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WIND RESOURCE ASSESSMENT

FINAL REPORT

KOSOVO

Zurich, December 6th, 2010

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1. INTRODUCTION

Kosovo declared its independence in February 2008, and is the youngest European state. It has already been acknowledged by most countries and is classified as a potential candidate country by the EU-Commission. The conflict over the past decades has significantly weakened the country and suppressed development. Despite the large amount of subsidies, Kosovo is still one of the poorest countries of Europe with high unemployment and poverty, a weak industry and enormous foreign trade deficits.

This current situation coupled with their attempt to join the EU, pose high challenges for Kosovo. The increasing demand for energy along with the environmental problems associated with today's energy production, call for new measures to be taken. The main energy production in Kosovo is provided by two coal-fired power plants with outdated technology, causing excessively high levels air pollution. Beside the environmental problems, electricity shortages are a major problem. Regular power cuts, lasting several hours, are a daily occurrence. Renewable energy resources are practically untouched.

The Government is aware of the importance of energy politicy changes as already illustrated in the "Energy strategy of Kosovo", published in 2005. One of the main strategies highlights the need to improve the conditions for private investment in the renewable energy sector, in order to increase their share of total production. A publication by the Ministry for Environment states that the promotion of renewable energies in Kosovo is one of the main strategies for environmental improvement[1].

In this context, the conference „Environment Protection and Energy Efficiency" was organized by the Ministry of Environment in October 2008. The conference came to the conclusion, that:

- Rapid changes are necessary in the energy sector to improve the quality of environment and living conditions, as well as to fulfil the EU-requirements.
- Resources for renewable energies are abundant in Kosovo and these could considerably substitute the conventionally produced power.
- Studies are necessary to evaluate the full potential of different energy sources in Kosovo.
- A wind monitoring program should be initiated, as reliable data regarding wind regimes in Kosovo are not available.

[1] Ministry of Environment and Spatial Planning: State of Environment Report. EPA, Prishtina, Kosovo. 2008

A study by the European Agency for Reconstruction and the Ministry of Energy regarding the potential for renewable energies in Kosovo[2] arrived at similar conclusions.

Following these conclusions, NEK Umwelttechnik AG (NEK) has decided to undertake a feasibility study for the use of wind energy in Kosovo. This project is financially supported by REPIC and approved by the Kosovo Ministry of Energy and Mines and the Ministry for Environment and Spatial Planning.

For the full project, we have defined the following 3 phases:

Phase 1: Pre-study to identify the general conditions for the development of wind energy projects in Kosovo *(completed in October 2009).*

Phase 2: Implementation of a wind measurement campaign for the preparation of a wind map *(completion presented with report at hand).*

Phase 3: Pilot project.

This report presents the results of phase 2 and covers our comprehensive wind measurement campaign in Kosovo. The study is intended to provide information on wind conditions and to identify suitable sites for wind energy developments. So far, no information on wind conditions are available for Kosovo. It was therefore a prerequisite for any wind energy development to estimate the conditions throughout the country. The final goal of this phase is, to deliver a reliable wind resource map of the country.

Wind has been measured for one year at ten sites throughout Kosovo. This report presents the results of the study.

[2] European Agency for Reconstruction, MEM: Assessment Study of Renewable Energy Resources in Kosovo. Denmark. 2008.

2. WIND RESOURCE ASSESSMENT

2.1 WIND MEASUREMENTS

2.1.1 Measurement sites

As there was hardly any information on wind conditions available for Kosovo, the objective for the campaign was to cover a large part of the country cost-efficiently. Therefore, it was decided to install measurement equipment throughout the country on existing GSM-towers. The local mobile network operator "IPKO" offered NEK the use of their towers.

The measurement sites have been selected considering several aspects:

- Availability of IPKO GSM-Towers
- Equal distribution of sites around the country
- Prospective wind conditions; e.g. higher elevation, absence of forest cover
- Accessibility
- Environmental issues

After investigation of the possible sites, including site visits, 10 sites were selected for the installation of measurement equipments (see Figure 1 and Table 1).

Table 1: Locations and tower heights for the selected sites.

Site name (IPKO)	City	Tower type	Altitude a.s.l. in m	Height in m
BBUT	Lypjan	Lattice	1055	37
ETEC	Lypjan	Cosmo	733	33
EBUD	Gjilan	Cosmo	592	33
BBUD	Theranda	Lattice	1667	38
SDUL	Theranda	Mono	858	34
WGJU	Klina	Lattice	578	44
EABR	Abri e Eperme	Lattice	763	45
BBZYM	Prizren	Lattice	658	37
SSTA	Kacanik	Lattice	578	37
BBZAT	Rahovec	Lattice	1016	35

Figure 1: Wind measurement sites in Kosovo.

The very northern part, around Mitrovice, and the very western part around Peja as well as the southern mountain region south of Prizren have not been covered with our measurements. Most of these regions are not suitable for developments due to the topographic conditions (steep slopes, difficult access and lack of grid connection, etc.).

2.1.2 Instruments and sensors

The equipment employed for our wind measurement campaign was installed successfully at all the selected sites during July 2009. At each site, two anemometers to measure the wind speed and one wind vane to measure the wind direction are in operation. At the sites at higher altitudes (BBUT, BBZAT and BBUD), thermometers were installed. This is necessary as the instruments freeze during periods of cold weather. Except for the thermometers, all instruments were fixed onto an extra pole, which was installed on top of the existing towers. Depending on the height of the GSM-tower, the absolute height of the anemometers is between 33 m and 45 m above ground. The instruments used for the installations are shown in Table 2. The set-up of the installations can be seen in Figure 2 and 3. A detailed photograph documentation of the installations can be found in Annex 1.

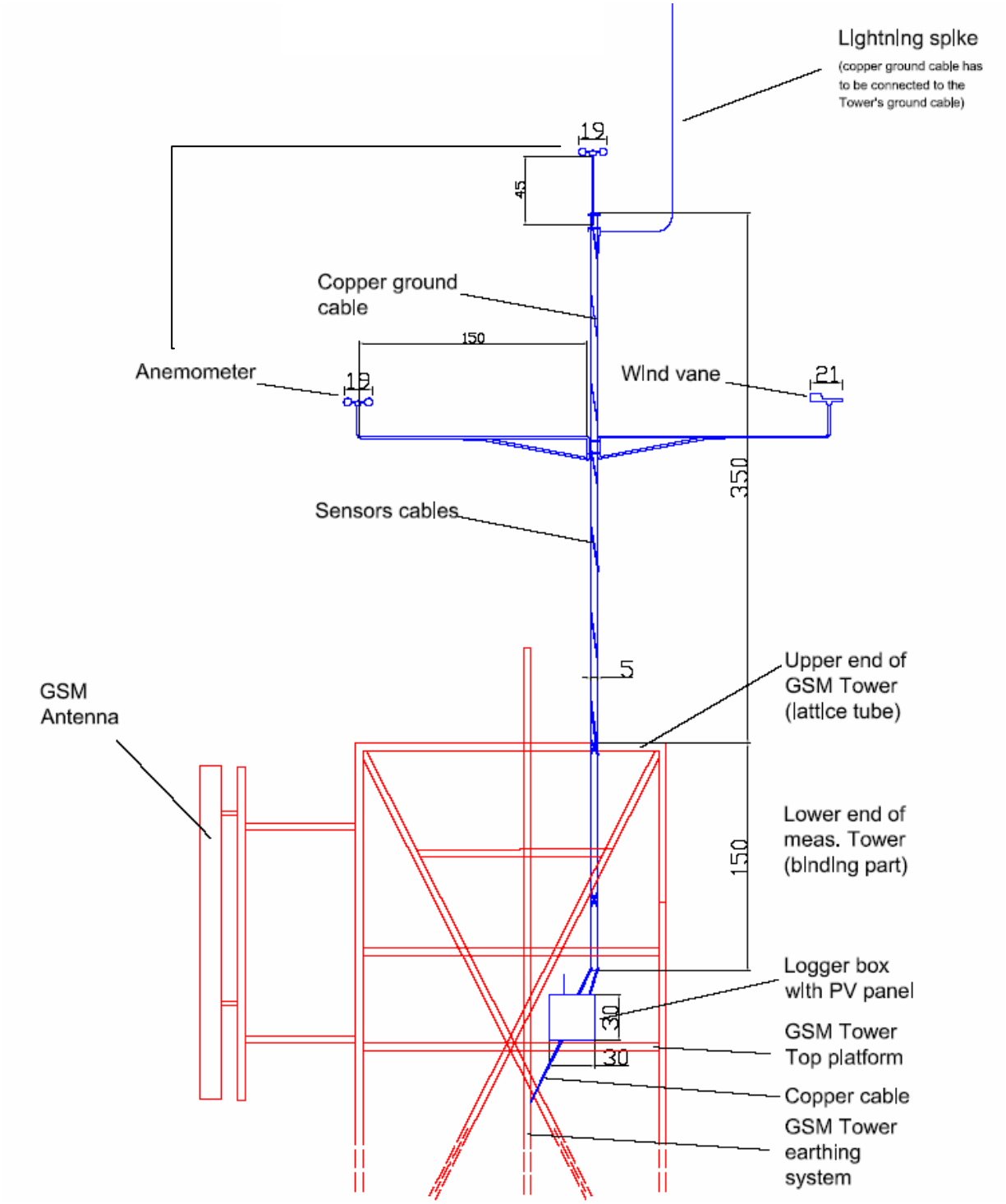


Figure 2: Example of an installation on a GSM-Tower.

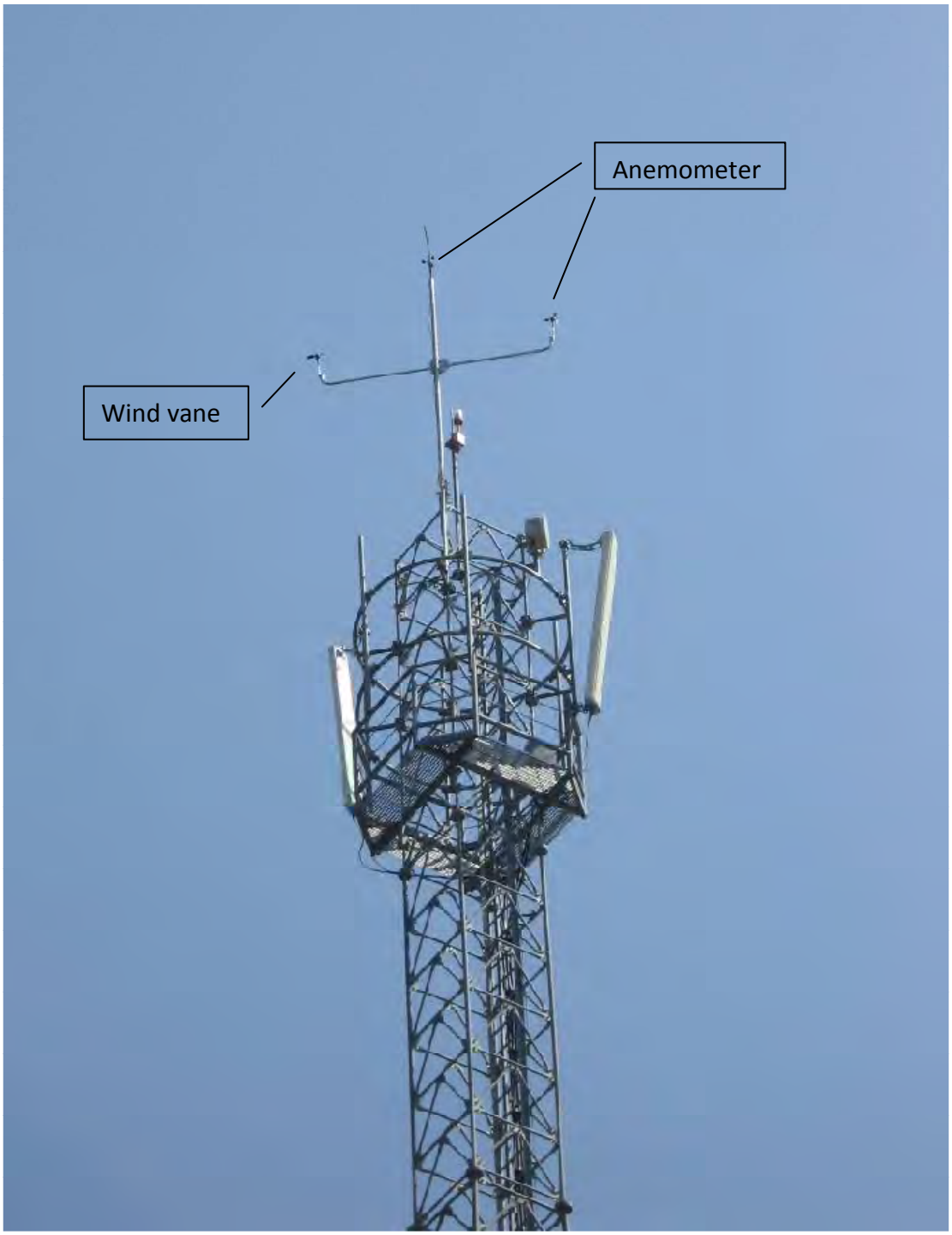


Figure 3: Example of an installation on top of a GSM-Tower (WGJU).

Table 2: Equipment used for the installation.

Parameter	Instrument type
Wind speed	NRG #40C
Wind direction	NRG 200P
Temperature	NRG #110S
Logger	NRG SymphoniePLUS

2.2 DATA ANALYSIS

All data cleaning and analysis of the wind data has been performed using Windographer. The full data analysis reports are given in Annex 2.

2.2.1 Data cleaning

Between July 22nd and 24th, 2009, all the equipment had been installed and started operating. The data has been checked on a weekly basis to detect possible defects in time and to limit any data losses. Nevertheless, some difficulties during the measurement period has resulted in some data loss:

- A lightning strike destroyed the measurement equipment at BBZAT on September 28th, 2009. Until the time the equipment was restored on October 23rd, 2009, about one month of data was lost.
- Icing of the instruments has caused data loss at all the sites (from October to March). The worst of the icing occurred at the higher locations (BBUD, BBZAT, BBUT).
- Damage of both anemometers at BBUD on April 21st, 2010; the cause could not be identified. Data was lost from that date and the equipment could not be repaired.

Table 3 shows the percentage of unavailable data per month for each site. As for the sites BBUT and BBZAT, data losses added up to more than one third of the total time, it was decided to exclude these sites from the wind assessment.

Table 3: Percentage of data loss per month. In blue losses due to icing; in red losses due to other reasons (see above).

	Aug. `09	Sep.` 09	Oct.` 09	Nov.` 09	Dec.` 09	Jan.` 10	Feb.` 10	Mar.` 10	Apr.` 10	May` 10	Jun.`10	Jul.` 10
BBUT	-	-	4 %	8 %	39 %	59 %	55 %	23 %	30 %	100 %	100 %	100%
ETEC	-	-	1 %	1 %	3 %	18 %	7 %	2 %	-	-	-	-
EBUD	-	-	1 %	4 %	7 %	6 %	3 %	-	-	-	-	-
BBUD	-	-	9 %	10 %	41 %	67 %	58 %	38 %	-	-	-	-
SDUL	-	-	-	2 %	8 %	8 %	11 %	-	-	-	-	-
WGJU	-	-	-	4 %	4 %	3 %	7 %	4 %	-	-	-	-
EABR	-	-	3 %	7 %	1 %	4 %	10 %	-	-	-	-	-
BBZYM	-	-	-	-	16 %	5 %	6 %	2 %				
SSTA	-	-	-	-	7 %	5 %	7 %	1 %	-	-	-	-
BBZAT	-	10 %	75 %	10 %	40 %	55 %	57 %	33 %	-	-	-	-

The following wind data assessment is based on a 12-month measuring period (from August 2009 until July 2010). At all sites, two anemometers were installed. To test on possible distortions of anemometers, a scatter plot has been created for each site (anemometer 1 versus anemometer 2). It was shown that only minor differences occurred due to:

- icing of one anemometer
- tower shading
- small height differences of anemometers

To eliminate these effects, only the higher value of both measurements has been used. With this procedure, one time line per site was produced, which was used for the analysis.

