0
24	B	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.014,3	6.807,5	206,8 2,9	87,2
25	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.237,6	5.200,3	37,3 0,7	96,9
26	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.730,1	4.666,2	64,0 1,4	94,3
27	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.687,9	4.686,3	1,6 0,0	93,8
28	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.837,1	4.835,6	1,5 0,0	92,9
29	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.075,1	5.074,2	0,8 0,0	97,0
30	A	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	8.511,9	8.442,9	68,9 0,8	96,8
31	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.306,7	6.253,6	53,1 0,8	93,4
32	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.228,2	6.226,2	2,0 0,0	94,3
33	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.453,9	4.439,0	14,9 0,3	96,4
34	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.711,4	4.700,7	10,7 0,2	94,9
35	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.664,4	4.661,5	3,0 0,1	97,1
36	C	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	4.899,0	4.896,7	2,3 0,0	96,5
37	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.703,0	6.698,0	5,0 0,1	95,0
38	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.663,9	6.660,7	3,3 0,0	92,1
39	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	7.110,3	7.108,7	1,6 0,0	92,4
40	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.676,5	6.671,8	4,7 0,1	94,2
41	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.410,7	6.409,5	1,3 0,0	93,6
42	C	Yes	VESTAS	V90-3.000	3.000	90,0	90,0	EMD	Level 0 - Estimated - 107.0 dB(A) - 06-2009	6.033,0	6.032,2	0,8 0,0	95,5
43	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.480,2	5.272,9	207,3 3,8	92,9
44	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.380,9	5.166,4	214,5 4,0	91,7
45	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.495,9	5.306,2	189,7 3,5	92,3
46	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.593,9	5.501,6	92,3 1,6	92,4
47	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.572,6	5.491,9	80,7 1,4	92,1
48	A	Yes	VESTAS	V90-1.800	1.800	90,0	80,0	EMD	Level 0 - Mode 0 - 07-2009	5.688,5	5.619,2	69,3 1,2	92,6
49	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.347,8	5.182,6	165,2 3,1	91,8
50	A	Yes	VESTAS	V90-2.000	2.000	90,0	80,0	EMD	Level 0 - - Mode 0 - 07-2009	5.551,4	5.422,5	128,9 2,3	90,7

Project:
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Description:
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Calculated:
29-11-2011 11:36/2.7.486

PARK - Main Result

Calculation: V90 3MW 90m HH with ex wtgs

WTG siting

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
1	Exist	492.557	4.577.491	953,4	VESTAS V42 600 42.0 !O! hub: 40,0 m (51)
2	Exist	492.125	4.579.251	940,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (52)
3	Exist	492.160	4.578.831	962,6	VESTAS V44 600 44.0 !O! hub: 40,0 m (53)
4	Exist	492.248	4.578.713	974,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (54)
5	Exist	492.330	4.578.613	984,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (55)
6	Exist	492.349	4.578.519	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (56)
7	Exist	492.360	4.578.416	992,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (57)
8	Exist	492.312	4.578.293	999,3	VESTAS V44 600 44.0 !O! hub: 40,0 m (58)
9	Exist	492.294	4.578.186	995,5	VESTAS V44 600 44.0 !O! hub: 40,0 m (59)
10	Exist	492.323	4.578.075	991,1	VESTAS V44 600 44.0 !O! hub: 40,0 m (60)
11	Exist	492.335	4.577.994	990,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (61)
12	Exist	492.614	4.577.441	950,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (62)
13	Exist	492.648	4.577.364	936,8	VESTAS V44 600 44.0 !O! hub: 40,0 m (63)
14	Exist	492.809	4.577.287	920,0	VESTAS V44 600 44.0 !O! hub: 40,0 m (64)
15	Exist	492.854	4.577.048	913,2	VESTAS V44 600 44.0 !O! hub: 40,0 m (65)
16	Exist	490.819	4.581.018	847,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (66)
17	Exist	491.740	4.582.376	819,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (67)
18	Exist	491.277	4.581.598	830,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (68)
19	Exist	491.419	4.581.367	838,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (69)
20	Exist	491.852	4.581.105	869,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (70)
21	Exist	492.064	4.580.937	849,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (71)
22	Exist	491.170	4.580.839	870,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (72)
23	Exist	491.444	4.580.723	894,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (73)
24	Exist	491.553	4.580.415	916,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (74)
25	Exist	494.397	4.577.141	860,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (75)
26	Exist	493.702	4.577.067	881,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (76)
27	Exist	495.455	4.575.687	849,1	VESTAS V90 1800 90.0 !O! hub: 80,0 m (77)
28	Exist	495.757	4.575.656	862,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (78)
29	Exist	496.471	4.575.175	864,8	VESTAS V90 1800 90.0 !O! hub: 80,0 m (79)
30	Exist	494.103	4.577.807	905,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (80)
31	Exist	494.189	4.577.359	890,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (81)
32	Exist	496.171	4.575.648	865,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (82)
33	Exist	494.303	4.576.268	826,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (83)
34	Exist	494.337	4.575.979	844,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (84)
35	Exist	494.591	4.575.842	835,2	VESTAS V90 1800 90.0 !O! hub: 80,0 m (85)
36	Exist	494.857	4.575.787	857,5	VESTAS V90 1800 90.0 !O! hub: 80,0 m (86)
37	Exist	494.879	4.575.096	918,9	VESTAS V90 3000 90.0 !O! hub: 90,0 m (87)
38	Exist	495.228	4.575.079	921,2	VESTAS V90 3000 90.0 !O! hub: 90,0 m (88)
39	Exist	495.613	4.575.009	936,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (89)
40	Exist	494.768	4.574.308	905,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (90)
41	Exist	494.955	4.574.190	894,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (91)
42	Exist	495.243	4.573.991	867,4	VESTAS V90 3000 90.0 !O! hub: 90,0 m (92)
43	Exist	489.205	4.577.783	730,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (93)
44	Exist	490.159	4.577.428	770,4	VESTAS V90 1800 90.0 !O! hub: 80,0 m (94)
45	Exist	490.247	4.577.061	766,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (95)
46	Exist	488.981	4.576.750	745,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (96)
47	Exist	489.134	4.576.400	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (97)
48	Exist	489.121	4.576.131	750,0	VESTAS V90 1800 90.0 !O! hub: 80,0 m (98)
49	Exist	489.494	4.577.635	745,9	VESTAS V90 2000 90.0 !O! hub: 80,0 m (99)
50	Exist	489.054	4.577.188	740,1	VESTAS V90 2000 90.0 !O! hub: 80,0 m (100)
51	New	492.264	4.576.339	848,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (97)
52	New	492.050	4.576.747	869,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (98)
53	New	491.982	4.577.148	907,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (99)
54	New	491.785	4.577.393	910,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (100)
55	New	491.540	4.577.732	877,5	VESTAS V90 3000 90.0 !O! hub: 90,0 m (101)
56	New	491.245	4.578.091	867,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (102)
57	New	491.099	4.578.379	825,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (103)
58	New	490.850	4.578.910	818,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (104)
59	New	490.613	4.579.227	799,0	VESTAS V90 3000 90.0 !O! hub: 90,0 m (105)
60	New	490.325	4.579.428	752,1	VESTAS V90 3000 90.0 !O! hub: 90,0 m (106)

To be continued on next page...

Project:
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Description:
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Calculated:
29-11-2011 11:36/2.7.486

PARK - Main Result

Calculation: V90 3MW 90m HH with ex wtgs

...continued from previous page

		UTM ED50 Zone: 33 East	North	Z [m]	Row data/Description
61	New	491.563	4.578.750	873,8	VESTAS V90 3000 90.0 !O! hub: 90,0 m (107)
62	New	491.344	4.579.235	873,6	VESTAS V90 3000 90.0 !O! hub: 90,0 m (108)
63	New	491.267	4.579.652	877,4	VESTAS V90 3000 90.0 !O! hub: 90,0 m (109)
64	New	490.664	4.578.404	792,7	VESTAS V90 3000 90.0 !O! hub: 90,0 m (110)
65	New	489.086	4.578.279	707,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (111)
66	New	488.795	4.578.503	671,3	VESTAS V90 3000 90.0 !O! hub: 90,0 m (112)

Project:
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Description:
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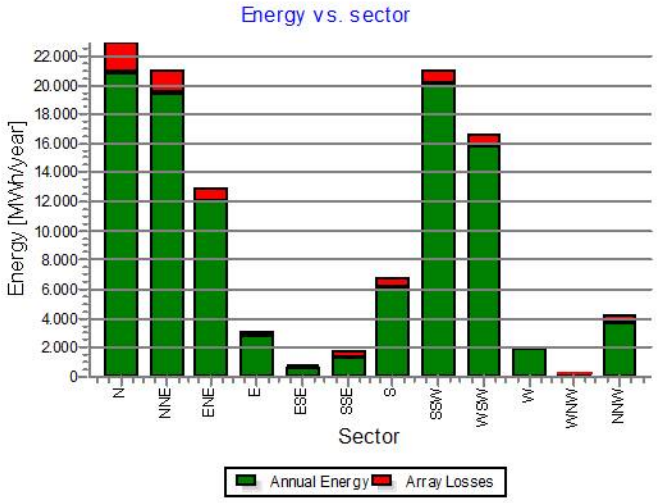
Calculated:
29-11-2011 11:36/2.7.486

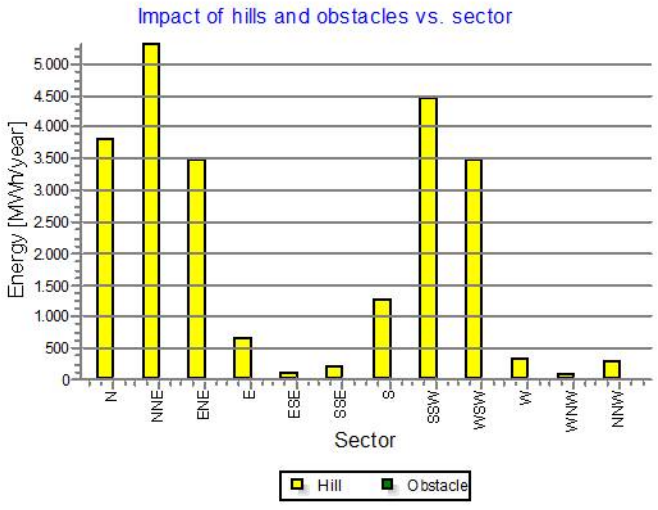
PARK - Production Analysis

Calculation: V90 3MW 90m HH with ex wtgs**WTG:** All new WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,128 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	19.082,8	15.624,0	9.372,8	2.459,4	694,2	1.560,3	5.498,7	16.553,4	13.180,9	1.693,7	178,1	3.866,5	89.765,0
+Increase due to hills	[MWh]	3.797,2	5.321,4	3.488,6	662,0	106,5	196,4	1.267,1	4.469,0	3.478,3	313,9	97,6	311,7	23.509,8
-Decrease due to array losses	[MWh]	2.006,2	1.505,7	808,7	292,9	118,7	471,0	687,8	980,0	763,2	130,1	20,7	523,6	8.308,5
Resulting energy	**[MWh]**	**20.873,8**	**19.439,6**	**12.052,8**	**2.828,6**	**682,1**	**1.285,7**	**6.078,0**	**20.042,4**	**15.896,1**	**1.877,5**	**255,1**	**3.654,7**	**104.966,2**
Specific energy	[kWh/m²]													1.031
Specific energy	[kWh/kW]													2.187
Increase due to hills	[%]	19,9	34,1	37,2	26,9	15,3	12,6	23,0	27,0	26,4	18,5	54,8	8,1	26,19
Decrease due to array losses	[%]	8,8	7,2	6,3	9,4	14,8	26,8	10,2	4,7	4,6	6,5	7,5	12,5	7,33
Utilization	[%]	33,8	34,7	36,5	37,1	34,5	29,5	35,1	32,6	28,6	26,8	31,6	31,5	32,9
Operational	[Hours/year]	1.613	1.255	786	259	119	311	830	1.314	813	149	62	316	7.827
Full Load Equivalent	[Hours/year]	435	405	251	59	14	27	127	418	331	39	5	76	2.187