2.2.2 Mean wind speed

From the available data, the mean wind speed has been calculated for each site. The mean is computed by averaging the recorded 10 minutes measurement values. Figure 4 and table 4 show the monthly mean wind speed for all sites.

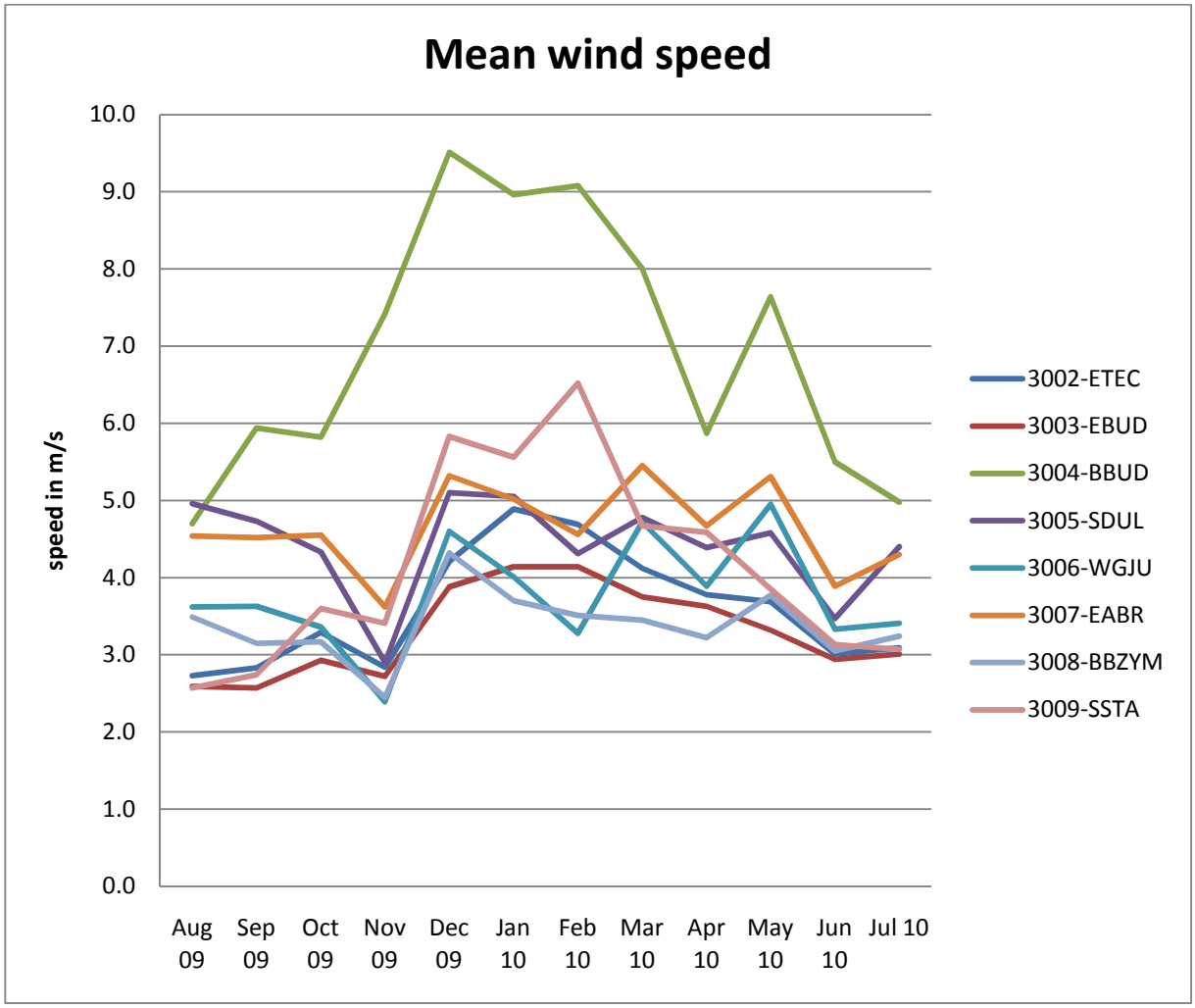


Figure 4: Monthly mean wind speed at ten sites, 01.08.2009 – 31.07.2010.

The highest wind speed has been measured at BBUD, in Budakova. This site is located at an altitude of 1'667 m above sea level, being the highest location of all the sites. Unfortunately, the results from the two other sites at high altitudes could not be evaluated due to excessive data loss (see above). All data show higher wind speeds during winter months and lower speeds during summer. The problems caused due to icing may have lead to an underestimation of wind speeds as maybe not all icing was detected. Especially during the winter months, the data might be severely distorted.

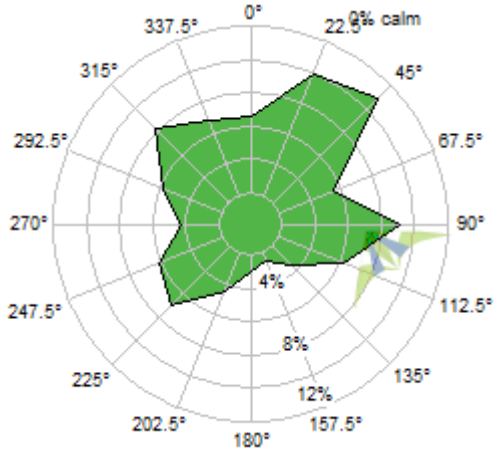
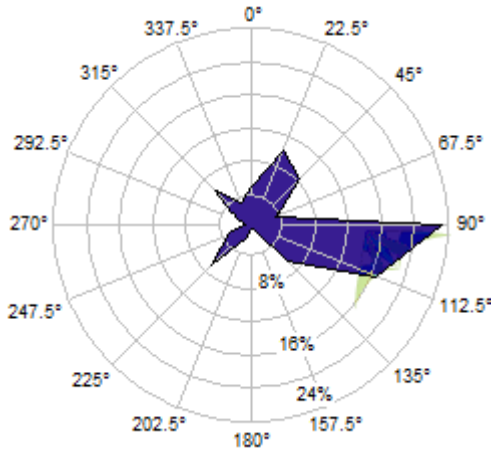
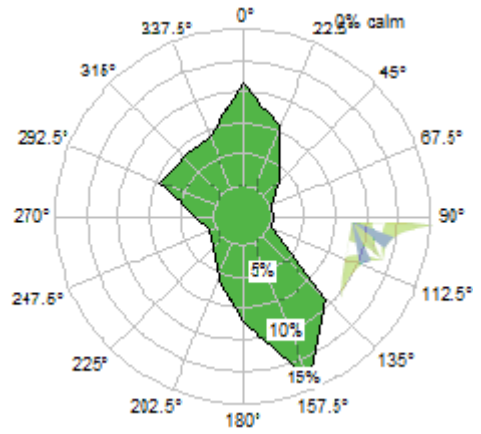
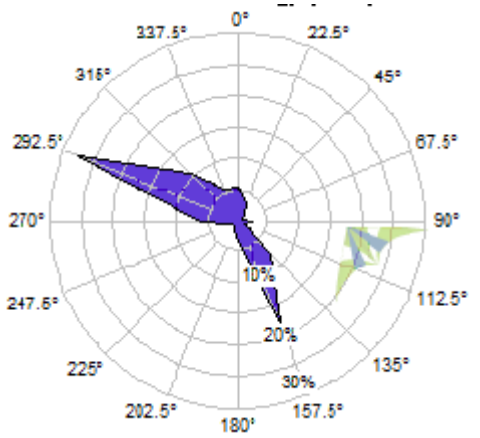
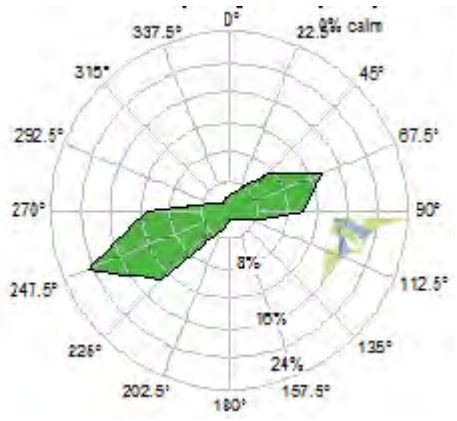
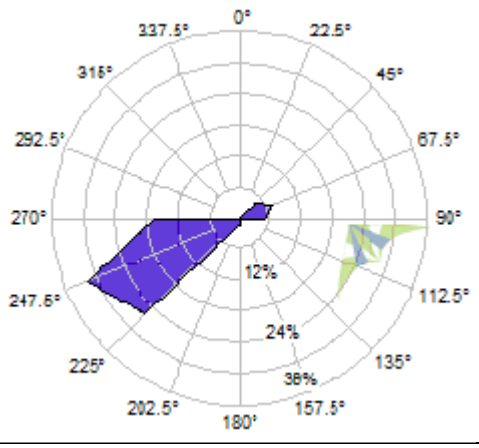
Table 4: Monthly mean wind speeds (in m/s) at assessed sites.

	3002-ETEC	3003-EBUD	3004-BBUD	3005-SDUL	3006-WGJU	3007-EABR	3008-BBZYM	3009-SSTA	Total mean
Aug 09	2.7	2.6	4.7	5.0	3.6	4.5	3.5	2.6	3.7
Sep 09	2.8	2.6	5.9	4.7	3.6	4.5	3.2	2.7	3.8
Oct 09	3.3	2.9	5.8	4.3	3.4	4.6	3.2	3.6	3.9
Nov 09	2.8	2.7	7.4	2.9	2.4	3.6	2.5	3.4	3.5
Dec09	4.2	3.9	9.5	5.1	4.6	5.3	4.3	5.8	5.3
Jan 10	4.9	4.1	9.0	5.1	4.0	5.0	3.7	5.6	5.2
Feb 10	4.7	4.1	9.1	4.3	3.3	4.6	3.5	6.5	5.0
Mar 10	4.1	3.8	8.0	4.8	4.7	5.5	3.5	4.7	4.9
Apr 10	3.8	3.6	5.9	4.4	3.9	4.7	3.2	4.6	4.3
May 10	3.7	3.3	7.6	4.6	5.0	5.3	3.8	3.9	4.6
Jun 10	3.0	2.9	5.5	3.5	3.3	3.9	3.1	3.1	3.5
Jul 10	3.1	3.0	5.0	4.4	3.4	4.3	3.2	3.1	3.7
1 Year	3.6	3.3	7.0	4.4	3.8	4.6	3.4	4.1	

2.2.3 Wind direction

At all sites, one wind vane has been installed to measure the 10 minute mean values of the wind direction. Wind roses for all sites have been calculated to show the predominant wind direction. In Figure 5, the frequency roses (in %) and energy roses (kWh/m^2/year) are depicted.

It can be seen, that the predominant wind direction (in frequency and energy) differs from site to site. This is due to the considerable distances between the sites and the topographic conditions.

Frequency (%)	Energy (kWh/m2/year)
3002_ETEC	
	
3003_EBUD	
	
3004_BBUD	
	

3005_SDUL	
3006_WGJU	
3007_EABR	

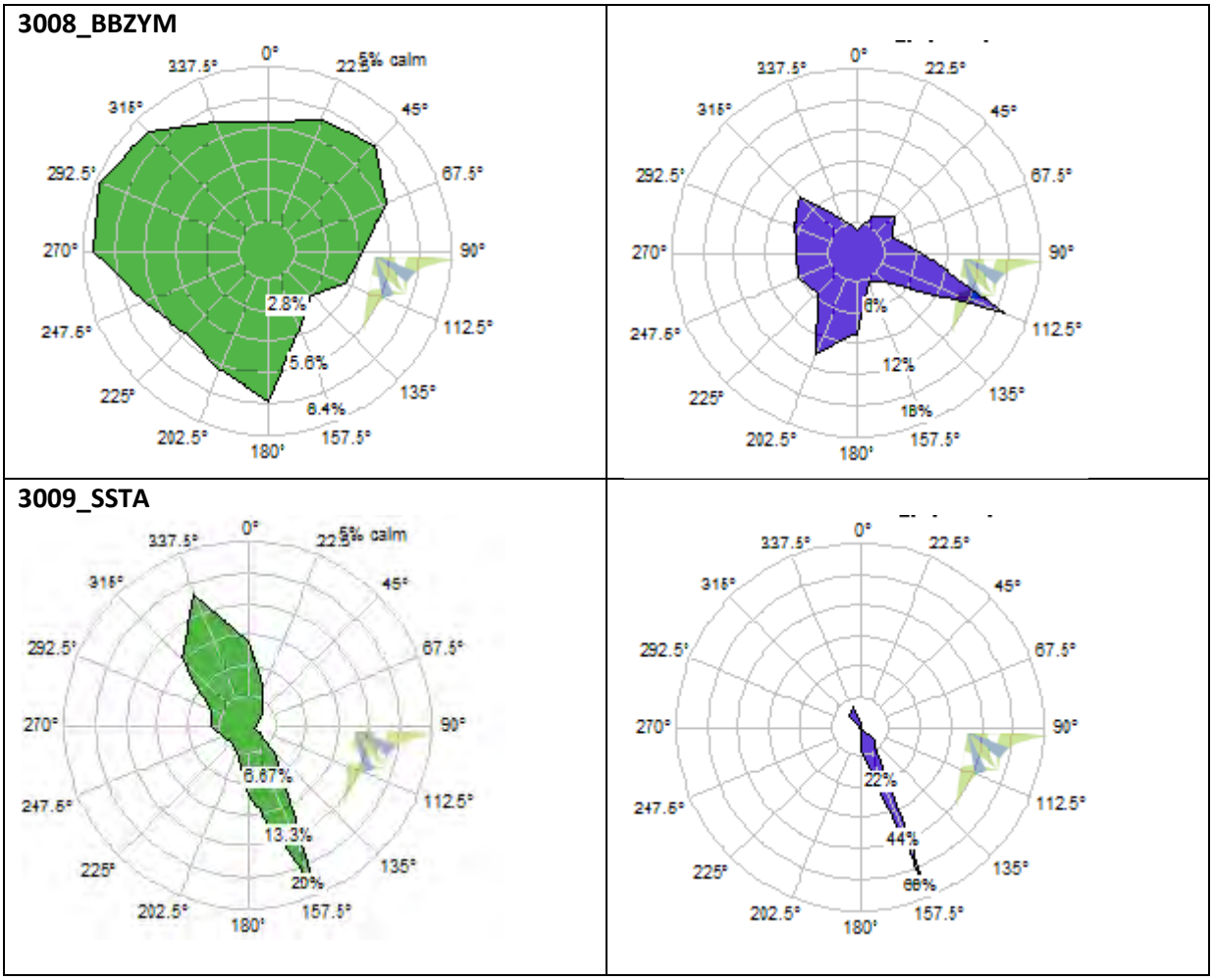


Figure 5: Wind direction for the ten measurement sites, 01.08.2009 - 31.07.2010.

2.2.4 Weibull distribution

Weibull distributions are often used to describe the characteristics of a wind speed distribution. This has also been calculated for each site using the WAsP algorithm, which finds the Weibull distribution, which matches that actual distribution in terms of two parameters: the mean wind power density and the proportion of values that exceed the mean.

The relevant values for the Weibull distribution of each site are shown in Table 6. The variables are described in Table 5.

Table 5: Description of statistical parameters for a fitted distribution.

Variable	Description
Weibull *k*	The shape factor of the two-parameter Weibull distribution.
Weibull *c*	The scale factor of the two-parameter Weibull distribution.
Mean	The arithmetic mean (average) value of the distribution, which may not be equal to measured mean.
Proportion Above Mean	The fraction of values in the distribution that exceed the mean value.
Power Density	The mean wind power density of the distribution.
R Squared	The goodness-of-fit parameter that indicates how closely the fitted Weibull distribution matches the frequency histogram of the measured data. Values approaching one indicate a good fit.

Table 6: Weibull distribution for wind speeds of the measurement sites.