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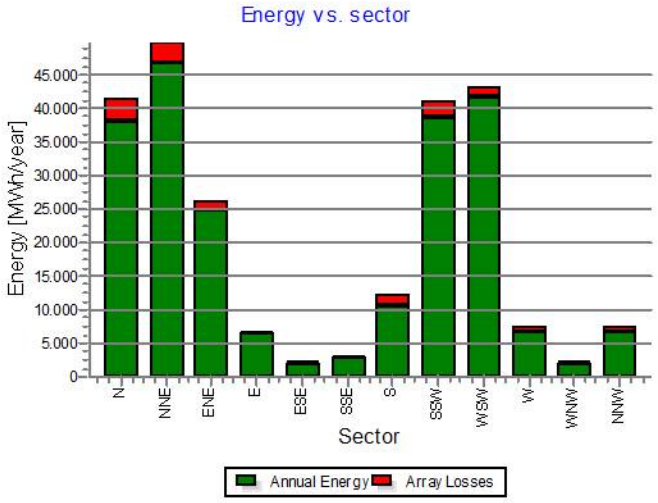
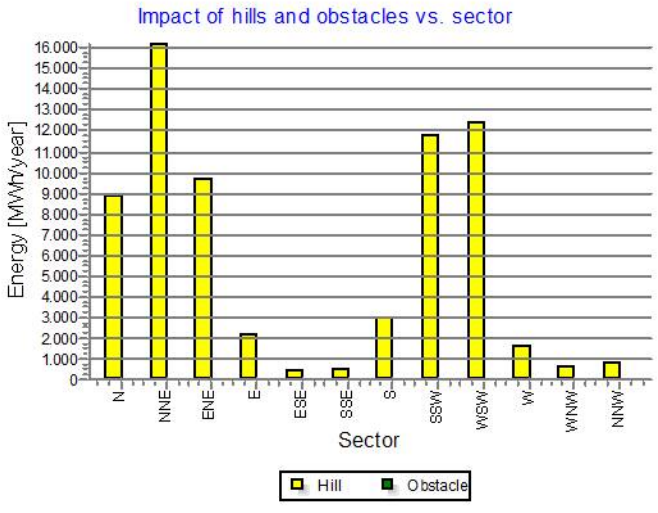
PARK - Production Analysis

Calculation: V90 3MW 90m HH with ex wtgs**WTG:** All existing WTGs, Air density varies with WTG position 1,098 kg/m³ - 1,128 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	32.480,1	33.508,8	16.289,3	4.616,0	1.938,9	2.560,0	9.208,5	29.474,4	30.707,3	5.890,8	1.661,9	6.683,2	175.019,5
+Increase due to hills	[MWh]	8.843,2	16.209,4	9.697,5	2.150,0	419,4	559,5	2.973,2	11.768,4	12.450,8	1.644,3	617,0	840,5	68.173,1
-Decrease due to array losses	[MWh]	3.320,5	3.000,8	1.243,8	509,5	333,2	445,9	1.662,9	2.681,0	1.605,9	768,3	368,9	749,8	16.690,4
Resulting energy	**[MWh]**	**38.002,9**	**46.717,4**	**24.743,0**	**6.256,5**	**2.025,1**	**2.673,6**	**10.518,8**	**38.561,8**	**41.552,2**	**6.766,9**	**1.909,9**	**6.773,9**	**226.502,0**
Specific energy	[kWh/m²]													923
Specific energy	[kWh/kW]													2.410
Increase due to hills	[%]	27,2	48,4	59,5	46,6	21,6	21,9	32,3	39,9	40,5	27,9	37,1	12,6	38,95
Decrease due to array losses	[%]	8,0	6,0	4,8	7,5	14,1	14,3	13,7	6,5	3,7	10,2	16,2	10,0	6,86
Utilization	[%]	31,5	32,4	34,5	35,4	34,1	33,9	31,5	29,0	27,0	26,5	29,0	31,1	30,5
Operational	[Hours/year]	1.049	1.245	792	251	135	225	597	1.211	1.193	297	134	242	7.370
Full Load Equivalent	[Hours/year]	404	497	263	67	22	28	112	410	442	72	20	72	2.410





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PARK - Park power curve

Calculation: V90 3MW 90m HH with ex wtgs

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,5	570	278	245	270	287	231	202	230	246	311	325	279	202	214
4,5	6.363	5.166	4.850	5.313	5.515	5.141	4.570	4.476	4.817	5.279	5.476	5.126	4.553	4.445
5,5	13.351	11.440	10.919	11.648	11.952	11.382	10.522	10.376	10.902	11.629	11.913	11.375	10.492	10.335
6,5	23.176	20.174	19.284	20.511	20.995	20.121	18.754	18.456	19.271	20.478	20.924	20.101	18.730	18.409
7,5	36.371	31.895	30.557	32.402	33.132	31.836	29.790	29.284	30.505	32.351	33.029	31.815	29.731	29.228
8,5	53.068	46.960	45.137	47.661	48.686	46.919	44.022	43.305	45.074	47.569	48.539	46.869	43.948	43.219
9,5	72.255	65.032	62.881	65.874	67.183	65.030	61.377	60.445	62.825	65.737	66.988	64.949	61.293	60.348
10,5	91.824	84.592	82.492	85.471	86.843	84.627	80.625	79.529	82.500	85.319	86.625	84.511	80.538	79.460
11,5	108.857	102.590	100.977	103.314	104.498	102.783	99.011	97.856	101.046	103.150	104.299	102.706	99.049	97.886
12,5	122.428	117.592	116.516	118.149	119.084	118.148	114.732	113.536	116.568	117.913	118.800	117.912	114.875	113.714
13,5	133.116	129.704	128.990	130.110	130.782	130.253	127.603	126.613	129.008	129.940	130.552	129.991	127.732	126.766
14,5	139.074	137.631	137.311	137.883	138.147	137.868	136.533	135.997	137.309	137.795	138.033	137.723	136.574	136.017
15,5	141.300	140.927	140.809	141.022	141.084	140.996	140.595	140.455	140.806	140.985	141.041	140.937	140.604	140.415
16,5	141.873	141.797	141.757	141.821	141.834	141.816	141.740	141.702	141.756	141.810	141.822	141.800	141.735	141.689
17,5	141.986	141.972	141.960	141.978	141.981	141.977	141.965	141.956	141.960	141.974	141.976	141.972	141.962	141.952
18,5	142.000	141.998	141.994	141.999	142.000	142.000	141.999	141.995	141.994	141.999	142.000	142.000	141.998	141.995
19,5	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000
20,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
21,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
22,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
23,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
24,5	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600	133.600
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes array losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in WindPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in WindPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

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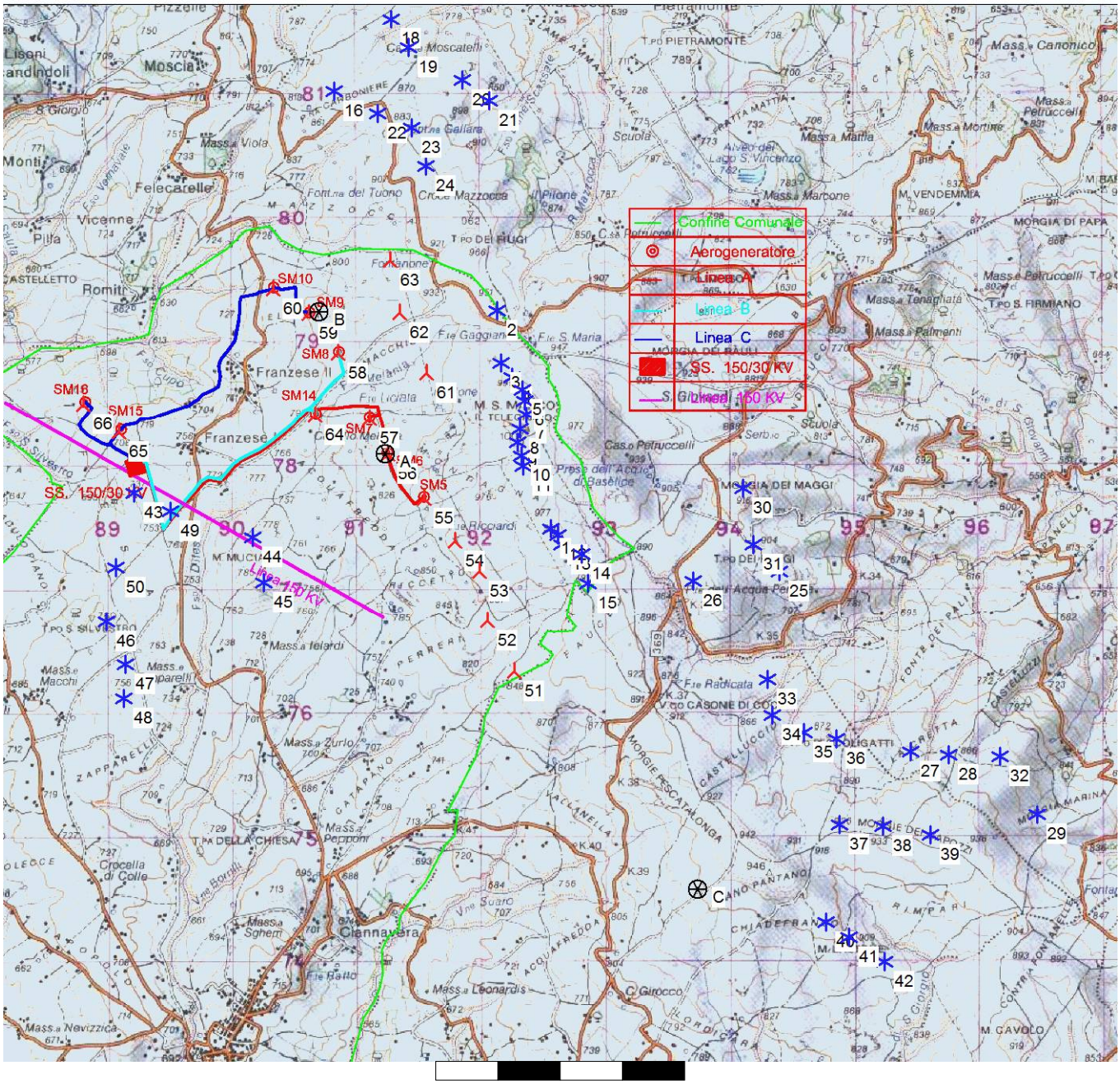
PARK - Map

Calculation: V90 3MW 90m HH with ex wtgs



Map: Corografia , Print scale 1:50.000, Map center UTM ED50 Zone: 33 East: 492.705 North: 4.578.293

New WTG Existing WTG Site Data

ANNEX 4 MCP reports

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MCP - Measure data - overview