	Measured mean m/s	Weibull-k	Weibull-c	Weibull mean m/s	Proportion > mean	Power density	R squared
3002_ETEC	3.53	1.450	4.133	3.747	0.420	92.2	0.879
3003_EBUD	3.26	1.088	3.063	2.967	0.381	78.6	0.923
3004_BBUD	6.42	1.825	7.487	6.654	0.447	380.0	0.971
3005_SDUL	4.61	1.559	4.991	4.486	0.429	142.2	0.991
3006_WGJU	3.79	1.343	4.011	3.682	0.410	99.2	0.977
3007_EABR	4.66	2.069	5.548	4.915	0.459	134.3	0.976
3008_BBZYM	3.39	1.412	3.732	3.397	0.417	71.7	0.983
3009_SSTA	3.98	1.082	3.921	3.805	0.380	167.7	0.990

3. WIND MODELLING

3.1 CALCULATION

The wind modelling was undertaken using WindPRO in combination with WAsP, which calculates wind statistics by parameterising the influence of topography, roughness and other obstacles.

In a first step, a wind statistic/Wind Atlas was generated from the cleaned data for each site, the surrounding contours and the roughness. Local terrain effects were removed, so that a regional wind climate could be established, which then was used to create a wind resource map for the specific hub heights. A resource map for a hub height of 80 m has been calculated using the cleaned data of the 8 towers (excluding BBZAT and BBUT).

3.2 INPUT DATA

Topography

For the elevation model, contours from the SRTMA (Shuttle Radar Topographic Mission) have been used and converted to 10 m contour lines. The total area covered by the contour lines used for the assessment is about 80 x 80 km.

Roughness

For simplification and as no appropriate data was available, a roughness class of 1.5 (farm land, rather open) has been selected for the total area (100 x 100 km).

3.3 WIND RESOURCE MAP

The wind resource map has been calculated taking into account all the wind data of the 8 analysed sites. Therefore, the results for each raster point on the map were calculated with information from all wind statistics, weighting them depending on their distance to the point. A resolution of 200 m has been selected for the map. Figure 6 shows the computed map for a height of 80 m above ground (see also Annex 3).

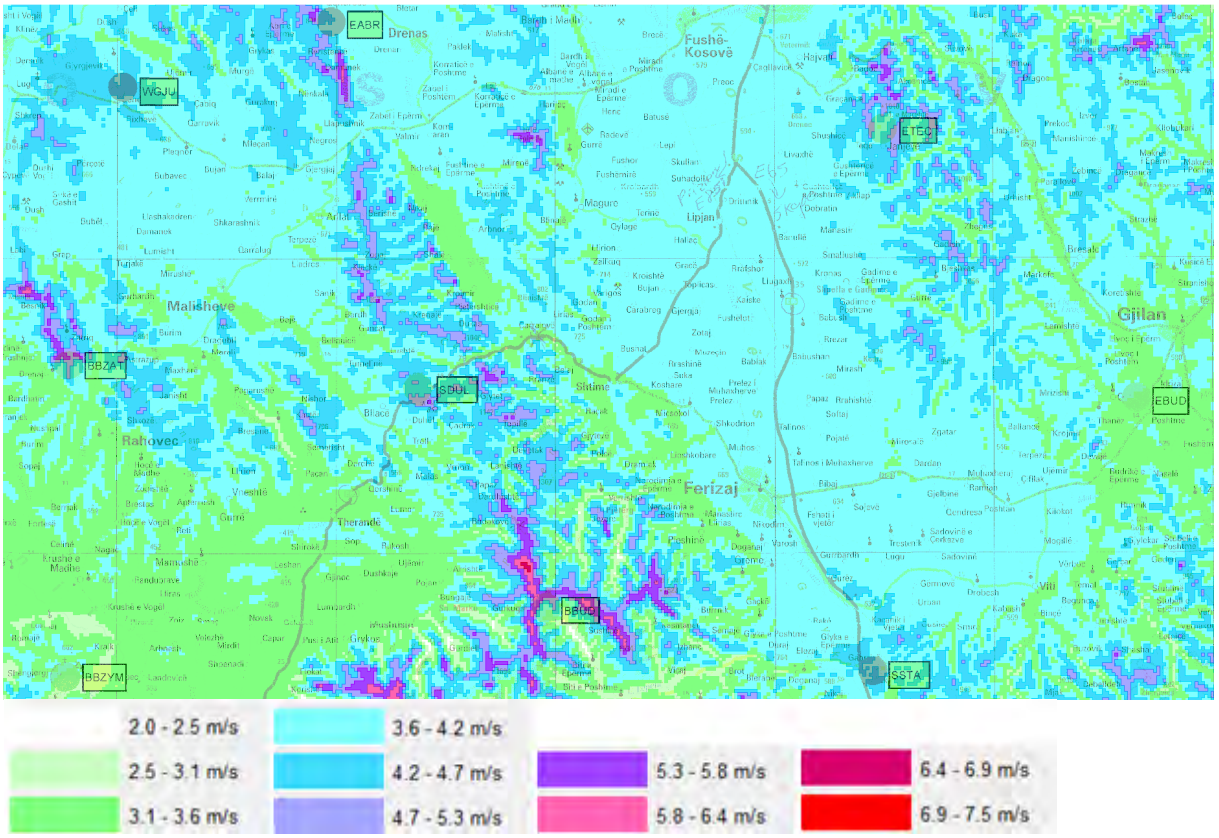


Figure 6: Wind resource map at 80 m above ground.

4. FRAMEWORK OF WIND ENERGY IN KOSOVO

A detailed description of the legal, political framework and the relevant infrastructure is given in our report "Feasibility Study for the Implementation of Wind Energy in Kosovo. Phase 1", dated October 30th, 2009. This report represents the results of Phase 1 of our project in Kosovo. The following provides a short resume and update:

4.1 GENERAL

Kosovo is a nation in transition that has a high level of poverty, low educational attainment, and a government that is seeking foreign expertise and investment to aid its development. Renewable energy is an economic development activity that is particularly favoured by the government, given the energy crisis in the country. In addition, their desire to accede to the EU brings recognition of the need for renewable energy generation in the nation to meet EU standards. The government's lack of capital to pursue renewable energy projects appears to drive their interest in reducing barriers to investment.

4.2 ENERGY SECTOR

Kosovo's main provider and producer of energy is the local operator KEK. The two lignite power plants of KEK produce 98 % of the energy used in the country. It is foreseen to disconnect these two out-dated plants from the grid in 2024, and replace them by a new plant in 2014. The main concern in the energy sector is the shortness of supply leading to regular power cuts, together with the environmental degradation related to the operation. To meet the increasing demand for energy (a 25 % increase in annual consumption is foreseen until 2020), new sources of power production must be developed.

Until now, the country is still in the beginning of the exploitation of its renewable resources for energy. Only few small size hydropower plants are installed with a total annual production of roughly 50`000 MWh. In the last few years sporadic project developments for wind energy have been initiated. So far, only 5 small-size turbines (second hand) have been installed. Although several large-scaled projects are being planned, the feasibility of those projects might be questioned. Unfortunately, unserious activities in the sector, limited knowledge and experience of the developers and local authorities have so far hindered the development of well-planned projects in this sector.

4.3 LEGAL FRAMEWORK

In collaboration with the mission of the United Nations (UNMIK), several policies have been developed and are now in force, which are oriented towards the EU-laws and regulations. The energy market is regulated by an independent energy regulation office (ERO). New feed-in tariffs for renewable energies (excluding large-scale hydropower plants) are being fixed at 84 €/MWh. A Power Purchase Agreement can be obtained for a five year period with an option for extensions for an additional five years. This period is intended to be extended in near future to ten plus ten years, as stated by the Ministry of Energy and Mining.

Although the country has almost no experience with the permitting procedure for a wind park, a theoretical proceeding and a number of required licenses and permits are defined below (table 7).

Table 7: Permits and licenses required to construct a wind farm in Kosovo

Permit/Fee	Institution Requiring*	Law/Rule Requiring
Registration as business organization	Ministry of Trade and Industry	
Certificate of financial soundness	Energy Regulatory Office*	Rule on Licensing Energy Activities, Article 23.2
Connection Agreement	KOSTT*	Law on Electricity, Article 10.1
Environmental Protection Permit (for installation > 5 MW)	Ministry of Environment and Spatial Planning	Law on Environment
Public Supply License	Energy Regulatory Office	Rule on Licensing Energy Activities, Article 23.2
Power Purchase Agreement	Energy Regulatory Office*	Law on Electricity, Article 21.3
Processing application fee to ERO	Energy Regulatory Office	Ibid, Article 7.1
Application for Construction of New Generation Capacities	Energy Regulatory Office	Ibid, Article 27.1
Application for Construction of New Generation Capacities	Municipalities	Ibid, Article 27.1
Certificates of Origin	ERO	Law on Electricity, Article 10.1
Annual License to operate energy generating facility	ERO	Ibid, Article 28

*Permits are required for approval of construction and operation, but need to be obtained from other agencies.

4.4 COMMERCIAL LEGISLATION

The uncertain legal status of Kosovo has created a business climate that has dampened investment. Kosovo is striving to create a commercial climate favourable to international investors. It has intentionally done this as it seeks international businesses to help with their development needs, especially in the energy sector. Businesses are easy to establish with minimal registration costs. An import tariff of 16 % (sometimes stated to be 10 %) on goods is comparable to other nations in Europe, less than others in the Balkans. Licenses to construct and operate energy generating facilities do not appear to require onerous procedures or information to obtain. The maximum corporate tax is 10 % and rules to prevent double taxation are in place.

The existing legal framework in Kosovo allows incentives for foreign and local investors. The tax code permits carrying forward of losses. The Corporate Income Tax Regulation No. 03/L-113 provides for a special allowance: new assets can be reduced from the tax base (10 percent of the cost of the acquisition of the asset). A multilateral Investment Guarantee Agency MIGA (a member of the World Bank Group) states that it guarantees investments in Kosovo in the value of 20 million Euro, while the US Overseas Private Investment Corporation (OPIC) also provides political risk insurance for foreign investors. Kosovo joined the IMF and the World Bank in 2009.

5. DEVELOPMENT OF A PILOT PROJECT

5.1 BACKROUND

From the beginning, the intention to start activities in Kosovo and to conduct this comprehensive wind measurement study throughout the country was, to develop a wind energy project in the country, if conditions would be suitable.

In phase 1, the framework conditions were identified (summarized in chapter 3), while this report presents the results of phase 2, namely the local wind conditions. Results from both phases have been encouraging and suggest that developments in the wind energy sector in Kosovo are not only possible, but necessary and highly desired by the Government of Kosovo.

The government has implemented the required policies to promote and realize wind energy projects in the country, such as a defined permitting procedure, feed-in tariffs and a power purchase agreement.

From the assessment of wind resources, it can be seen that the wind conditions are promising at different sites namely those at higher altitudes.

Taking into account the results of wind measurements, local infrastructure, availability of space and distance to the grid, a suitable site has been identified by NEK Umwelttechnik AG for further development.

5.2 LOCATION

The site for the planned development belongs to the municipality of Rahovec (Orahovac) in the western part of the country, along the mountain ridges around the village of Zatriq (Figures 7 and 8). Although we have a wind installation at this site on top of a GSM-tower (at 47 m), unfortunately too much data was lost for it to be included in the analysis. Nevertheless, the data we obtained from the site showed good results, as well as the results from the wind resource map. The locations are at about 1’000 m above sea level. The wind map shows an average wind speed of 4.7 - 5.8 m/s for the area (Figure 9) . Connection to the grid is possible within a distance of 4 - 6 km.

The region is characterized by small-scale agricultural activities, and like the rest of the country suffers from high unemployment and poverty.

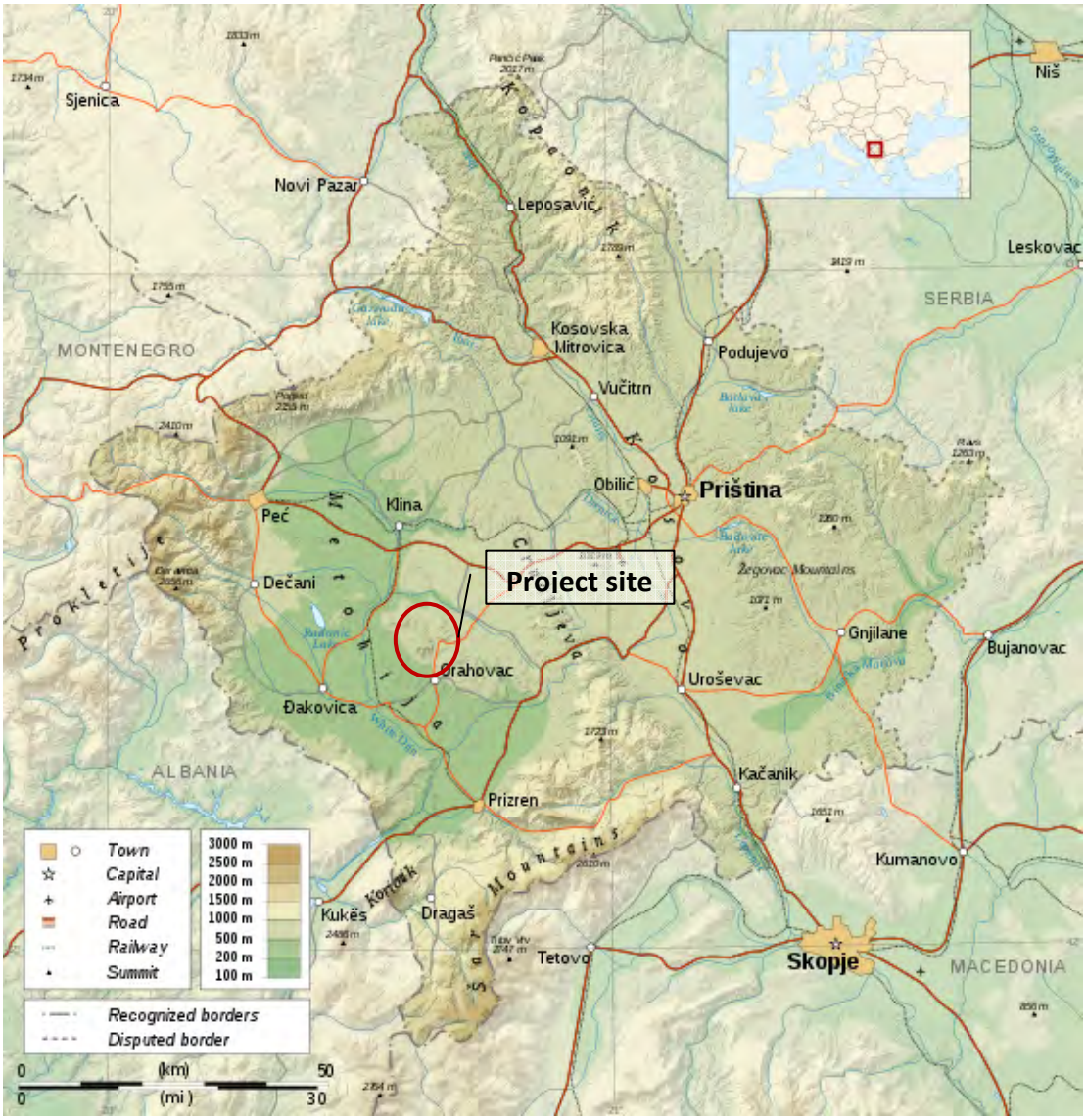


Figure 7: Location of project site in the municipality of Rahovec.

Figure 8: Satellite picture of the project area (3-D view). Elevations are doubled. Locations are on ridges around Zatriq (yellow pin).

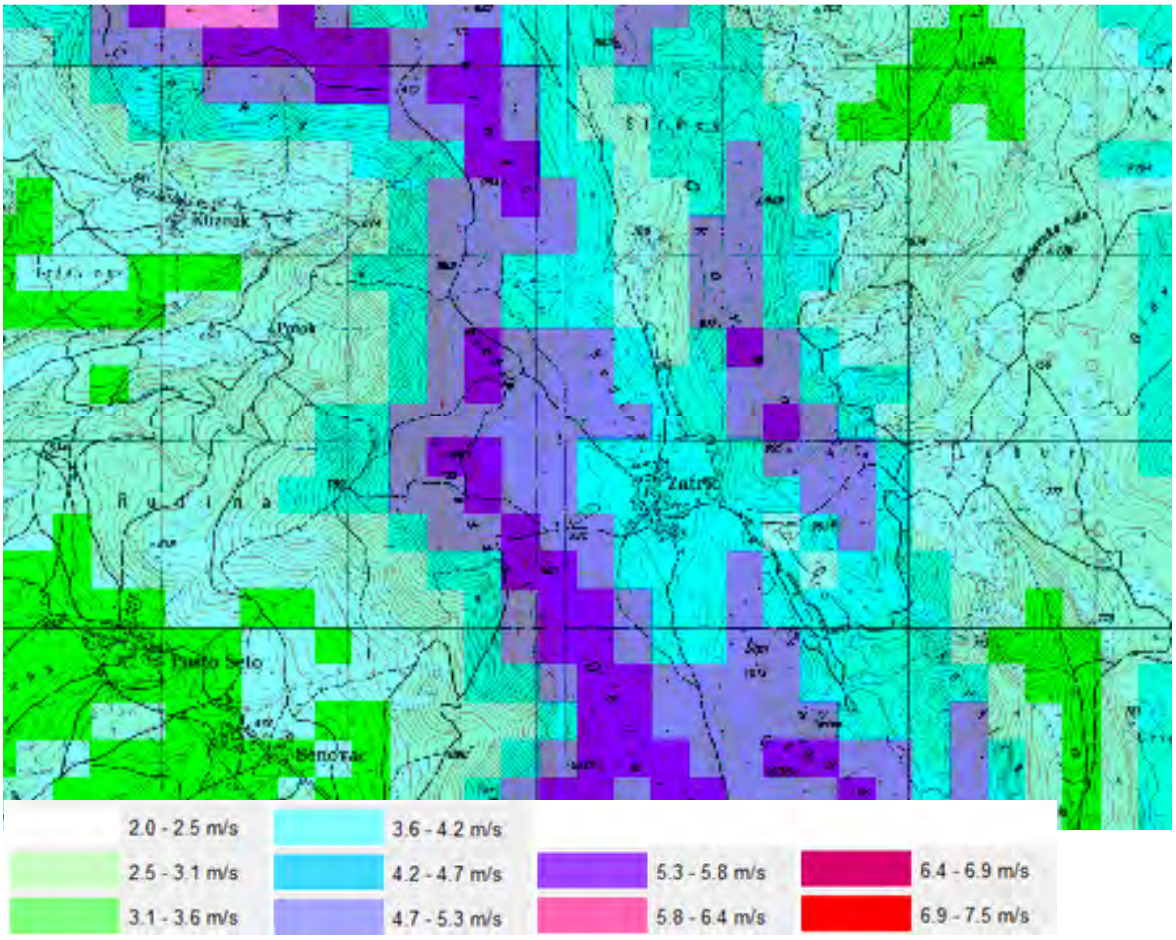


Figure 9: Wind resource map of Zatriq for 80 m above ground.

5.3 WIND PARK

A preliminary layout, considering the topographic conditions, has been drafted to give an idea of the wind energy potential at that specific site (Figures 10 and 11). The drafted layout consists of 10 turbines with a power capacity of 2 MW and a hub height of 80 m each. The total capacity of the wind park makes up 20 MW. Using the wind resource map (see above), an energy output calculation (PARK) with WindPRO was undertaken (see Annex 4).

The results of the park calculation (with REpower MM 92, 2 MW) give an annual electricity output of 36'400 MWh, resulting in an average annual output of 3'630 MWh and 1'640 full load hours per turbine. The mean wind speeds at the turbine locations range from 4.8 to 5.7 m/s, with a mean of 5.3 m/s.

Nevertheless, it is important to mention that these numbers only give a rough estimate, due to:

- Significant distance of measurements used to produce the wind resource map.
- Low resolution (200 m) of the resource map.
- Simplification procedure in the calculation of the resource map (e.g. only a single roughness value).
- Incomplete data in measuring time lines due to icing incidents.
- Missing data for the hub height, therefore large extrapolation during resource map calculation.
- Miscellaneous effects.

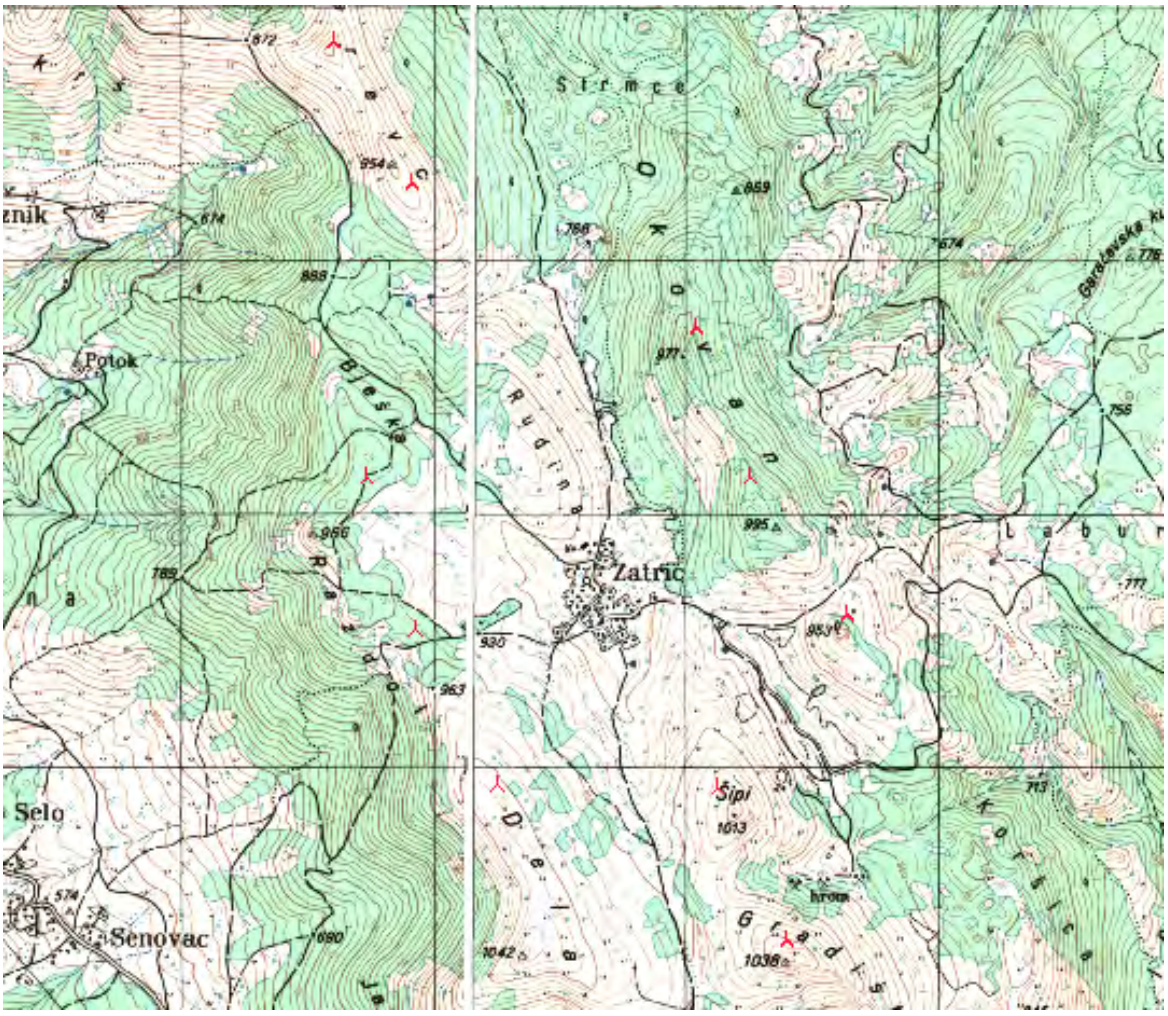


Figure 10: Draft layout of potential wind farm at Zatriq.

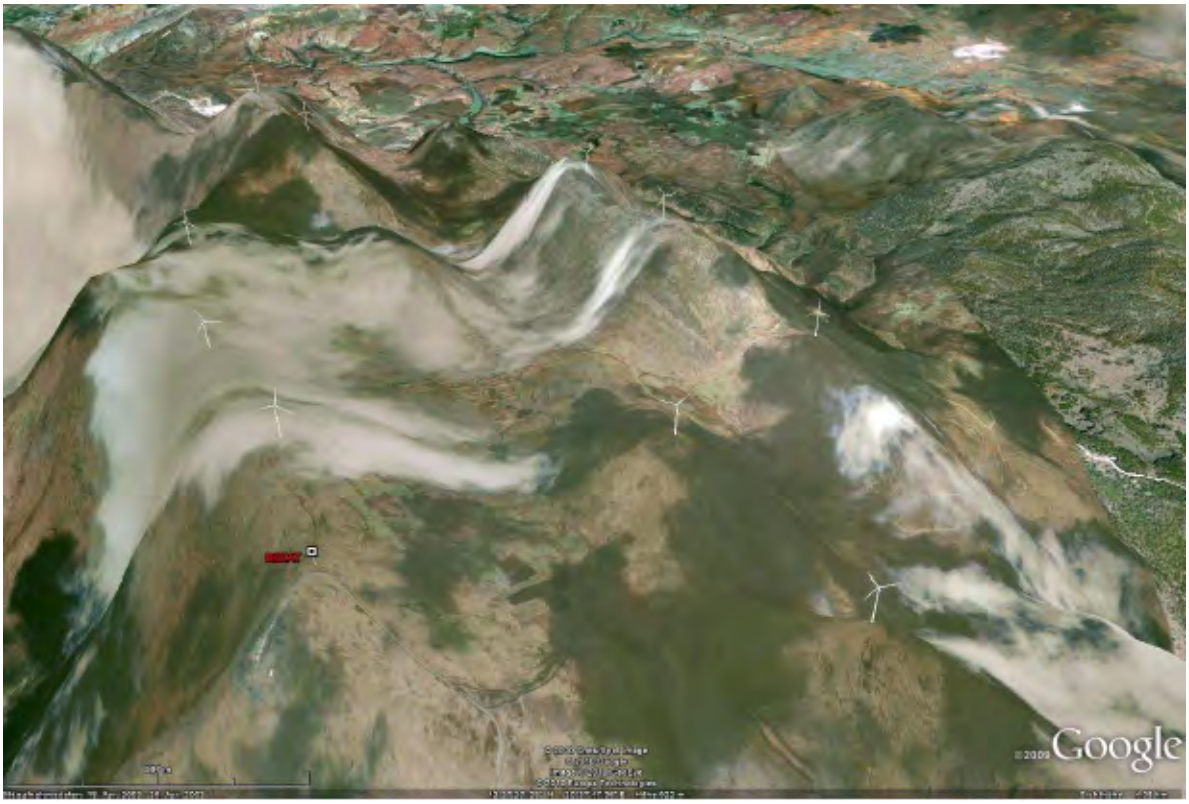


Figure 11: Simulation of preliminary wind park at Zatriq.

5.4 NEXT STEPS

The outcome of the studies has convinced us to continue with our activities in Kosovo and to put our efforts into the development of a wind park in Zatriq.

A prerequisite for the development is reliable data for the effective wind speed at hub height. As a first step, an additional wind measurement study with 60 m towers at the site is planned. To avoid any data losses due to icing, this time heated anemometers will be employed. The required permit for this measurement campaign has already been issued by the municipal government (Annex 5), and IPKO has agreed on the provision of electricity for the heated anemometers. It is intended to install two towers for measurements in March 2011 and to run the measurement programme for at least another year. The measured data will be analysed to deliver reliable estimates for the potential yield at the site.

During the measurement period, the technical planning of the wind park will be initiated, including the final layout, park access, internal grid, evaluation of the different potential turbine types for the site (including calculation of profitability), and planning of the access to the grid. In addition, documents for the permitting process will be prepared (including the required studies, e.g. environmental impact) and submitted for approval.

The final goal is to provide a complete and comprehensive technical planning for a wind farm, as well as all required permits and approvals, in order to facilitate the realization of a wind farm in the nearest future at the selected site.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the second phase of our activities in Kosovo are presented in this report. The wind measurement campaign has been completed successfully and a wind resource map covering a large part of the country has been compiled.

The results provide good estimates of the wind conditions within the country. However, we must expect that there will be variations from the real wind speeds due to the nature of the campaign, trying to cover a larger area by simplifying the set-up and the analysis. Generally, it can be said, that the average wind speeds within the country are considerably low, due to the topographic location of the country. Though, at higher altitudes, several sites with sufficient wind speeds for wind energy projects have been identified. Due to the lack of renewable energies developments in the country, the high degree of environmental impact due to the current energy production and an insufficient energy supply, it is highly recommended to support further developments in the country. Due to the history and status of the country, investments might face difficulties. Nevertheless, the government is putting its efforts into creating a favourable environment for investments in the renewable energy sector.

So far, policies have been introduced and established, but knowledge and routine is still lacking, especially at the local level. To further promote wind energy, more training on the municipal level would seem to be crucial.

Based on our feasibility study, we are eager to continue with our efforts to develop wind energy projects in Kosovo based on EU-standards.

NEK UMWELTTECHNIK AG

Dr. Ch. Kapp I. Jaisli

Zurich, November 29th, 2010 Ja/Kp/Nm/re

NEK\wind\20555\Berichte\Kosovo_final_Report_phase2_291110.doc

ANNEX 1

Photo documentation of installation

Photo 1: BBUTO

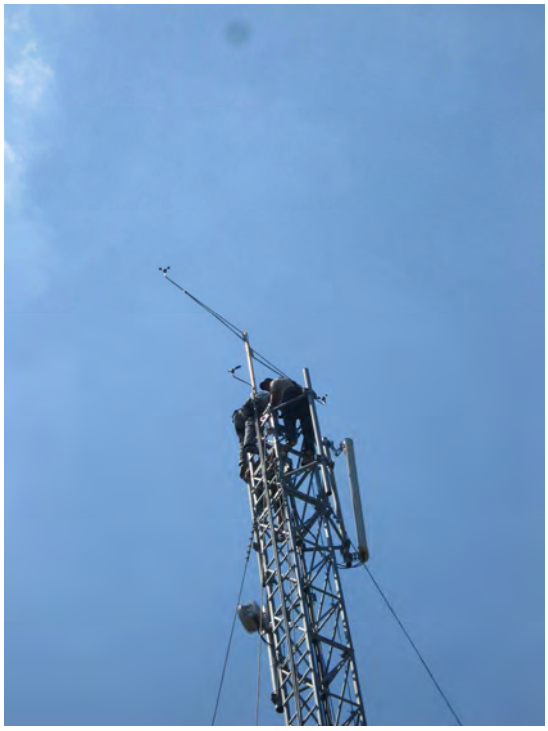


Photo 2: ETEC

Photo 3: EBUD

Photo 4: WGJU

Photo 5: EABR

Photo 6: BBUD

Photo 7: SDUL

Photo 8: SSTTA

Photo 9: BBZYM

Photo 10: BBZAT

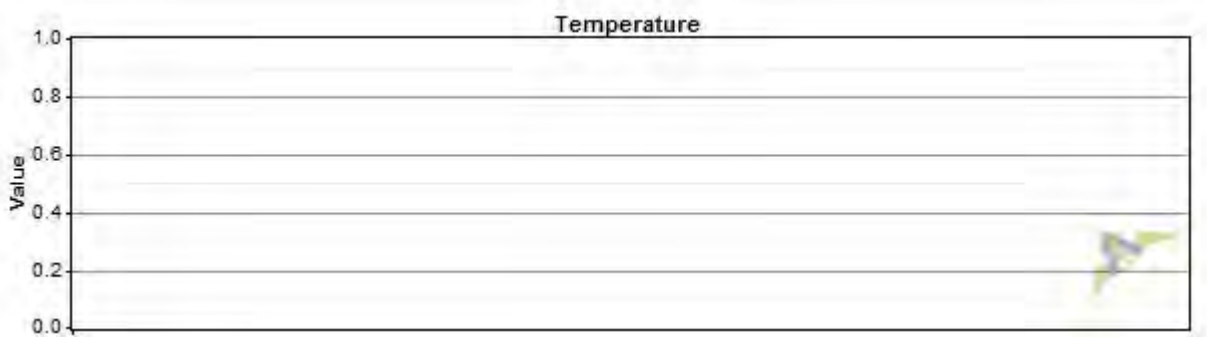
ANNEX 2

Windographer reports

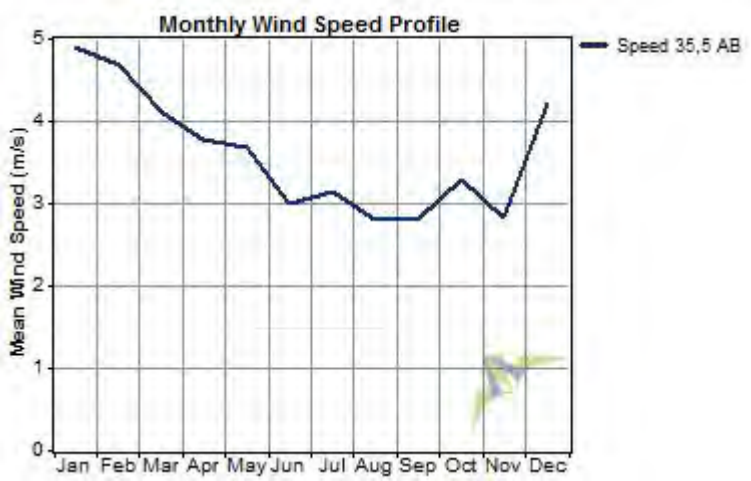
Data Set Properties

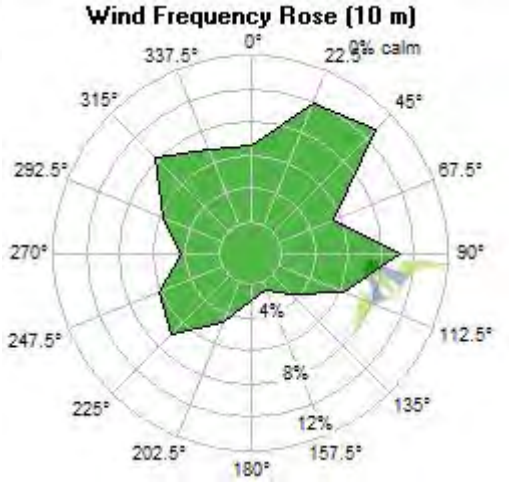
Report Created: 05.11.2010 13:53 using Windographer 2.0.4
Filter Settings: <Unflagged data>