Meteo data objects

1: Local measurements (site data): San Marco 2398 & 9484.30,0m - C1 Subst all
First date: 01-11-2006
Last date: 14-11-2011
Time step: 10 min
Data points: 264894
Enabled: 100,0 %
Mean wind speed: 6,24 m/s
Time Series Data: Yes

2: Long term reference: NCAR_BASIC_N40.0_E15.0.42,0m - srf
First date: 01-01-1981
Last date: 06-11-2011
Time step: 360 min
Data points: 45068
Enabled: 100,0 %
Mean wind speed: 5,62 m/s
Time Series Data: Yes

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MCP -

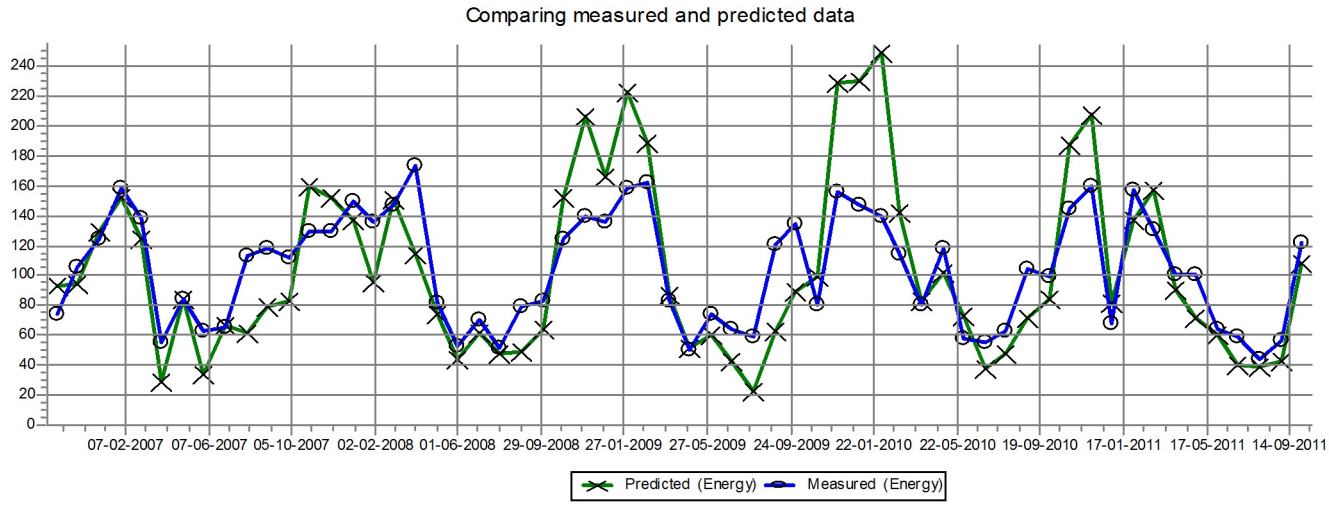
1: Local measurements (site data)	San Marco 2398 & 9484
Height	30,00 m
Period	01-11-2006 to 14-11-2011 5,0 years
Mean wind speed	6,24 m/s
Filters used	Not Filtered
2: Long term reference	NCAR_BASIC_N40.0_E15.0
Height	42,00 m
Period	01-01-1981 to 06-11-2011 30,8 years
Mean wind speed	5,62 m/s
Filters used	Not Filtered

Calculation setup

Power curve	Use actual power curve for:VESTAS V90 3000 90.0 !O! Level 0 - Estimated - 107.0 dB(A) - 06-2009
Minimum data available	60 %
Wind speed scaling	Scale both site and reference to mean wind speed 6,00 m/s

Results

Measure height a.g.l.	30,0 m
Key height a.g.l.	50,0 m
Mean wind in key height	6,71 m/s
Wind energy	71,1
WTG energy	80,8
r - wind index	0,8312
s - wind index	32,4957 %
Time of calculation	28-11-2011 15:44



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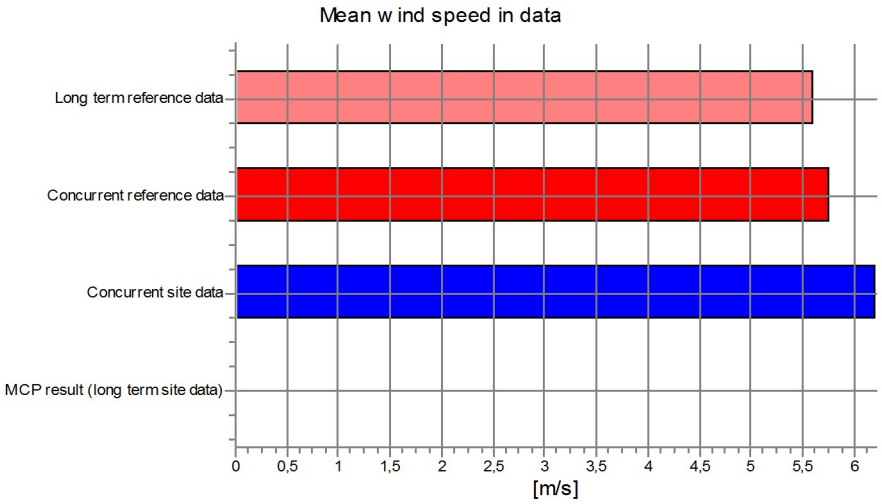
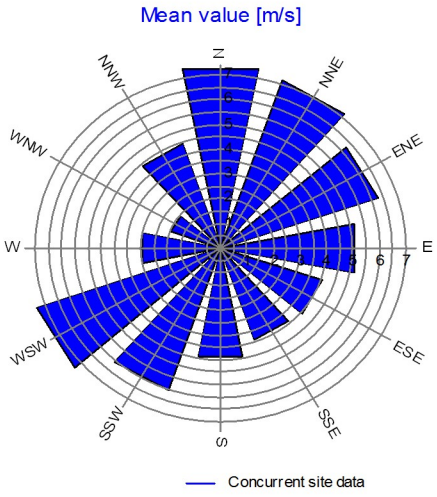
MCP - Wind Index Calculation - input data

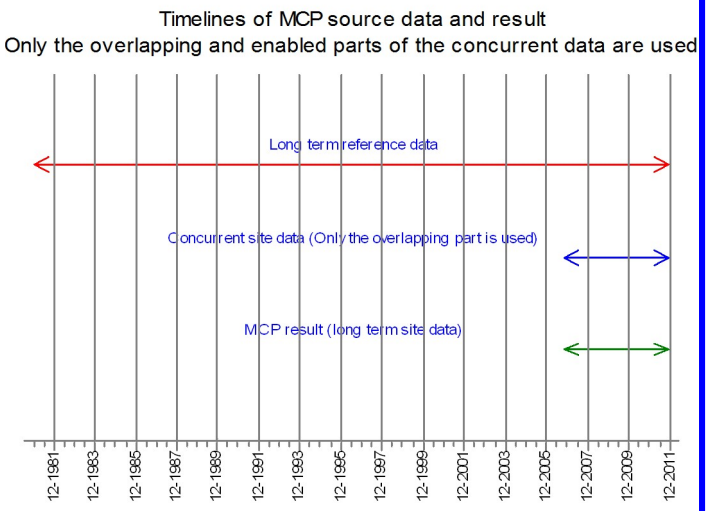
MCP method used:
Wind Index MCP

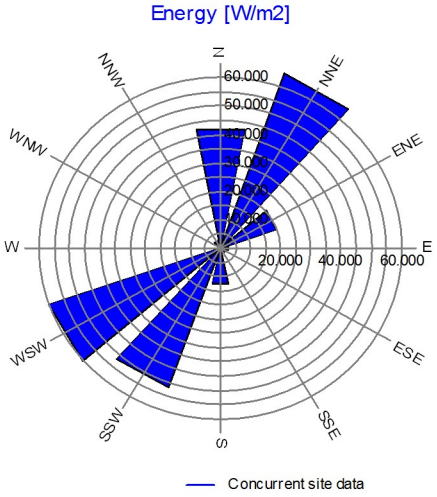
Long term reference data:
NCAR_BASIC_N40.0_E15.0
Height: 42,00

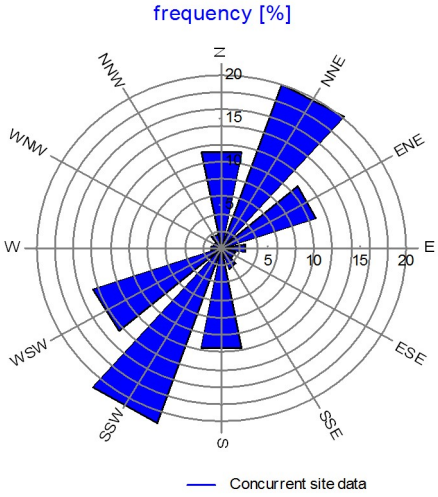
Concurrent site data:
San Marco 2398 & 9484
Height: 30,00











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MCP - Wind Index Calculation - results

Wind index results for the total period considered

Index for the reference period:100,0
Index for the reference period (concurrent period):103,3
Index for the local data (concurent period):103,3
Long term correction factor: 0,97

WTG Power curve used: VESTAS V90 3000 90.0 !O! (Level 0 - Estimated - 107.0 dB(A) - 06-2009)
Only months with at least 60,0 % data availability have been used.
Wind speed scaling: Scale both site and reference to mean wind speed 6,00 m/s

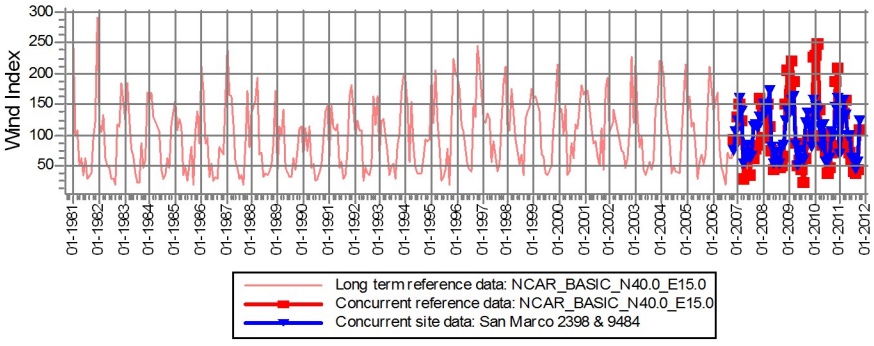
Monthly wind indices - Long term reference data: NCAR_BASIC_N40.0_E15.0

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	100,2	148,3	146,8	131,4	103,2	66,7	49,3	45,8	42,4	61,4	91,1	145,5	174,2
Standard deviation	56,5	56,1	36,2	34,9	28,5	23,8	16,4	17,1	14,7	31,1	32,0	45,1	48,9
Minimum	18,3	38,9	96,1	55,0	28,8	26,0	26,8	21,3	22,0	18,3	20,4	60,2	82,0
Maximum	292,7	249,9	248,9	205,1	154,3	116,0	91,0	87,2	80,6	147,4	163,6	246,6	292,7
Number of samples	370	31	31	31	31	31	31	31	31	31	31	30	30

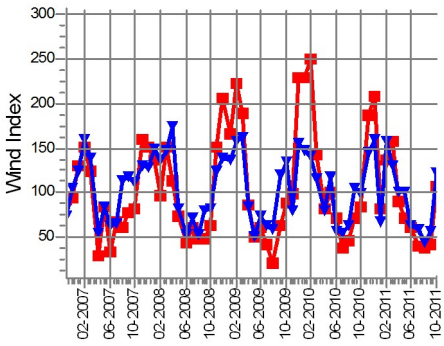
Monthly wind indices - Concurrent site data: San Marco 2398 & 9484