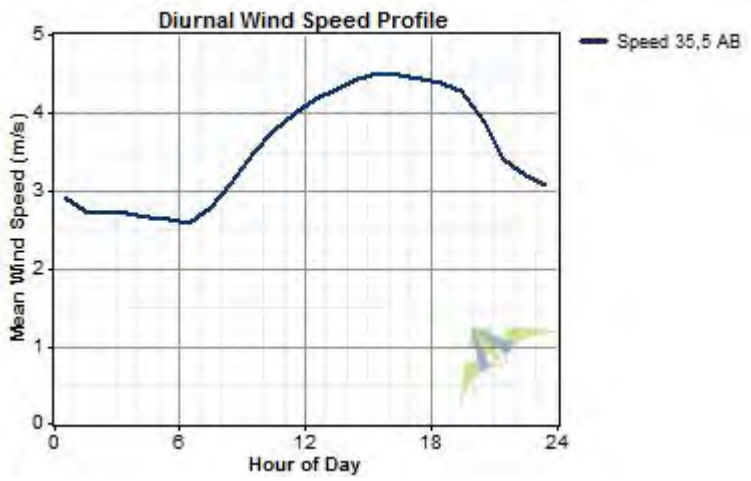
Variable	Value
Latitude	N 42.562481
Longitude	E 21.237171
Elevation	733 m
Start date	22.07.2009 14:30
End date	16.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	10.2 °C
Mean pressure	92.87 kPa
Mean air density	1.141 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

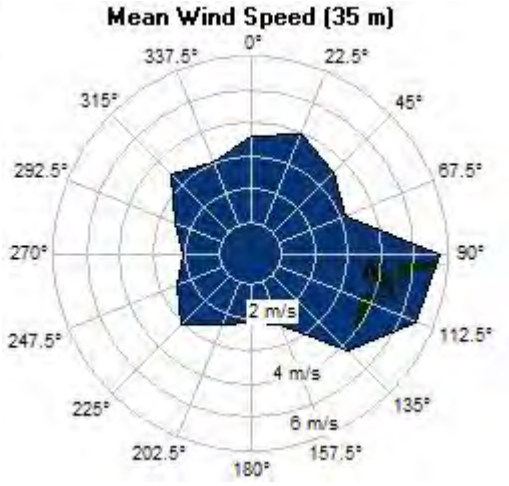


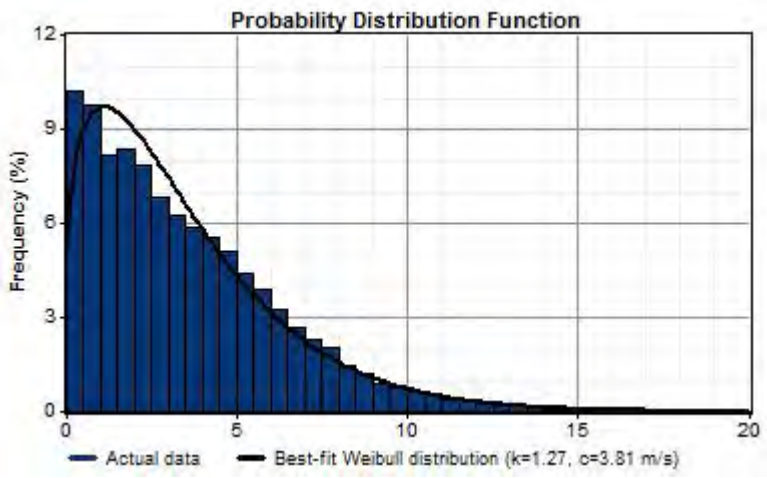
Wind Speed and Direction

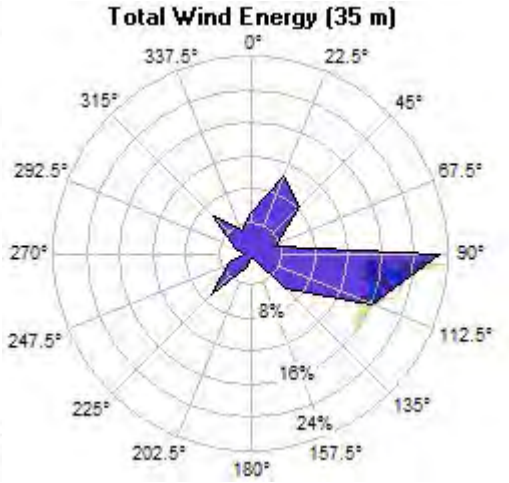












Data Set Properties

Report Created: 05.11.2010 13:55 using Windographer 2.0.4
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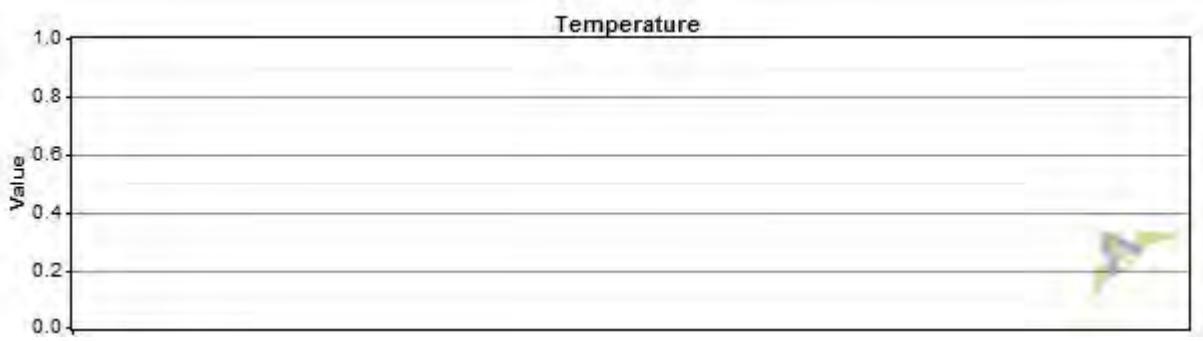
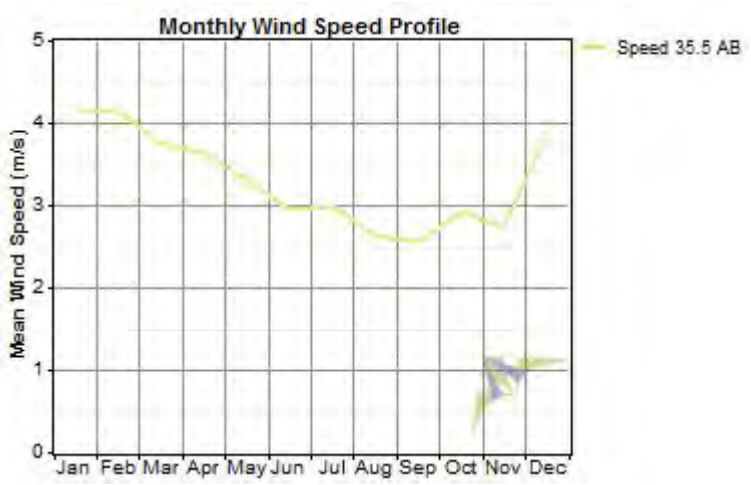
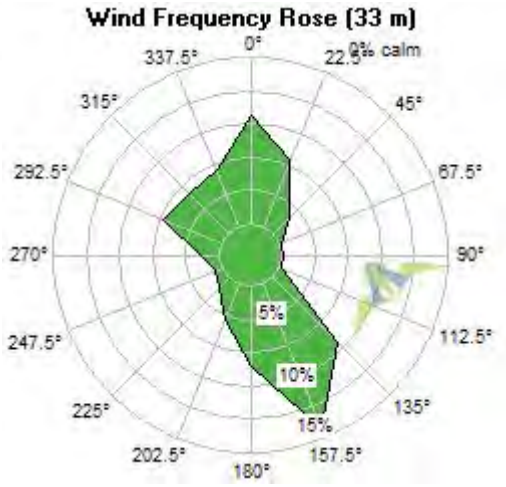
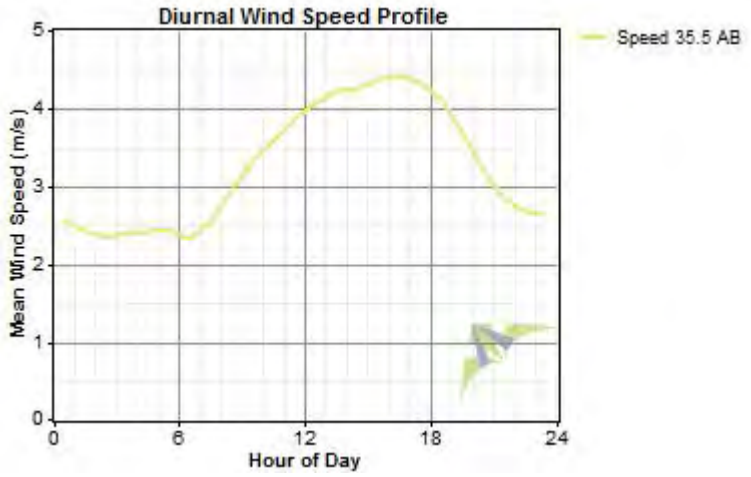
Variable	Value
Latitude	N 42.426082
Longitude	E 21.437354
Elevation	592 m
Start date	23.07.2009 00:00
End date	16.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	11.2 °C
Mean pressure	94.45 kPa
Mean air density	1.157 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

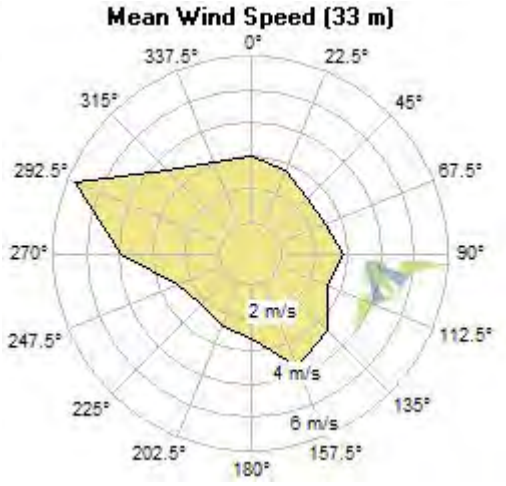


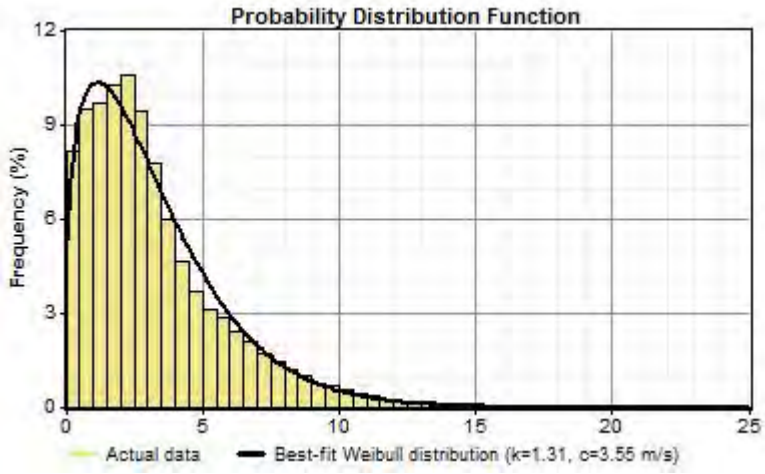
Wind Speed and Direction

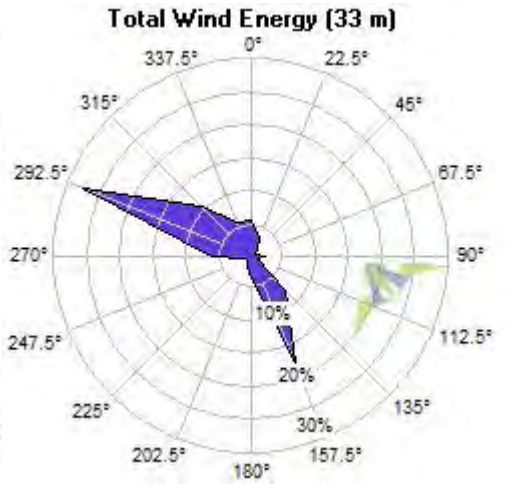








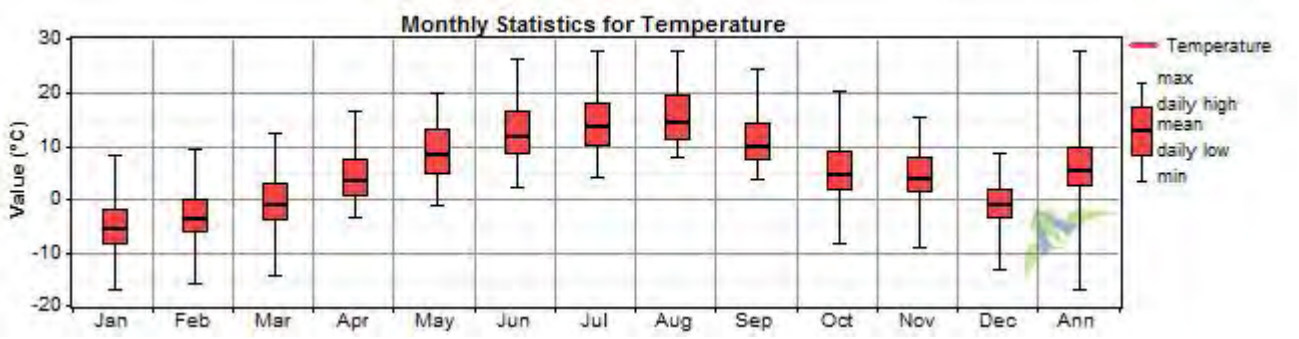




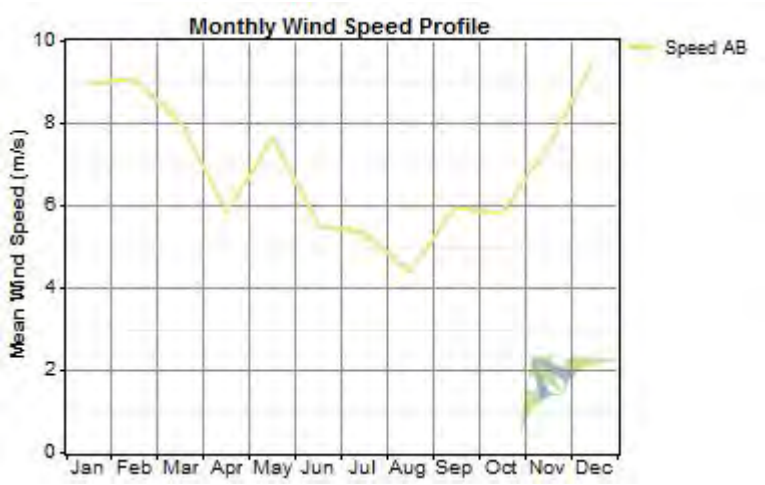
Data Set Properties

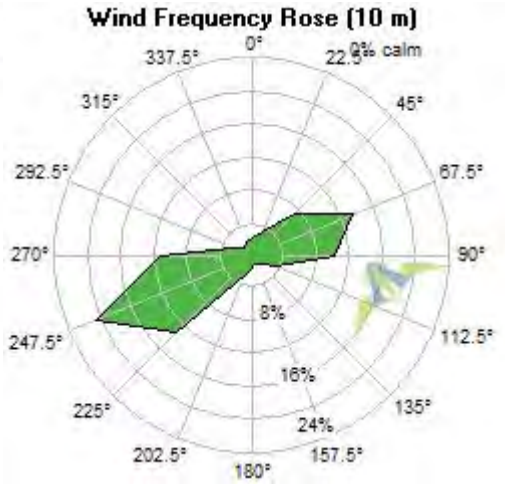
Report Created: 05.11.2010 13:56 using Windographer 2.0.4
Filter Settings: <Unflagged data>