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	103,7	124,9	150,1	138,7	98,6	86,8	62,4	62,8	66,3	95,7	110,1	110,9	137,9
Standard deviation	37,2	33,6	11,1	17,6	44,9	25,0	7,8	6,1	27,4	27,3	19,8	31,1	21,7
Minimum	43,8	67,4	136,0	114,7	54,7	50,1	53,3	54,9	43,8	56,2	82,8	74,7	106,0
Maximum	173,4	149,8	158,9	162,2	173,4	117,6	74,3	70,8	113,6	120,1	134,2	144,1	159,3
Number of samples	60	5	5	5	5	5	5	5	5	5	5	5	5

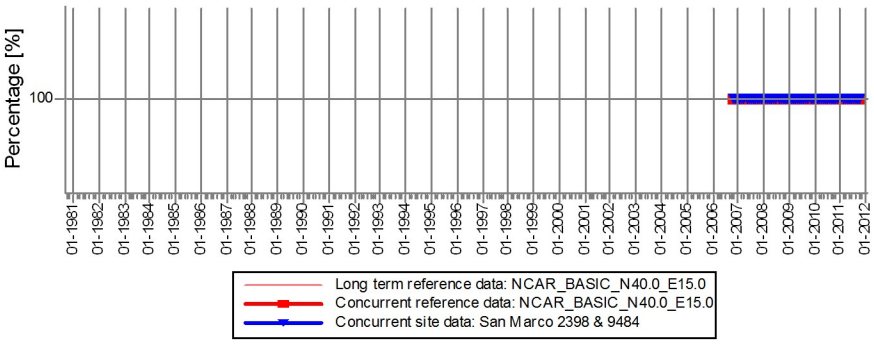
Wind index data from 01-01-1981 00:00 to 01-10-2011 00:00



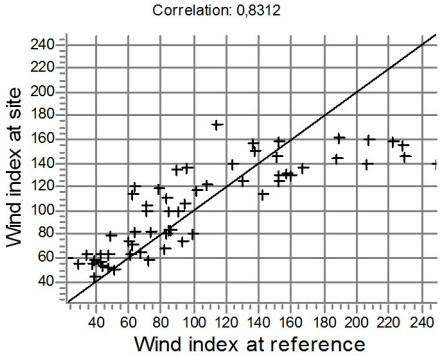
01-11-2006 00:00 to 01-10-2011 00:00



The percentage of data available in each month from 01-01-1981 00:00 to 01-10-2011 00:00



Correlation between wind indices
Correlation: 0,8312



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Kent Larsen / kent.larsen@kentec.dk / www.kentec.dk
Calculated:
28-11-2011 15:42/2.7.486

MCP - Measure data - overview

Meteo data objects

1: Local measurements (site data): San Marco 4210.30,0m - C2 Subst
First date: 27-12-2007
Last date: 14-11-2011
Time step: 10 min
Data points: 204182
Enabled: 100,0 %
Mean wind speed: 5,63 m/s
Time Series Data: Yes

2: Long term reference: NCAR_BASIC_N40.0_E15.0.42,0m - srf
First date: 01-01-1981
Last date: 06-11-2011
Time step: 360 min
Data points: 45068
Enabled: 100,0 %
Mean wind speed: 5,62 m/s
Time Series Data: Yes

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Calculated:
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MCP -

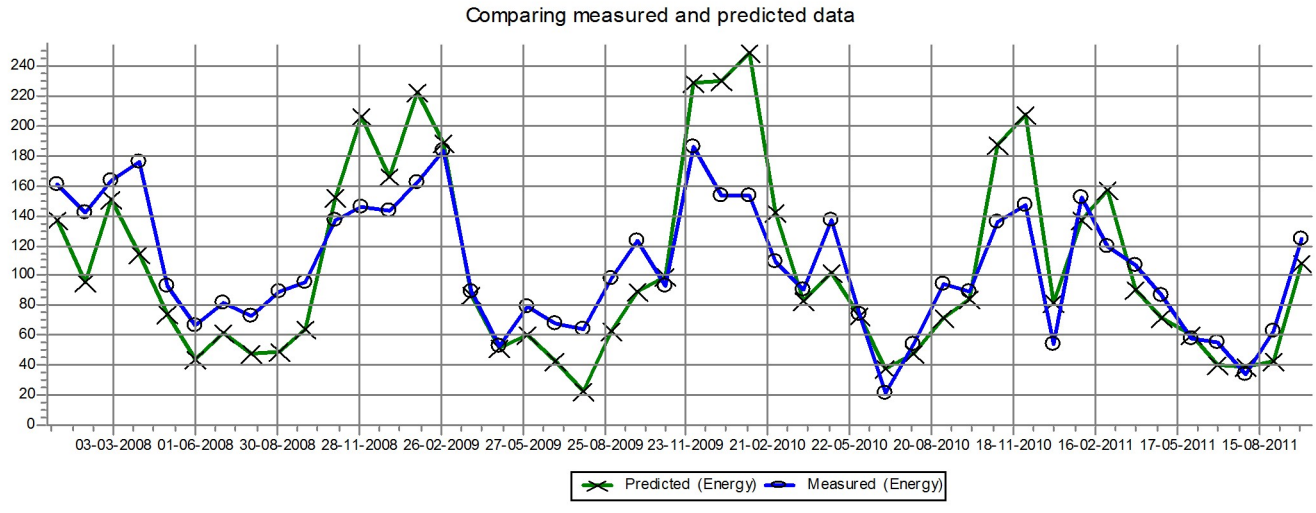
1: Local measurements (site data)	San Marco 4210
Height	30,00 m
Period	27-12-2007 to 14-11-2011 3,9 years
Mean wind speed	5,63 m/s
Filters used	Not Filtered
2: Long term reference	NCAR_BASIC_N40.0_E15.0
Height	42,00 m
Period	01-01-1981 to 06-11-2011 30,8 years
Mean wind speed	5,62 m/s
Filters used	Not Filtered

Calculation setup

Power curve	Use actual power curve for:VESTAS V90 3000 90.0 !O! Level 0 - Estimated - 107.0 dB(A) - 06-2009
Minimum data available	60 %
Wind speed scaling	Scale both site and reference to mean wind speed 6,00 m/s

Results

Measure height a.g.l.	30,0 m
Key height a.g.l.	50,0 m
Mean wind in key height	6,04 m/s
Wind energy	62,7
WTG energy	73,7
r - wind index	0,8432
s - wind index	33,8098 %
Time of calculation	28-11-2011 15:39



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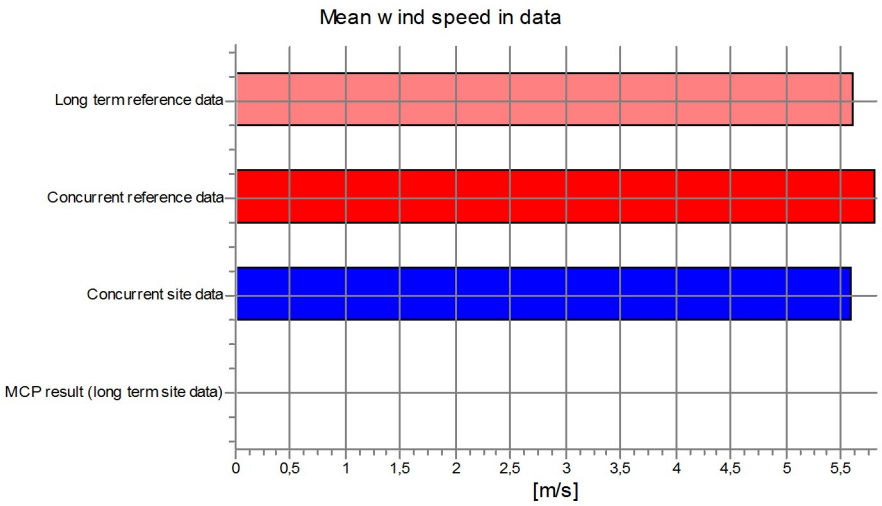
28-11-2011 15:42/2.7.486

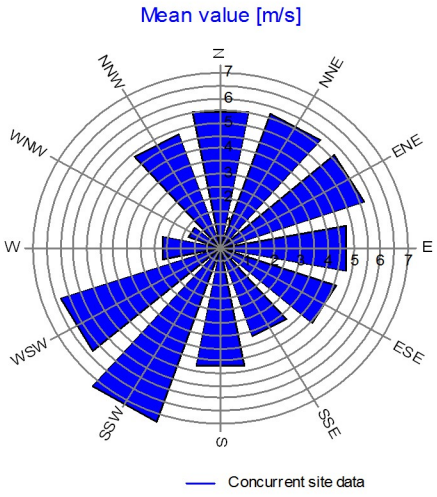
MCP - Wind Index Calculation - input data

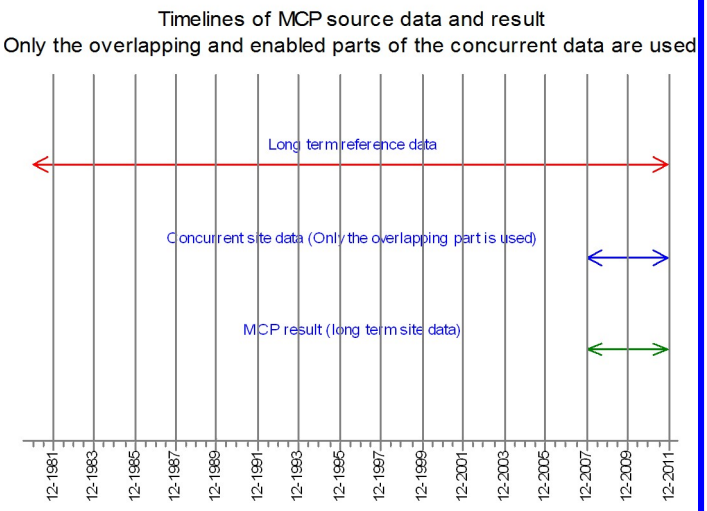
MCP method used:
Wind Index MCP

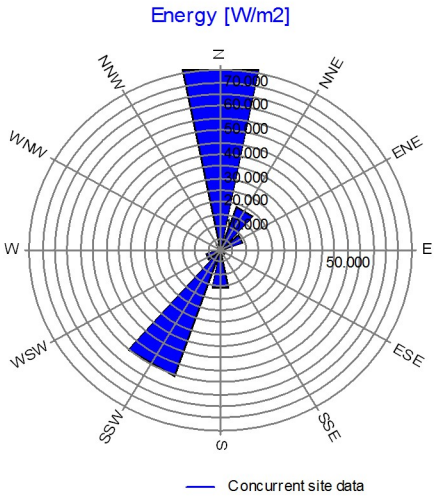
Long term reference data:
NCAR_BASIC_N40.0_E15.0
Height: 42,00

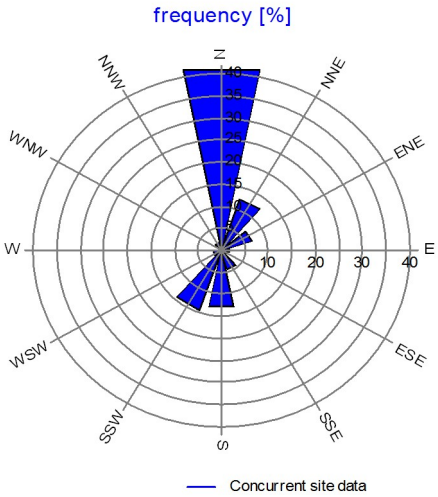
Concurrent site data:
San Marco 4210
Height: 30,00