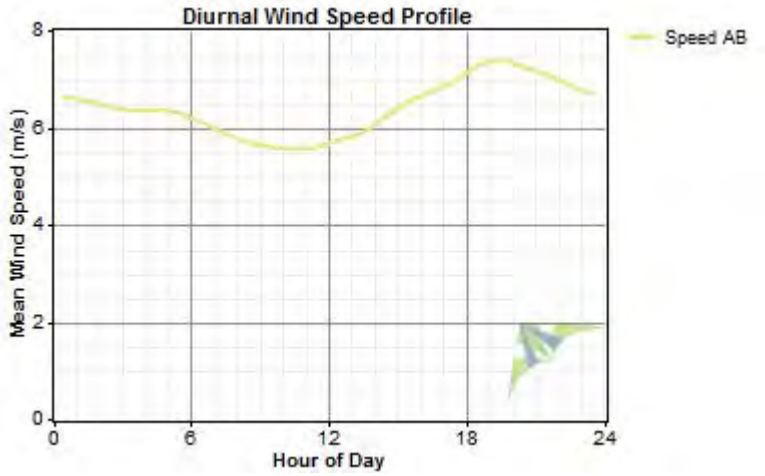
Variable	Value
Latitude	N 42.323518
Longitude	E 20.977475
Elevation	1667 m
Start date	25.07.2009 00:00
End date	16.08.2010 09:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	5.68 °C
Mean pressure	82.89 kPa
Mean air density	1.037 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

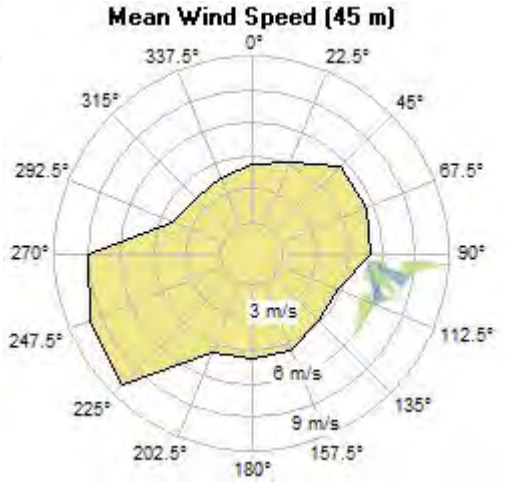


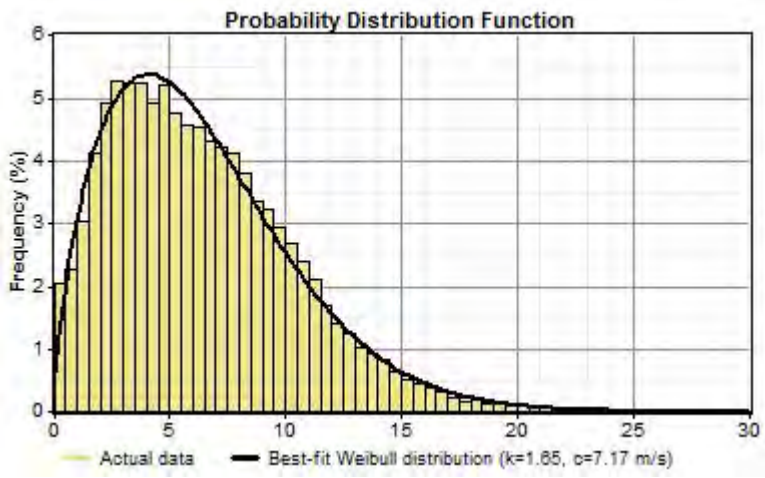
Wind Speed and Direction

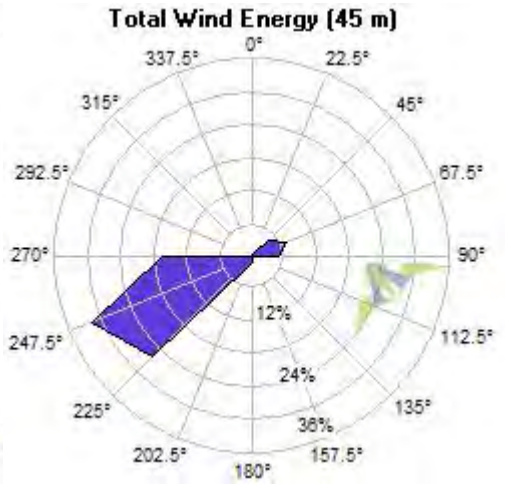












Data Set Properties

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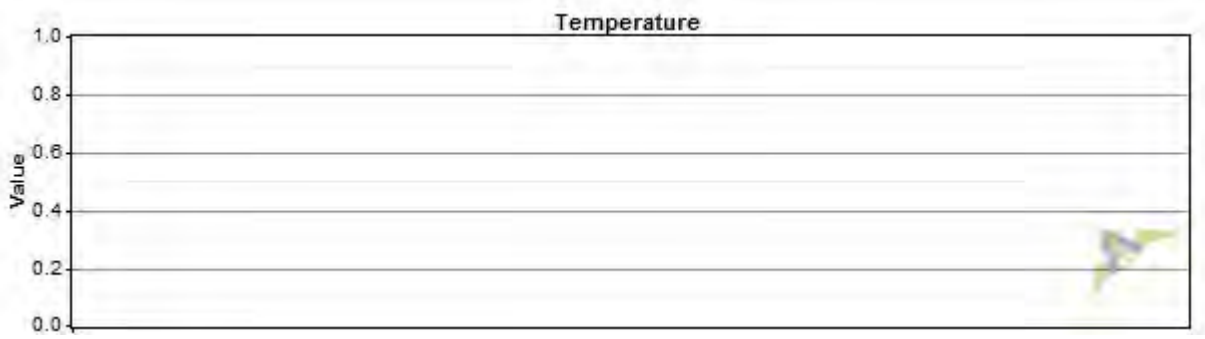
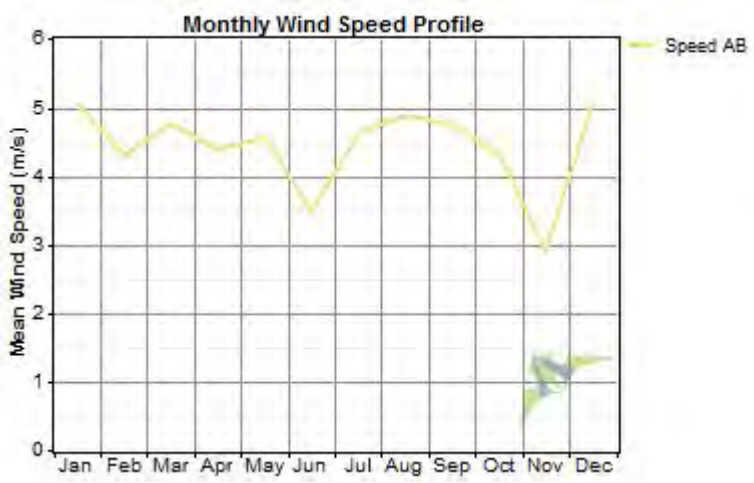
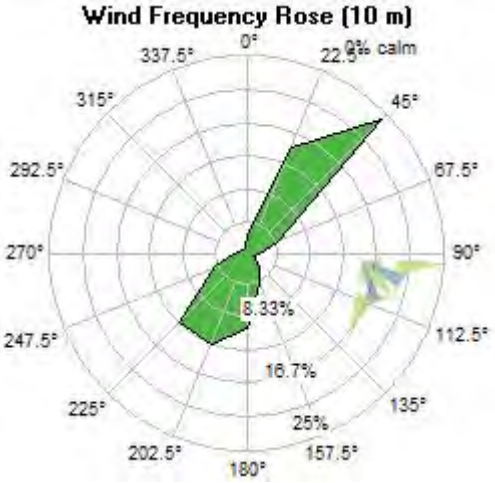
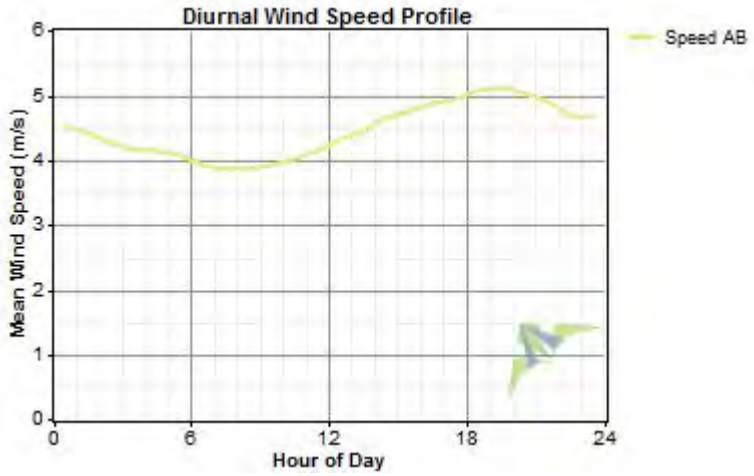
Variable	Value
Latitude	N 42.418944
Longitude	E 20.892372
Elevation	858 m
Start date	26.07.2009 00:00
End date	24.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	9.43 °C
Mean pressure	91.49 kPa
Mean air density	1.128 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