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Calculated:
28-11-2011 15:42/2.7.486

MCP - Wind Index Calculation - results

Wind index results for the total period considered

Index for the reference period:100,0
Index for the reference period (concurrent period):105,4
Index for the local data (concurent period):105,4
Long term correction factor: 0,94

WTG Power curve used: VESTAS V90 3000 90.0 !O! (Level 0 - Estimated - 107.0 dB(A) - 06-2009)
Only months with at least 60,0 % data availability have been used.
Wind speed scaling: Scale both site and reference to mean wind speed 6,00 m/s

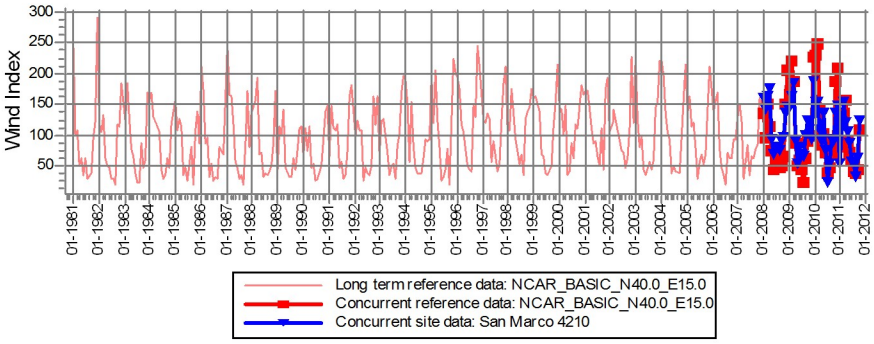
Monthly wind indices - Long term reference data: NCAR_BASIC_N40.0_E15.0

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	100,2	148,3	146,8	131,4	103,2	66,7	49,3	45,8	42,4	61,4	91,1	145,5	174,2
Standard deviation	56,5	56,1	36,2	34,9	28,5	23,8	16,4	17,1	14,7	31,1	32,0	45,1	48,9
Minimum	18,3	38,9	96,1	55,0	28,8	26,0	26,8	21,3	22,0	18,3	20,4	60,2	82,0
Maximum	292,7	249,9	248,9	205,1	154,3	116,0	91,0	87,2	80,6	147,4	163,6	246,6	292,7
Number of samples	370	31	31	31	31	31	31	31	31	31	31	30	30

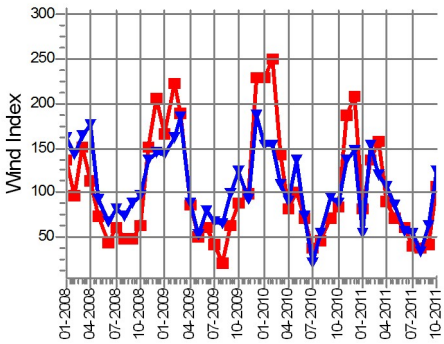
Monthly wind indices - Concurrent site data: San Marco 4210

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	106,2	128,0	152,6	144,0	115,6	92,4	69,6	56,7	56,5	86,0	108,5	121,7	159,5
Standard deviation	42,3	49,5	8,2	35,5	41,3	34,6	9,4	25,4	17,2	16,0	18,4	24,8	23,0
Minimum	22,0	54,5	142,5	109,4	88,9	52,5	57,8	22,0	33,4	62,8	89,3	93,1	146,0
Maximum	186,1	160,9	162,4	183,9	176,3	137,0	79,6	81,3	73,5	98,2	124,7	136,4	186,1
Number of samples	46	4	4	4	4	4	4	4	4	4	4	3	3

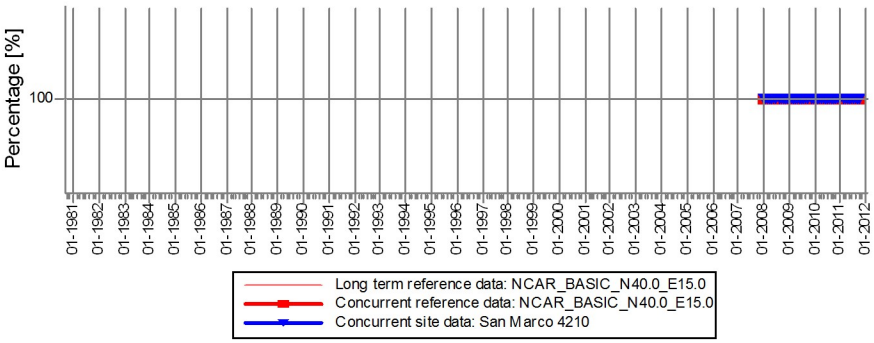
Wind index data from 01-01-1981 00:00 to 01-10-2011 00:00



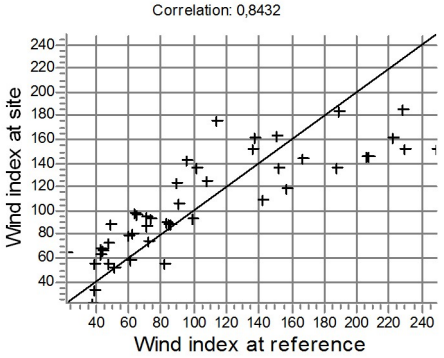
01-01-2008 00:00 to 01-10-2011 00:00



The percentage of data available in each month from 01-01-1981 00:00 to 01-10-2011 00:00



Correlation between wind indices
Correlation: 0,8432



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Calculated:
23-11-2011 10:25/2.7.486

MCP - Measure data - overview

Meteo data objects

1: Local measurements (site data): Molinara.50,0m - C1
First date: 12-08-2009
Last date: 14-11-2011
Time step: 10 min
Data points: 118689
Enabled: 100,0 %
Mean wind speed: 6,02 m/s
Time Series Data: Yes

2: Long term reference: NCAR_BASIC_N40.0_E15.0.42,0m - srf
First date: 01-01-1981
Last date: 06-11-2011
Time step: 360 min
Data points: 45068
Enabled: 100,0 %
Mean wind speed: 5,62 m/s
Time Series Data: Yes

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Calculated:
23-11-2011 10:25/2.7.486

MCP -

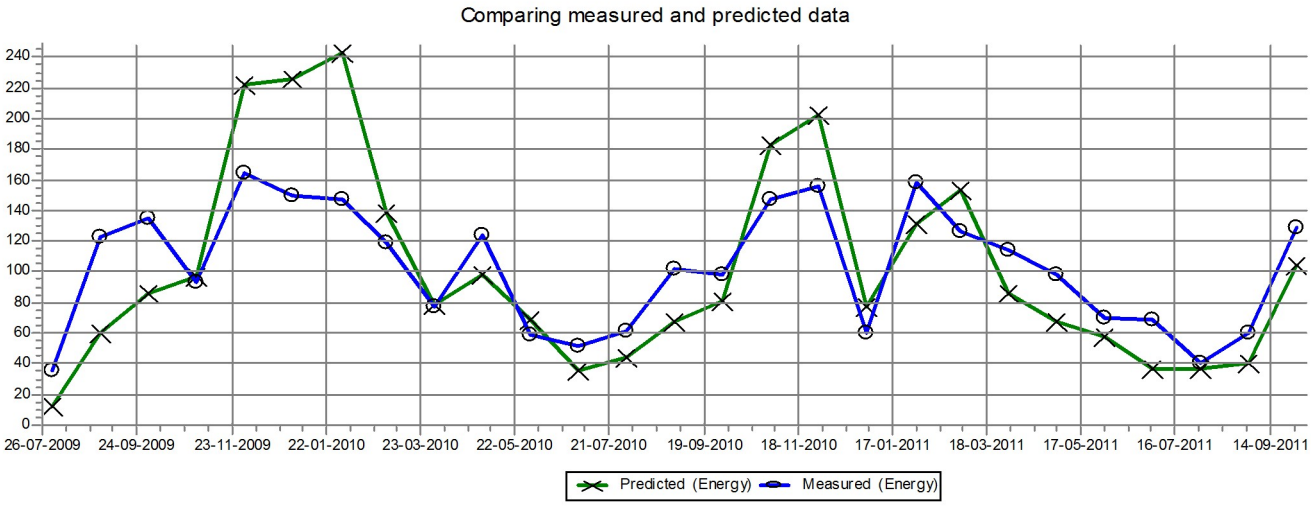
1: Local measurements (site data)	Molinara
Height	50,00 m
Period	12-08-2009 to 14-11-2011 2,3 years
Mean wind speed	6,02 m/s
Filters used	Not Filtered
2: Long term reference	NCAR_BASIC_N40.0_E15.0
Height	42,00 m
Period	01-01-1981 to 06-11-2011 30,8 years
Mean wind speed	5,76 m/s
Filters used	Not Filtered

Calculation setup

Power curve	Use actual power curve for:VESTAS V90 3000 90.0 !O! Level 0 - Estimated - 107.0 dB(A) - 06-2009
Minimum data available	60 %
Wind speed scaling	Scale both site and reference to mean wind speed 6,00 m/s

Results

Measure height a.g.l.	50,0 m
Key height a.g.l.	50,0 m
Mean wind in key height	5,97 m/s
Wind energy	51,8
WTG energy	56,7
r - wind index	0,8399
s - wind index	35,6984 %
Time of calculation	23-11-2011 10:21



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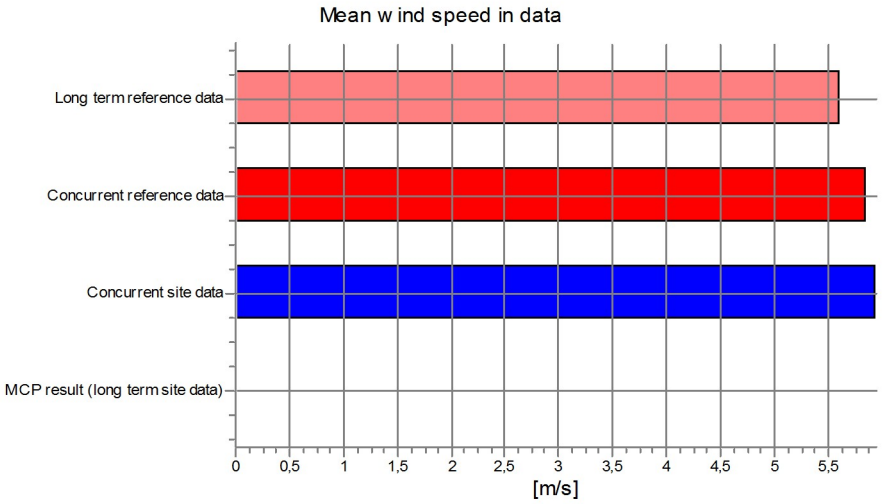
Calculated:
23-11-2011 10:25/2.7.486

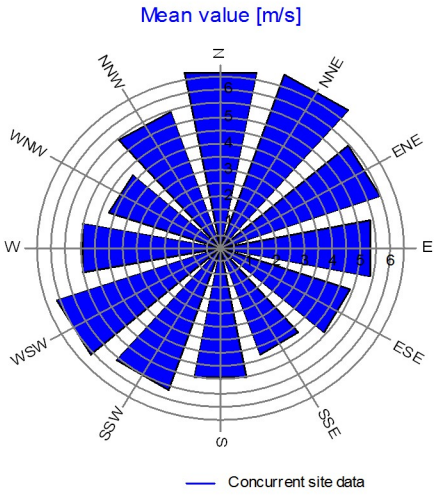
MCP - Wind Index Calculation - input data

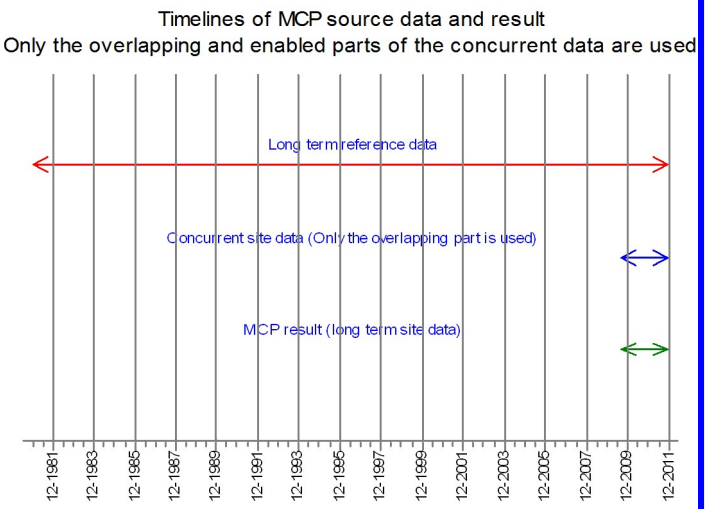
MCP method used:
Wind Index MCP

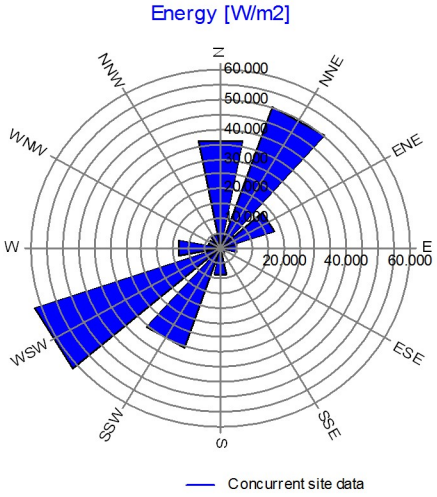
Long term reference data:
NCAR_BASIC_N40.0_E15.0
Height: 42,00

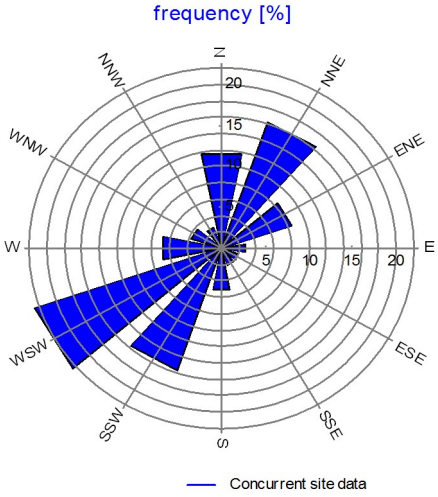
Concurrent site data:
Molinara
Height: 50,00











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Calculated:
23-11-2011 10:25/2.7.486

MCP - Wind Index Calculation - results

Wind index results for the total period considered

Index for the reference period:100,0
Index for the reference period (concurrent period):102,7
Index for the local data (concurent period):102,7
Long term correction factor: 0,97

WTG Power curve used: VESTAS V90 3000 90.0 !O! (Level 0 - Estimated - 107.0 dB(A) - 06-2009)
Only months with at least 60,0 % data availability have been used.
Wind speed scaling: Scale both site and reference to mean wind speed 6,00 m/s

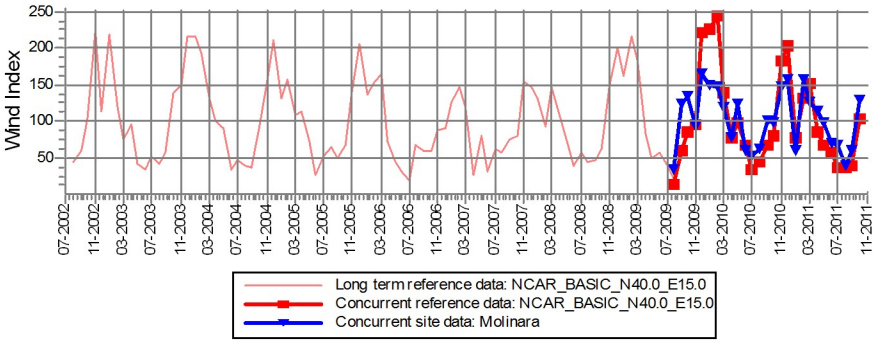
Monthly wind indices - Long term reference data: NCAR_BASIC_N40.0_E15.0

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	100,1	158,4	161,4	135,7	85,4	68,5	42,6	45,0	46,2	55,2	87,4	148,6	179,0
Standard deviation	58,1	51,0	47,5	31,9	25,9	19,9	14,7	13,4	14,1	11,9	24,0	40,7	48,9
Minimum	19,7	77,6	92,6	76,0	26,9	43,0	27,5	19,7	20,4	36,1	59,5	88,8	89,5
Maximum	242,9	225,2	242,9	183,4	114,7	98,0	68,9	63,5	67,6	74,6	138,9	223,2	221,9
Number of samples	111	9	9	9	9	9	9	9	10	10	10	9	9

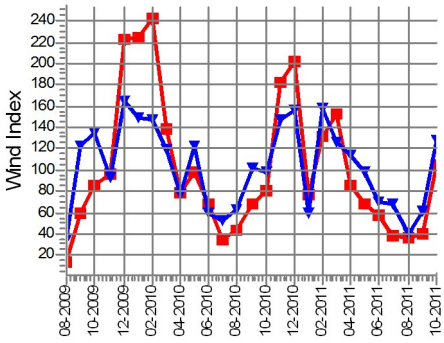
Monthly wind indices - Concurrent site data: Molinara

Period	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	102,5	104,7	152,5	122,3	95,9	111,0	64,9	59,8	45,8	95,1	120,8	119,8	160,4
Standard deviation	39,5	63,2	8,2	5,5	26,5	17,4	7,8	11,8	14,2	31,8	19,6	38,4	6,0
Minimum	35,1	60,1	146,7	118,4	77,1	98,6	59,4	51,5	35,1	60,4	98,5	92,7	156,1
Maximum	164,6	149,4	158,3	126,1	114,6	123,3	70,4	68,2	61,9	123,0	135,4	147,0	164,6
Number of samples	27	2	2	2	2	2	2	2	3	3	3	2	2

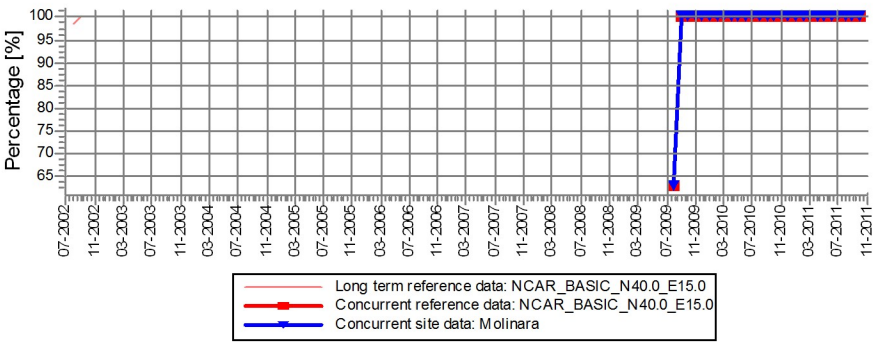
Wind index data from 01-08-2002 00:00 to 01-10-2011 00:00



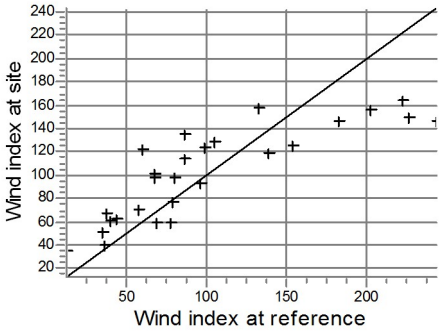
01-08-2009 00:00 to 01-10-2011 00:00



The percentage of data available in each month from 01-08-2002 00:00 to 01-10-2011 00:00



Correlation between wind indices
Correlation: 0,8399



ANNEX 5 Technical details of the Wind Turbine Generators

VESTAS V90 3000 90.0 !O!

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Company	VESTAS
Type/Version	V90
Rated power	3.000,0 kW
Secondary generator	0,0 kW
Rotor diameter	90,0 m
Tower	Tubular
Grid connection	50 Hz
Origin country	DK
Blade type	Vestas
Generator type	One generator
Rpm, rated power	16,1 rpm
Rpm, initial	8,6 rpm
Hub height(s)	80,0; 105,0; 90,0 m
Maximum blade width	3,51 m
Blade width for 90% radius	0,92 m
Valid	Yes
Creator	EMD
Created	07-07-2010 12:34
Edited	07-07-2010 12:34

Valid hub height for 50 Hz : 80 m, 105 m.
(80 m available as Dibt and IEC certification, 105m hub height only available as Dibt certification).

Power curve: Level 0 - Estimated - 107.0 dB(A) - 06-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
30-06-2009 12:49	EMD	23-08-2004 16:46	24-09-2010 14:38	Yes	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct values based on item no: 0000-5450 V04 2009-06-30.
Please contact Vestas for information on latest power curve.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	581,00	886,00	1.273,00	1.710,00	2.145,00	2.544,00	2.837,00	2.965,00	2.995,00	3.000,00	3.000,00	3.000,00
Ce	0,309	0,390	0,419	0,435	0,444	0,448	0,439	0,414	0,378	0,331	0,277	0,228	0,188	0,157	0,132

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00
Ce	0,112	0,096	0,083	0,072	0,063	0,056	0,049

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,81	0,80	0,73	0,66	0,57	0,49	0,38	0,30	0,24	0,20	0,17	0,14	0,12	0,10	0,09	0,08	0,07	0,06

Power curve: Level 1 - Estimated - 105.9 dB(A) - 06-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
30-06-2009 12:49	EMD	23-08-2004 16:46	24-09-2010 14:38	No	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct-values based on item no: 0000-5450 V04 2009-06-30.
Please contact Vestas for information on latest power curve.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	581,00	886,00	1.272,00	1.696,00	2.106,00	2.489,00	2.797,00	2.951,00	2.993,00	2.999,00	3.000,00	3.000,00
Ce	0,309	0,390	0,419	0,435	0,444	0,448	0,435	0,406	0,370	0,327	0,276	0,228	0,188	0,157	0,132

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00
Ce	0,112	0,096	0,083	0,072	0,063	0,056	0,049

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,81	0,80	0,71	0,61	0,52	0,46	0,38	0,30	0,24	0,20	0,17	0,14	0,12	0,10	0,09	0,08	0,07	0,06

VESTAS V90 3000 90.0 !O!