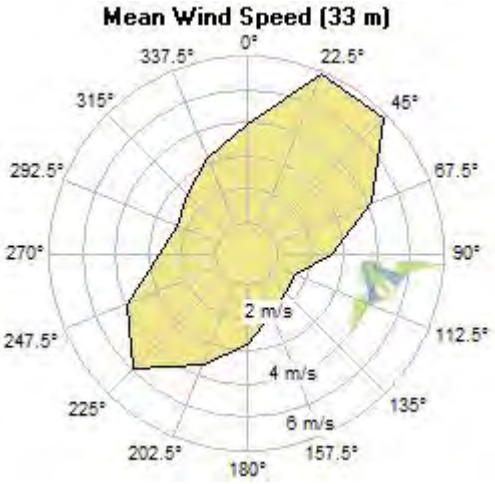


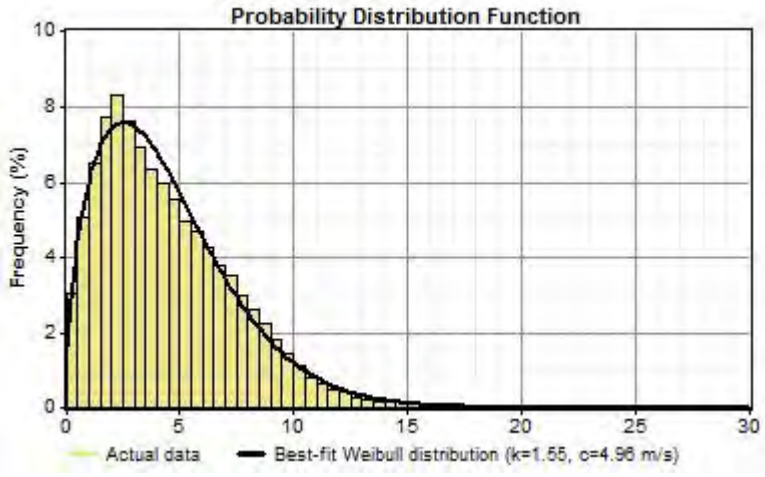
Wind Speed and Direction

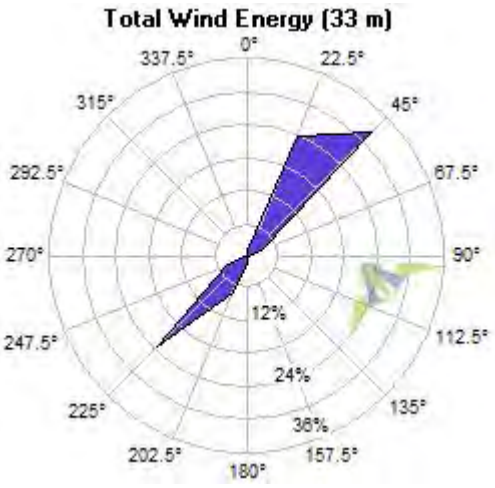












Data Set Properties

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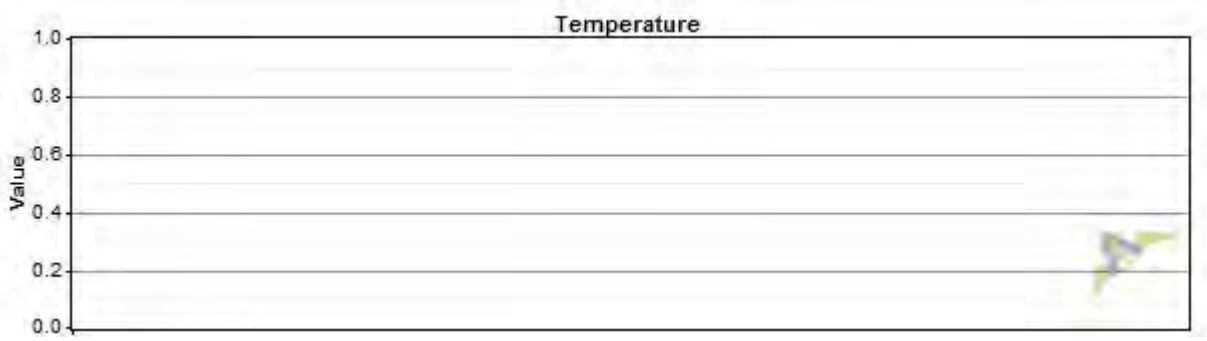
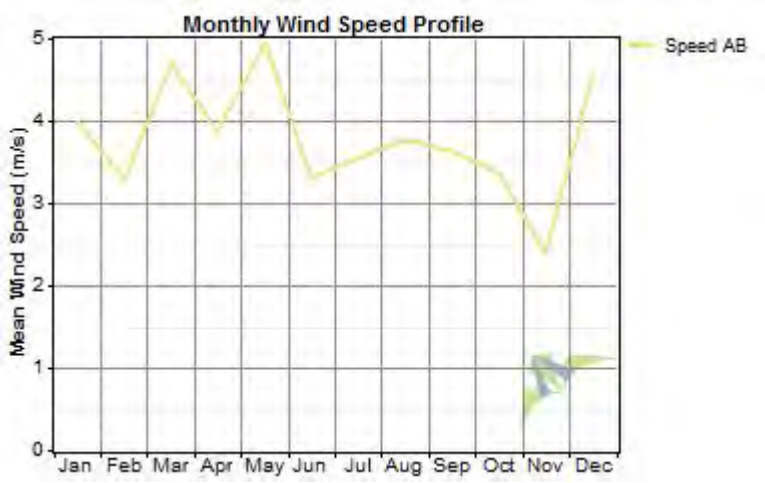
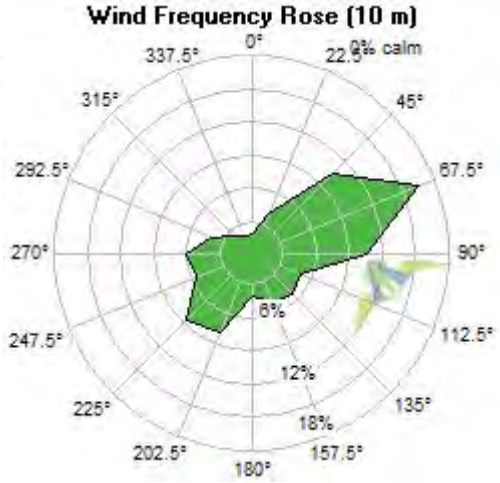
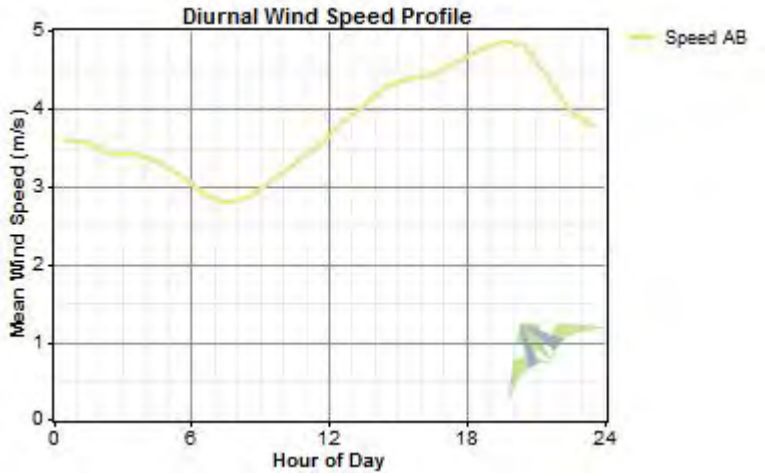
Latitude	N 42.594381
Longitude	E 20.630038
Elevation	578 m
Start date	24.07.2009 00:00
End date	24.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	11.3 °C
Mean pressure	94.61 kPa
Mean air density	1.159 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

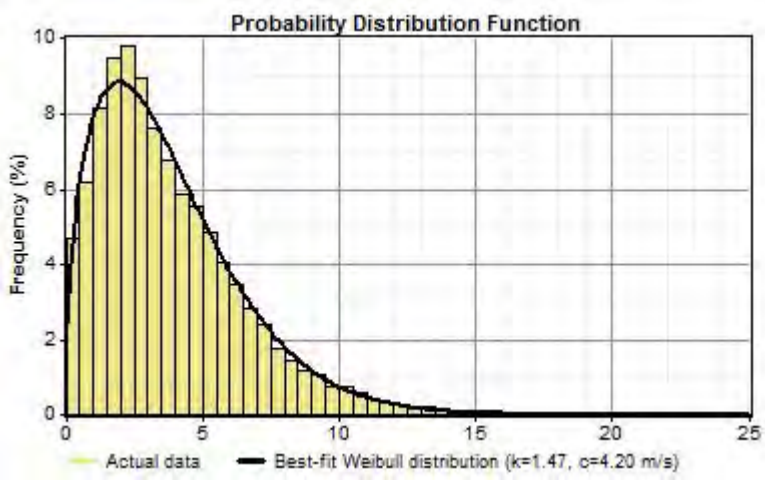


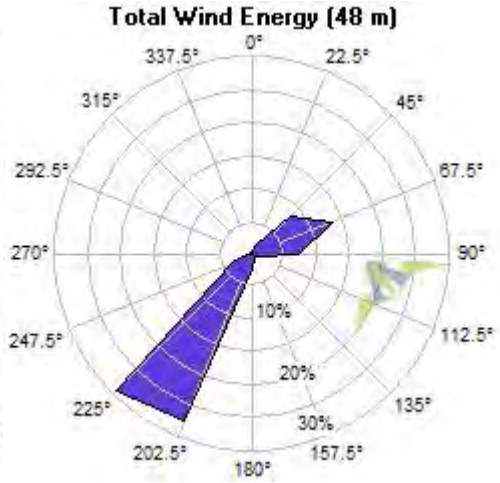
Wind Speed and Direction







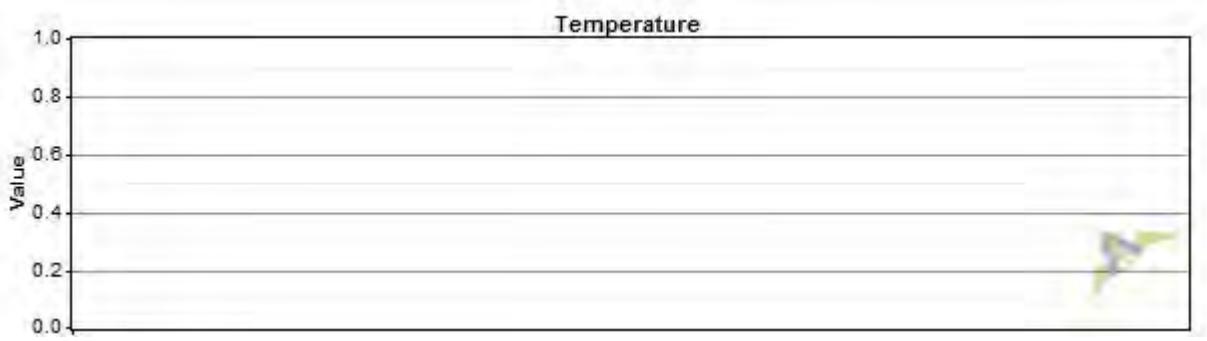




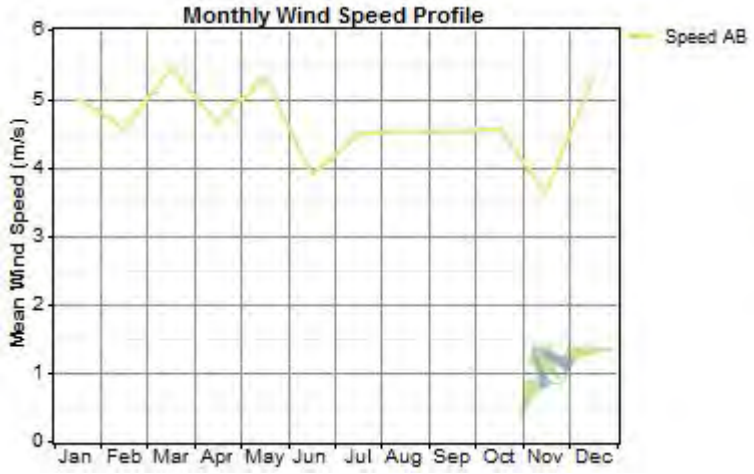
Data Set Properties

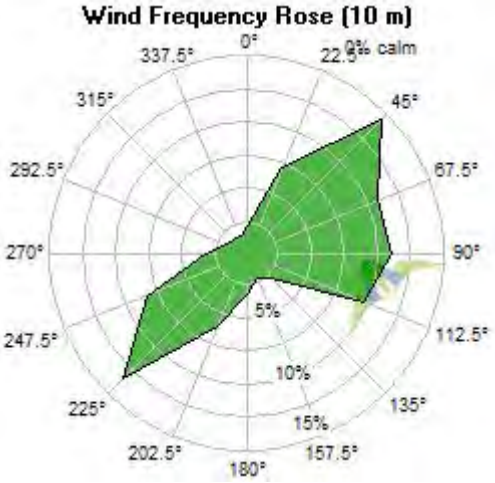
Report Created: 05.11.2010 13:58 using Windographer 2.0.4
Filter Settings: <Unflagged data>

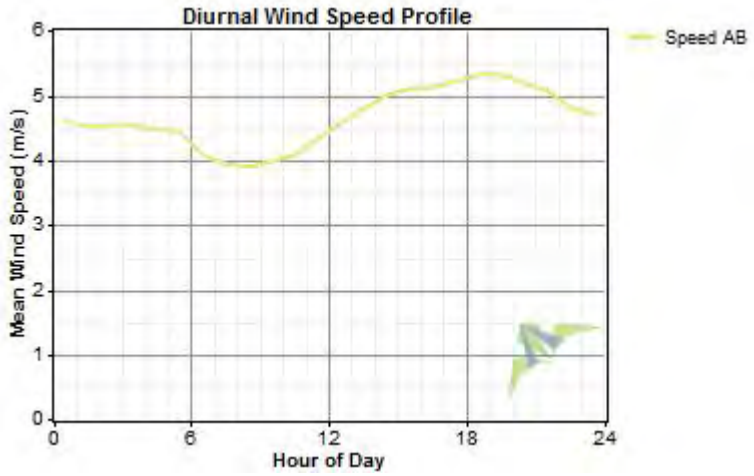
Variable	Value
Latitude	N 42.633448
Longitude	E 20.786928
Elevation	763 m
Start date	23.07.2009 13:20
End date	24.08.2010 09:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	10.1 °C
Mean pressure	92.54 kPa
Mean air density	1.138 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

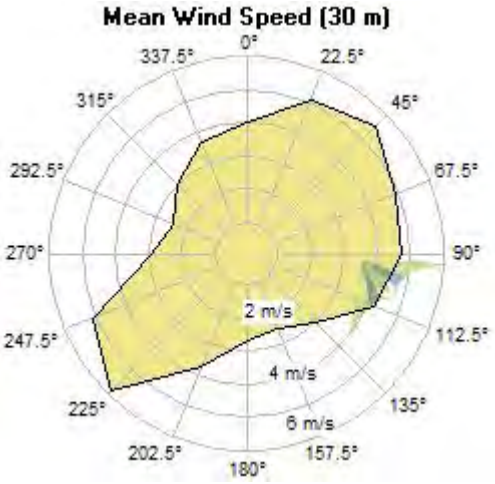


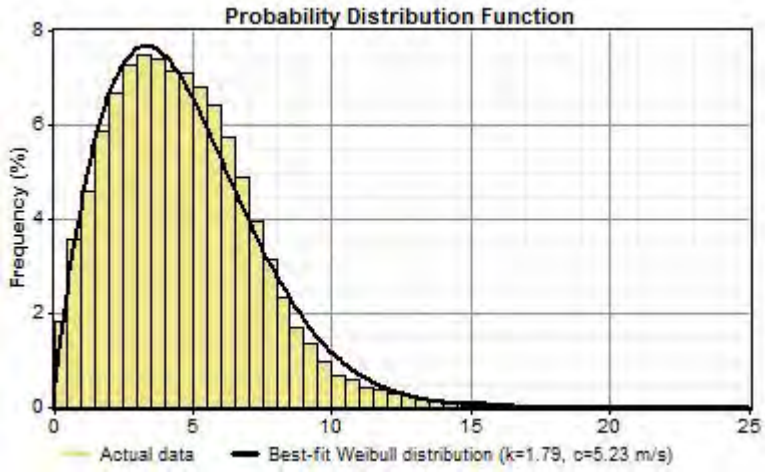
Wind Speed and Direction

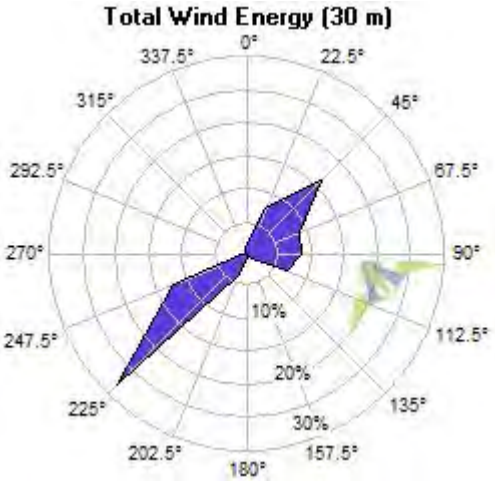












Data Set Properties

Report Created: 05.11.2010 13:58 using Windographer 2.0.4
Filter Settings: <Unflagged data>

Variable	Value
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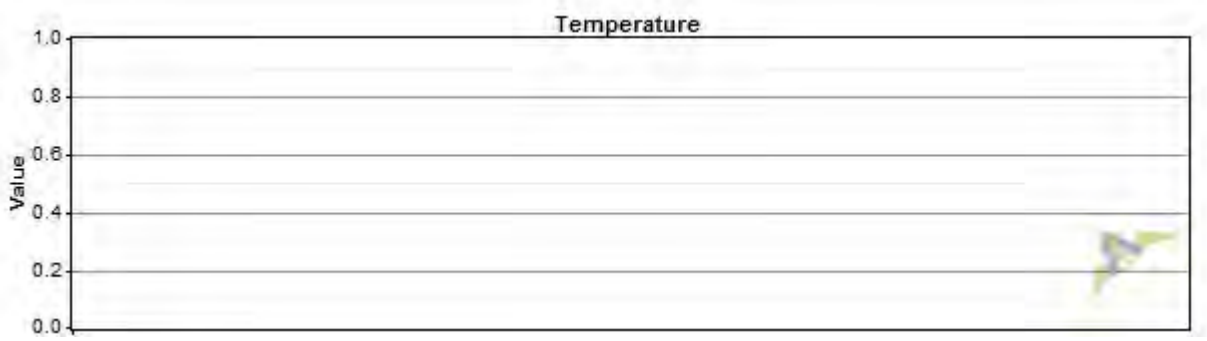
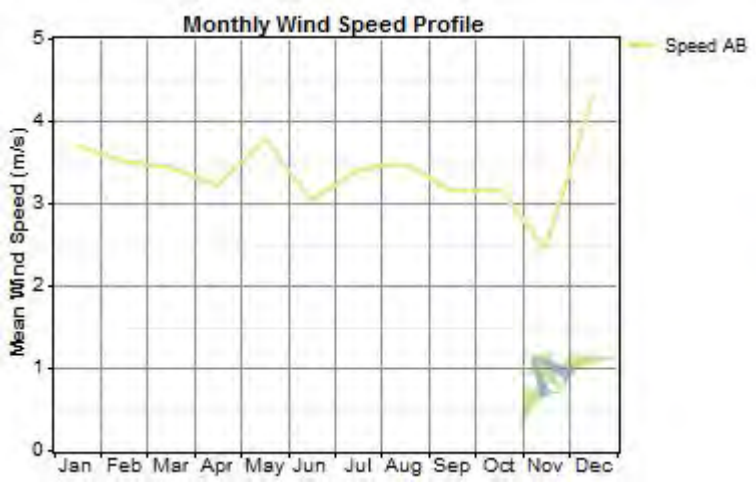
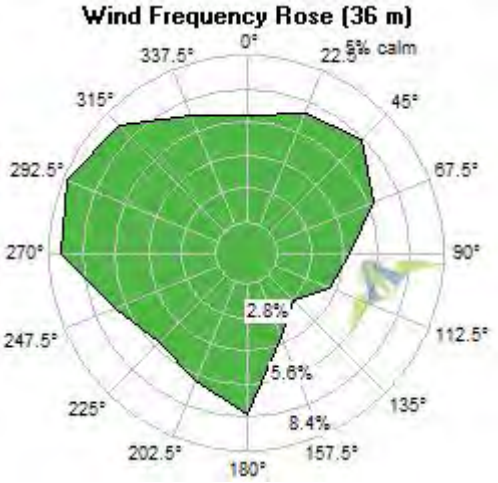
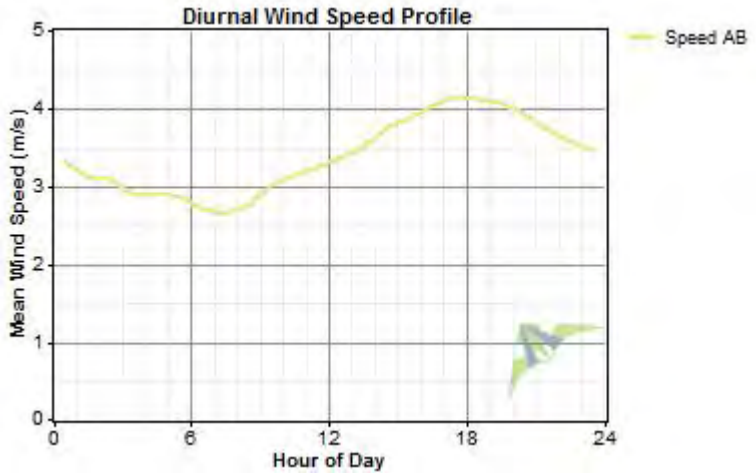
Longitude	E 20.627465
Elevation	658 m
Start date	24.07.2009 00:00
End date	25.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0.4 m/s
Mean temperature	10.7 °C
Mean pressure	93.71 kPa
Mean air density	1.149 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