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Power curve: Level 2 - Estimated - 105.5 dB(A) - 06-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
30-06-2009 12:49	EMD	23-08-2004 16:46	24-09-2010 14:38	No	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct-values based on item no: 0000-5450 V04 2009-06-30.
Please contact Vestas for information on latest power curve.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	581,00	885,00	1.258,00	1.641,00	2.004,00	2.353,00	2.671,00	2.888,00	2.976,00	2.997,00	3.000,00	3.000,00
Ce	0,309	0,390	0,419	0,435	0,444	0,443	0,421	0,386	0,349	0,312	0,270	0,226	0,188	0,157	0,132

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00
Ce	0,112	0,096	0,083	0,072	0,063	0,056	0,049

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,81	0,77	0,65	0,55	0,48	0,42	0,37	0,30	0,24	0,20	0,17	0,14	0,12	0,10	0,09	0,08	0,07	0,06

Power curve: Level 6 - Estimated - Mode 6 - 01-2010
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
04-01-2010 12:49	EMD	07-07-2010 13:10	24-09-2010 14:40	No	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct-values based on item no: 0007-9707 V00 2010-01-04.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	574,00	817,00	1.077,00	1.382,00	1.746,00	2.197,00	2.653,00	2.904,00	2.988,00	3.000,00	3.000,00	3.000,00
Ce	0,309	0,390	0,419	0,429	0,410	0,379	0,355	0,337	0,326	0,310	0,272	0,227	0,188	0,157	0,132

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00
Ce	0,112	0,096	0,083	0,072	0,063	0,056	0,049

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,66	0,56	0,51	0,47	0,45	0,45	0,38	0,30	0,24	0,20	0,17	0,14	0,12	0,10	0,09	0,08	0,07	0,06

Power curve: Level 5 - Estimated - Mode 5 - 01-2010
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
04-01-2010 12:49	EMD	07-07-2010 12:58	24-09-2010 14:40	No	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct-values based on item no: 0007-9706 V00 2010-01-04.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	581,00	867,00	1.163,00	1.444,00	1.699,00	1.927,00	2.170,00	2.417,00	2.603,00	2.699,00	2.736,00	2.748,00
Ce	0,309	0,390	0,419	0,435	0,435	0,409	0,371	0,328	0,286	0,253	0,226	0,198	0,169	0,143	0,121

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	2.750,00	2.750,00	2.750,00	2.750,00	2.750,00	2.750,00	2.750,00
Ce	0,103	0,088	0,076	0,066	0,058	0,051	0,045

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,78	0,65	0,55	0,47	0,39	0,34	0,30	0,27	0,22	0,18	0,15	0,13	0,11	0,10	0,09	0,08	0,07	0,06

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Power curve: Level 3 - Estimated - Mode 3 - 01-2010

Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
04-01-2010 12:49	EMD	07-07-2010 12:44	24-09-2010 14:39	No	25,0	1,225	0,0	Pitch	User defined

Estimated power curves and Ct-values based on item no: 0007-9703 V00 2010-01-04.

Power curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00
Power [kW]	77,00	190,00	353,00	581,00	872,00	1.177,00	1.466,00	1.733,00	1.899,00	2.001,00	2.259,00	2.607,00	2.858,00	2.964,00	2.993,00
Ce	0,309	0,390	0,419	0,435	0,437	0,414	0,376	0,334	0,282	0,234	0,211	0,198	0,179	0,155	0,132

Wind speed [m/s]	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	2.999,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00	3.000,00
Ce	0,112	0,096	0,083	0,072	0,063	0,056	0,049

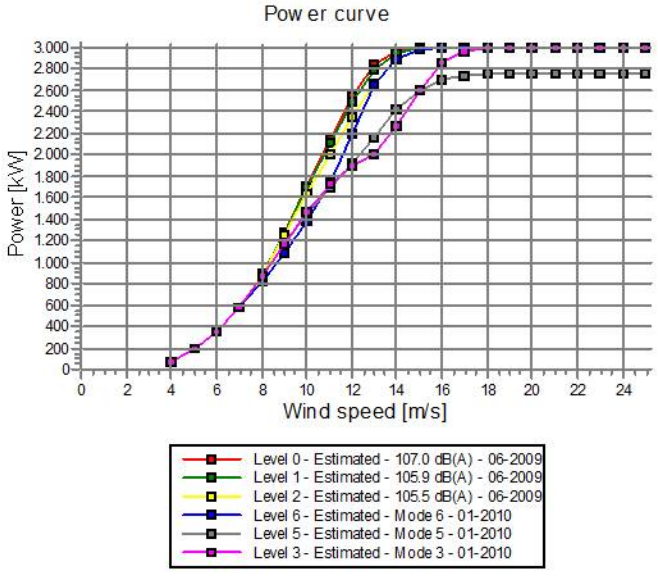
Ct curve

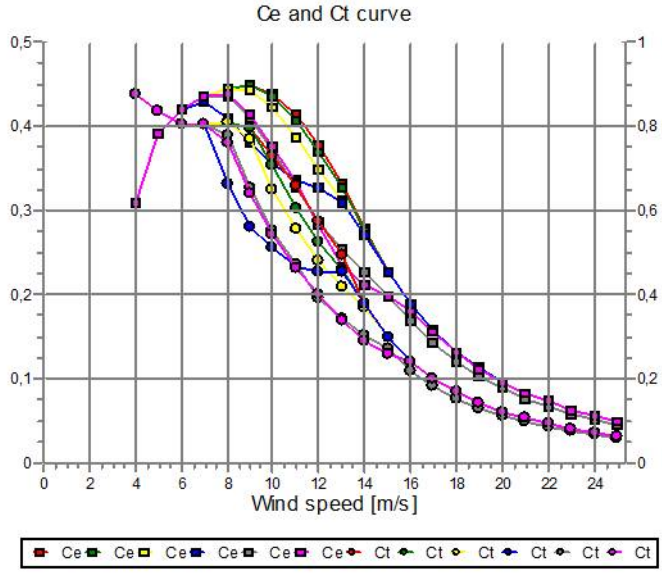
Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,87	0,84	0,81	0,81	0,76	0,64	0,54	0,46	0,40	0,34	0,29	0,26	0,24	0,20	0,17	0,14	0,12	0,10	0,09	0,08	0,07	0,06

HP curve comparison

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	3.019	5.077	7.277	9.571	11.471	13.103
Level 0 - Estimated - 107.0 dB(A) - 06-2009	[MWh]	3.277	5.338	7.554	9.708	11.660	13.324
Check value	**[%]**	**-8**	**-5**	**-4**	**-1**	**-2**	**-2**
Level 1 - Estimated - 105.9 dB(A) - 06-2009	[MWh]	3.262	5.302	7.497	9.635	11.577	13.237
Check value	**[%]**	**-7**	**-4**	**-3**	**-1**	**-1**	**-1**
Level 2 - Estimated - 105.5 dB(A) - 06-2009	[MWh]	3.214	5.191	7.321	9.410	11.322	12.968
Check value	**[%]**	**-6**	**-2**	**-1**	**2**	**1**	**1**
Level 6 - Estimated - Mode 6 - 01-2010	[MWh]	2.990	4.806	6.822	8.852	10.748	12.406
Check value	**[%]**	**1**	**6**	**7**	**8**	**7**	**6**
Level 5 - Estimated - Mode 5 - 01-2010	[MWh]	3.019	4.735	6.556	8.350	10.011	11.462
Check value	**[%]**	**0**	**7**	**11**	**15**	**15**	**14**
Level 3 - Estimated - Mode 3 - 01-2010	[MWh]	3.027	4.737	6.559	8.379	10.101	11.637
Check value	**[%]**	**0**	**7**	**11**	**14**	**14**	**13**

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.





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Noise: Level 0 - - 107.0 dB(A) - 06-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default
30-06-2009 13:33	EMD	23-08-2004 17:05	13-07-2010 12:52	Yes

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	104,2	1,0	No
	7,0	106,1	1,0	No
	8,0	107,0	1,0	No
	9,0	106,9	1,0	No
	10,0	105,6	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	101,3	1,0	No
	6,0	104,5	1,0	No
	7,0	106,2	1,0	No
	8,0	107,0	1,0	No
	9,0	106,9	1,0	No
	10,0	105,4	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	101,6	1,0	No
	6,0	105,0	1,0	No
	7,0	106,4	1,0	No
	8,0	107,0	1,0	No
	9,0	106,7	1,0	No
	10,0	105,3	1,0	No
	11,0	105,2	1,0	No
	12,0	105,4	1,0	No
	13,0	105,5	1,0	No

Noise data for standard operation (level 0) based on technical specification no.: 0000-5450 V04, dated 30-06-2009. Please contact Vestas on information on the latest noise data.Accuracy = +/- 2 dB(A)

Noise: Level 1 - - 105.9 dB(A) - 06-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default
30-06-2009 13:33	EMD	23-08-2004 17:05	13-07-2010 12:52	No

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	104,2	1,0	No
	7,0	105,8	1,0	No
	8,0	105,9	1,0	No
	9,0	105,9	1,0	No
	10,0	105,6	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	101,3	1,0	No
	6,0	104,5	1,0	No
	7,0	105,9	1,0	No
	8,0	105,9	1,0	No

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Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
	9,0	105,9	1,0	No
	10,0	105,4	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	101,6	1,0	No
	6,0	105,0	1,0	No
	7,0	105,9	1,0	No
	8,0	105,9	1,0	No
	9,0	105,9	1,0	No
	10,0	105,3	1,0	No
	11,0	105,2	1,0	No
	12,0	105,4	1,0	No
	13,0	105,5	1,0	No

Noise data based on technical specification no.: 0000-5450 V04, dated 30-06-2009. Please contact Vestas on information on the latest noise data.Accuracy = +/- 2 dB(A)

Noise: Level 2 - - 105.5 dB(A) - 06-2009

Source Manufacturer

Source date	Creator	Created	Edited	Default
30-06-2009 13:33	EMD	23-08-2004 17:05	13-07-2010 12:52	No

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	104,1	1,0	No
	7,0	105,0	1,0	No
	8,0	105,0	1,0	No
	9,0	105,0	1,0	No
	10,0	105,4	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	101,3	1,0	No
	6,0	104,5	1,0	No
	7,0	105,0	1,0	No
	8,0	105,0	1,0	No
	9,0	105,0	1,0	No
	10,0	105,4	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	101,6	1,0	No
	6,0	104,7	1,0	No
	7,0	105,0	1,0	No
	8,0	105,0	1,0	No
	9,0	105,1	1,0	No
	10,0	105,3	1,0	No
	11,0	105,2	1,0	No
	12,0	105,4	1,0	No
	13,0	105,5	1,0	No

Noise data based on technical specification no.: 0000-5450 V04, dated 30-06-2009. Please contact Vestas on information on the latest noise data. Accuracy = +/- 2 dB(A)

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Noise: Level 6 - Estimated - Mode 6 - 01-2010
Source Manufacturer

Source date	Creator	Created	Edited	Default
04-01-2010 13:33	EMD	07-07-2010 13:15	24-09-2010 14:41	No

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	101,0	1,0	No
	7,0	102,0	1,0	No
	8,0	103,0	1,0	No
	9,0	105,1	1,0	No
	10,0	105,6	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	100,9	1,0	No
	6,0	101,2	1,0	No
	7,0	102,1	1,0	No
	8,0	103,4	1,0	No
	9,0	105,5	1,0	No
	10,0	105,4	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	100,9	1,0	No
	6,0	101,3	1,0	No
	7,0	102,2	1,0	No
	8,0	103,7	1,0	No
	9,0	105,7	1,0	No
	10,0	105,2	1,0	No
	11,0	105,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No

Noise data based on technical specification no.: 0007-9707 V00 2010-01-04.

Noise: Level 5 - Estimated - Mode 5 - 01-2010
Source Manufacturer

Source date	Creator	Created	Edited	Default
04-01-2010 13:33	EMD	07-07-2010 13:05	24-09-2010 14:41	No

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	102,9	1,0	No
	7,0	102,9	1,0	No
	8,0	102,9	1,0	No
	9,0	103,6	1,0	No
	10,0	103,7	1,0	No
	11,0	103,7	1,0	No
	12,0	103,8	1,0	No
	13,0	103,9	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	101,3	1,0	No
	6,0	102,9	1,0	No
	7,0	102,9	1,0	No
	8,0	103,1	1,0	No
	9,0	103,6	1,0	No

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Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
	10,0	103,7	1,0	No
	11,0	103,7	1,0	No
	12,0	103,8	1,0	No
	13,0	103,9	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	101,6	1,0	No
	6,0	102,9	1,0	No
	7,0	102,9	1,0	No
	8,0	103,3	1,0	No
	9,0	103,6	1,0	No
	10,0	103,7	1,0	No
	11,0	103,8	1,0	No
	12,0	103,9	1,0	No
	13,0	104,0	1,0	No

Noise data based on technical specification no.: 0007-9706 V00 2010-01-04.

Noise: Level 3 - Estimated - Mode 3 - 01-2010

Source Manufacturer

Source date	Creator	Created	Edited	Default
04-01-2010 13:33	EMD	07-07-2010 12:52	24-09-2010 14:41	No

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
80,0	4,0	97,9	1,0	No
	5,0	100,9	1,0	No
	6,0	102,6	1,0	No
	7,0	102,8	1,0	No
	8,0	102,9	1,0	No
	9,0	103,3	1,0	No
	10,0	103,6	1,0	No
	11,0	104,2	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
90,0	4,0	98,0	1,0	No
	5,0	101,3	1,0	No
	6,0	102,6	1,0	No
	7,0	102,8	1,0	No
	8,0	102,9	1,0	No
	9,0	103,3	1,0	No
	10,0	103,6	1,0	No
	11,0	104,6	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No
105,0	4,0	98,2	1,0	No
	5,0	101,6	1,0	No
	6,0	102,7	1,0	No
	7,0	102,8	1,0	No
	8,0	102,9	1,0	No
	9,0	103,3	1,0	No
	10,0	103,6	1,0	No
	11,0	105,1	1,0	No
	12,0	105,3	1,0	No
	13,0	105,4	1,0	No

Noise data based on technical specification no.: 0007-9703 V00, dated 2010-01-04.

WINWIND WWD-3-D90 3000 90.0

File D:\WindPRO Data\WTG data\WINWIND WWD-3-D90 3000 90.0.wtg

Company	WINWIND
Type/Version	WWD-3-D90
Rated power	3.000,0 kW
Secondary generator	0,0 kW
Rotor diameter	90,0 m
Tower	Other - unknown
Grid connection	50 Hz
Origin country	FI
Blade type	EU-90
Generator type	Variable
Rpm, rated power	16,0 rpm
Rpm, initial	5,0 rpm
Hub height(s)	88,0; 80,0; 90,0; 100,0 m
Maximum blade width	4,15 m
Blade width for 90% radius	1,78 m
Valid	Yes
Creator	EMD
Created	06-08-2003 11:43
Edited	06-08-2003 11:43

Power curve: Level 0 - calculated - 0 - 07-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
13-07-2009 00:00	EMD	04-12-2006 15:09	27-07-2009 16:08	No	25,0	1,225	0,0	Pitch	Standard pitch

Power curve

Wind speed [m/s]	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00
Power [kW]	0,00	0,00	94,00	211,00	373,00	604,00	901,00	1.299,00	1.753,00	2.281,00	2.740,00	3.041,00	3.070,00	3.070,00	3.070,00
Ce	0,000	0,000	0,377	0,433	0,443	0,452	0,452	0,457	0,450	0,440	0,407	0,355	0,287	0,233	0,192

Wind speed [m/s]	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00
Ce	0,160	0,135	0,115	0,098	0,085	0,074	0,065	0,057	0,050

Ct curve

Wind speed [m/s]	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00
Ct	0,10	0,10	0,10	0,80	0,82	0,84	0,79	0,72	0,66	0,59	0,53	0,46	0,40	0,33	0,28	0,23	0,20	0,16	0,13	0,12	0,12	0,11	0,11	0,10

Power curve: Level 0 - calculated - 0 - 11-2009
Source Manufacturer

Source date	Creator	Created	Edited	Default	Stop windSpeed [m/s]	Air density [kg/m3]	Tip angle [°]	Power control	CT curve type
15-11-2009 12:49	EMD	04-12-2006 15:09	15-01-2010 12:53	Yes	25,0	1,225	0,0	Pitch	User defined

Power curve

Wind speed [m/s]	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00
Power [kW]	0,00	0,00	94,00	213,00	381,00	616,00	926,00	1.313,00	1.771,00	2.303,00	2.739,00	2.971,00	3.059,00	3.070,00	3.070,00
Ce	0,000	0,000	0,377	0,437	0,453	0,461	0,464	0,462	0,455	0,444	0,407	0,347	0,286	0,233	0,192

Wind speed [m/s]	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Power [kW]	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00	3.070,00
Ce	0,160	0,135	0,115	0,098	0,085	0,074	0,065	0,057	0,050

Ct curve

Wind speed [m/s]	4,00	5,00	6,00	7,00	8,00	9,00	10,00	11,00	12,00	13,00	14,00	15,00	16,00	17,00	18,00	19,00	20,00	21,00	22,00	23,00	24,00	25,00
Ct	0,79	0,79	0,79	0,79	0,79	0,77	0,77	0,71	0,53	0,42	0,28	0,20	0,17	0,15	0,13	0,11	0,10	0,08	0,08	0,07	0,06	0,06

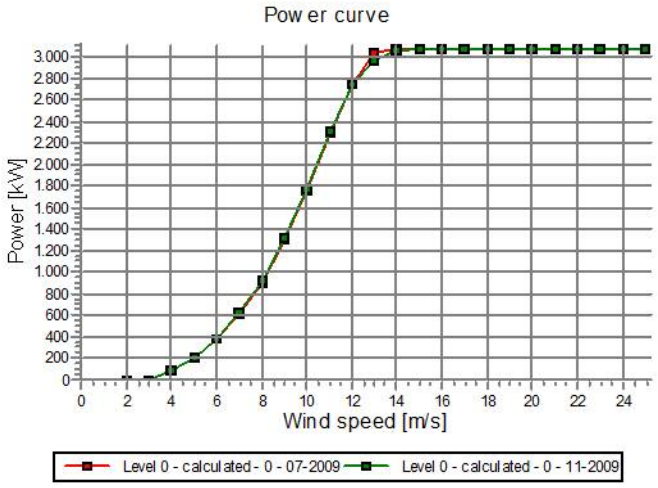
WINWIND WWD-3-D90 3000 90.0

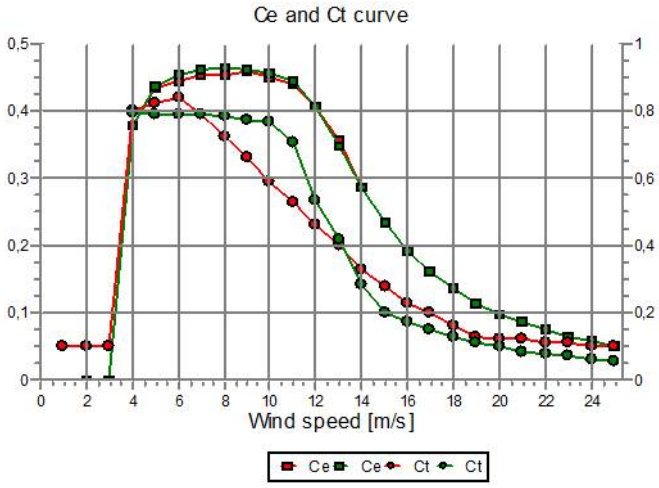
File D:\WindPRO Data\WTG data\WINWIND WWD-3-D90 3000 90.0.wtg

HP curve comparison

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	3.019	5.077	7.277	9.571	11.471	13.103
Level 0 - calculated - 0 - 07-2009	[MWh]	3.438	5.586	7.897	10.136	12.154	13.866
Check value	**[%]**	**-12**	**-9**	**-8**	**-6**	**-6**	**-6**
Level 0 - calculated - 0 - 11-2009	[MWh]	3.483	5.639	7.948	10.179	12.188	13.892
Check value	**[%]**	**-13**	**-10**	**-8**	**-6**	**-6**	**-6**

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.





Noise: Level 0 - measured - 0 - 05-2007
Source Windtest

Source date	Creator	Created	Edited	Default
15-05-2007 13:33	EMD	27-07-2009 16:09	27-07-2009 16:12	Yes

Hub height [m]	Wind speed [m/s]	Lwa,ref [dB(A)]	Wind speed dependency [dB(A)/m/s]	Pure tones
All	95%	104,7	1,0	No
	5,0	95,9	1,0	No
	6,0	99,8	1,0	No
	7,0	102,5	1,0	No
	8,0	104,1	1,0	No
	9,0	104,8	1,0	No
	10,0	104,9	1,0	No
	11,0	104,9	1,0	No

ANNEX 6 Installation details of San Marco and Molinara wind stations.

SCHEDA ANEMOMETRO DI SAN MARCO DEI CAVOTI-1

MACCHIONI

	NUMERO SERIE		SLOPE		OFFSET		GRADI	
NOMAD DATA LOGGER								
WIND VANE 27 metri	**50351**		**-**		**-**		**50°**	
WIND SPEED 15 metri	**3903**		**0.763**		**0.352**		**300°**	
WIND SPEED 30 metri	**3904**		**0.761**		**0.367**		**300°**	
COORDINATE UTM	**LATITUDINE**	**0**	**4**	**9**	**1**	**2**	**2**	**2**
	LONGITUDINE	**4**	**5**	**7**	**8**	**1**	**2**	**1**

SCHEDA ANEMOMETRO DI SAN MARCO DEI CAVOTI-2

IELARDI

	NUMERO SERIE		SLOPE		OFFSET		GRADI	
NOMAD DATA LOGGER								
WIND VANE 35 metri	**6501**		**-**		**-**		**225°**	
WIND SPEED 10 metri	**2681**		**0.768**		**0.331**		**225°**	
WIND SPEED 30 metri	**01-583**		**0.778**		**0.259**		**225°**	
WIND SPEED 40 metri	**01-579**		**0.774**		**0.301**		**225°**	
COORDINATE UTM	**LATITUDINE**	**0**	**4**	**9**	**0**	**6**	**7**	**0**
	LONGITUDINE	**4**	**5**	**7**	**9**	**2**	**2**	**9**

SCHEDA ANEMOMETRO DI MOLINARA-1

PIANO PANTANO

		SLOPE	OFFSET	GRADI
NOMAD DATA LOGGER	**06447**	**-**	**-**	
WIND VANE 45 metri	**50231**	**-**	**-**	**360°**
WIND VANE 25 metri	**50232**	**-**	**-**	**360°**
WIND SPEED 30 metri	**179500073064**	**0.758**	**0.38**	**360°**
WIND SPEED 40 metri	**179500073069**	**0.759**	**0.33**	**360°**
WIND SPEED 50 metri	**179500073074**	**0.76**	**0.33**	**360°**
WIND SPEED 50 metri	**179500073080**	**0.759**	**0.39**	**180°**
COORDINATE UTM	**LATITUDINE**	**0 4 9**	**3 7**	**4 1**
	LONGITUDINE	**4 5 7**	**4 5**	**7 0**
ALTEZZA QUOTA CAMPAGNA H=900 MT				