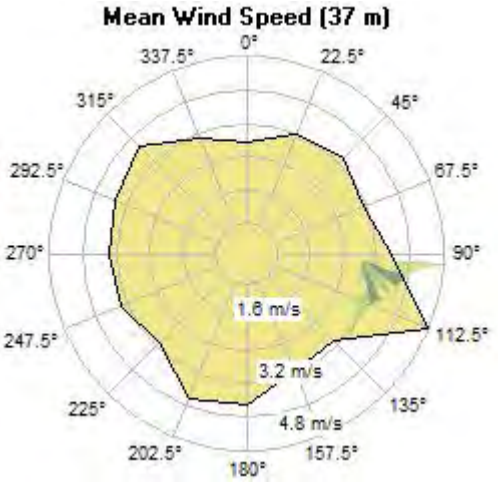


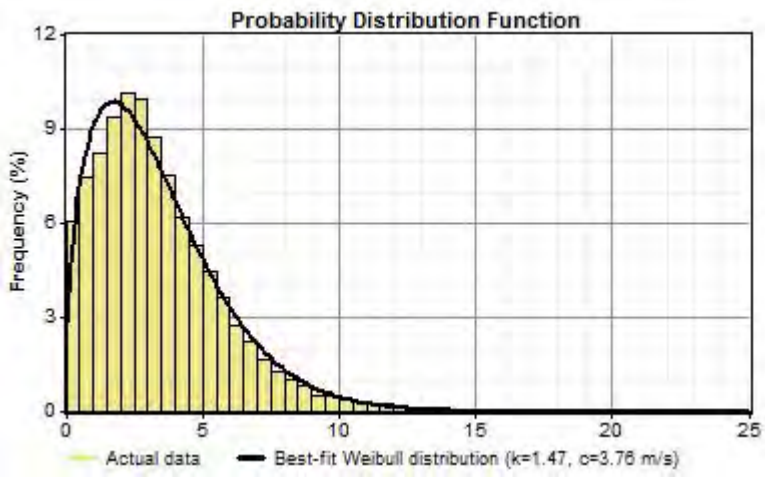
Wind Speed and Direction

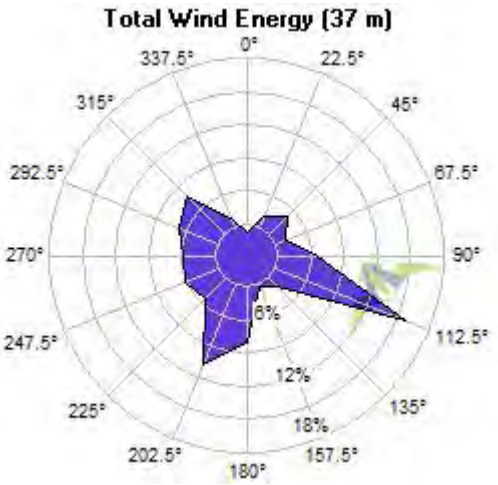








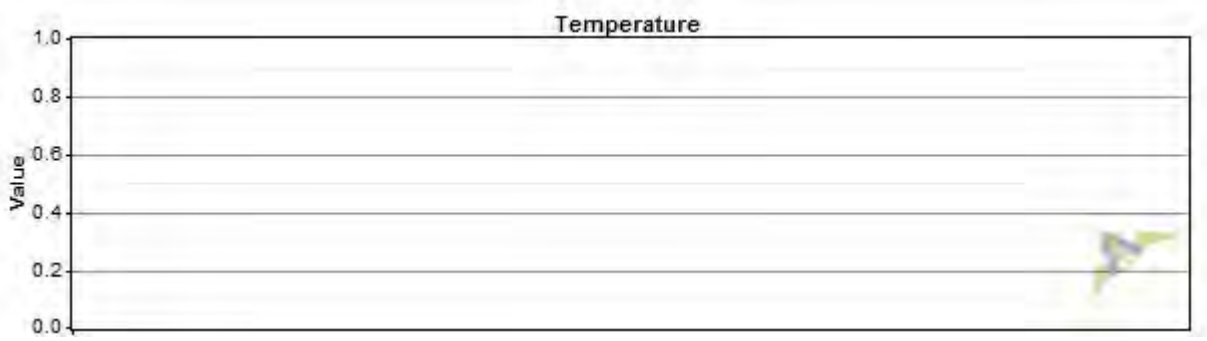




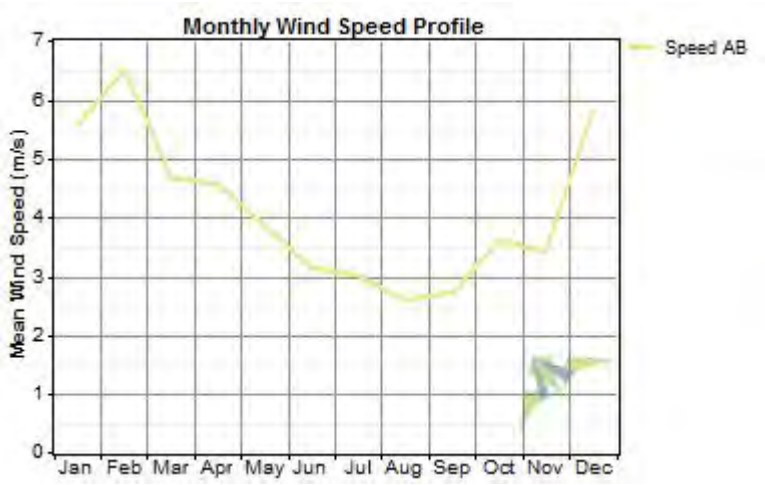
Data Set Properties

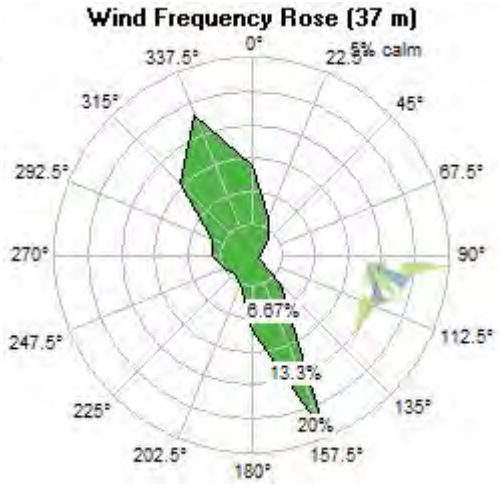
Report Created: 05.11.2010 13:59 using Windographer 2.0.4
Filter Settings: <Unflagged data>

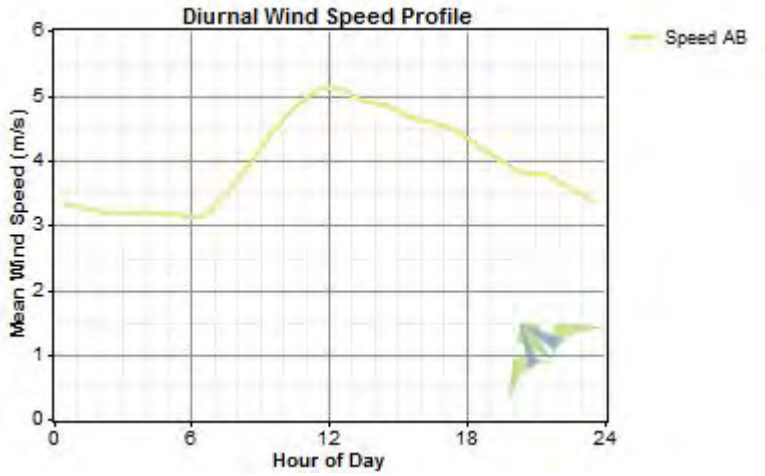
Variable	Value
Latitude	N 42.271330
Longitude	E 21.222535
Elevation	578 m
Start date	28.07.2009 06:00
End date	25.08.2010 08:00
Duration	13 months
Length of time step	10 minutes
Calm threshold	0.35 m/s
Mean temperature	11.3 °C
Mean pressure	94.61 kPa
Mean air density	1.159 kg/m³
Power density at 50m	n/a
Wind power class	n/a
Power law exponent	n/a
Surface roughness	n/a
Roughness class	n/a
Roughness description	n/a

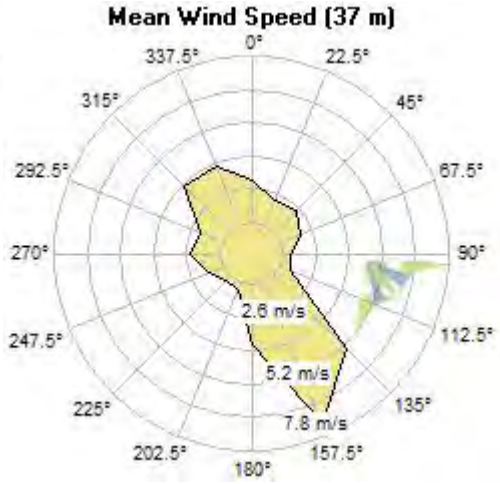


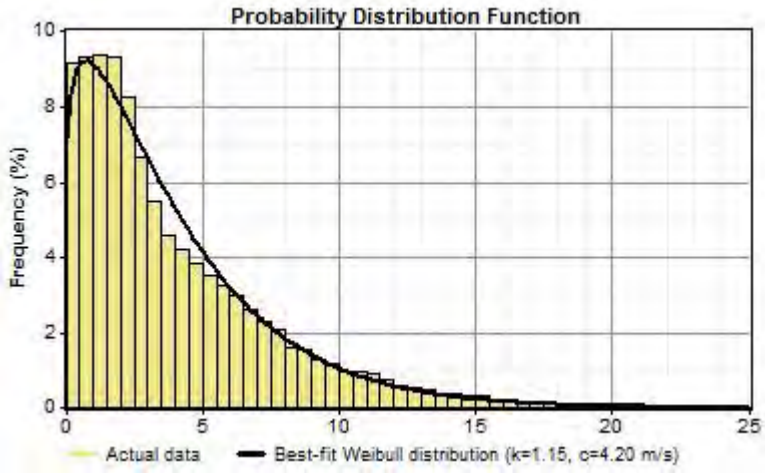
Wind Speed and Direction





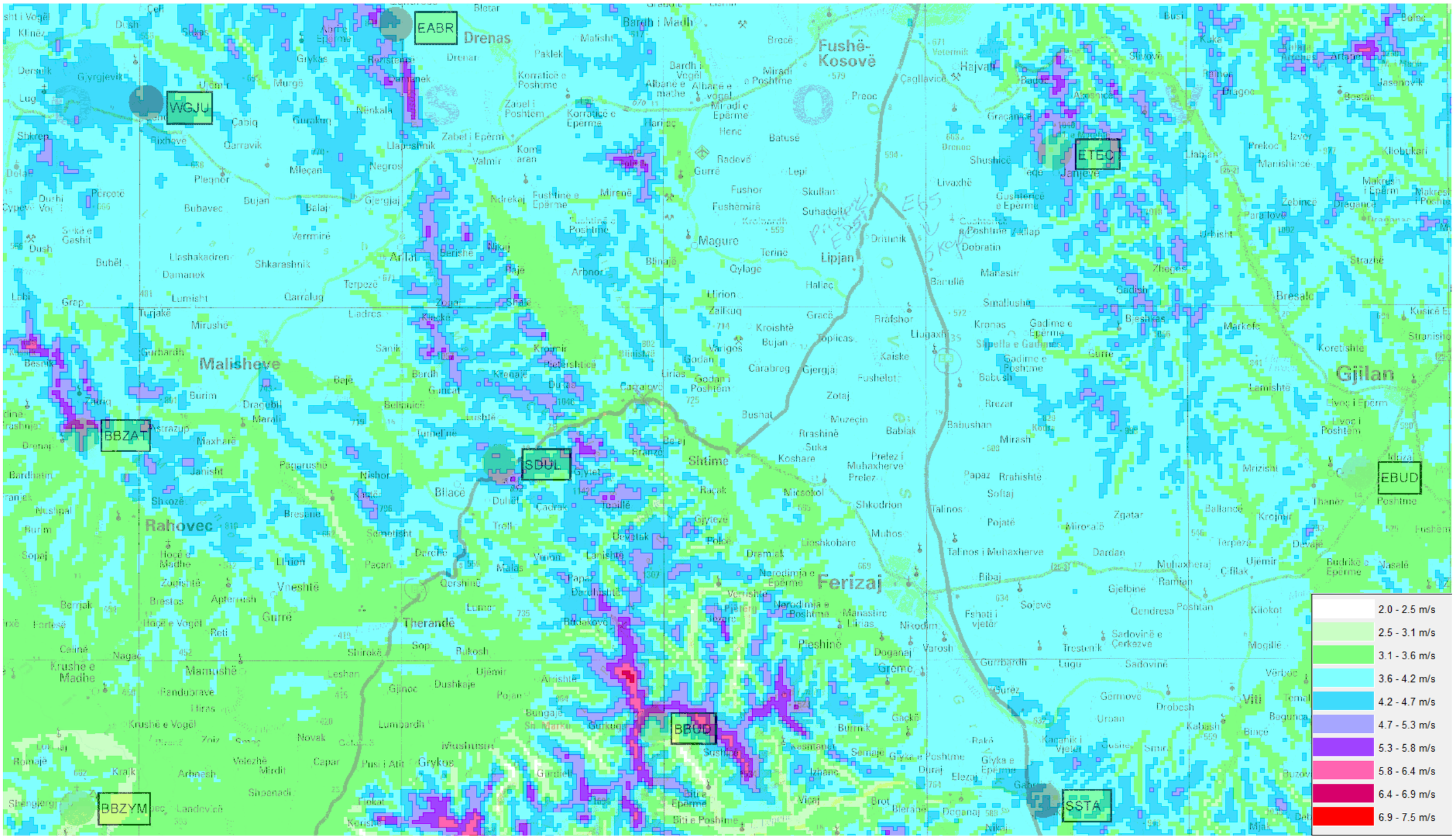






ANNEX 3

Wind resource map


EABR
WGJU
ETEC
SDUL
BBZAT
BBZYM
BBUD
SSTA
EBUD
Drenas
Fushë-Kosovë
Malisheve
Rahovec
Ferizaj
Gjilan
Shtime
Lipjan
Therandë
Gurrë
2.0 - 2.5 m/s
2.5 - 3.1 m/s
3.1 - 3.6 m/s
3.6 - 4.2 m/s
4.2 - 4.7 m/s
4.7 - 5.3 m/s
5.3 - 5.8 m/s
5.8 - 6.4 m/s
6.4 - 6.9 m/s
6.9 - 7.5 m/s

ANNEX 4

PARK calculation

Project:
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Licensed user:
NEK Umwelttechnik AG
Clausiusstrasse 41
CH-8033 Zürich
+41 44 261 07 07
Jaisli / i.jaisli@nek.ch

Calculated:
04.11.2010 14:00/2.7.473

PARK - Main Result

Calculation: Zatriq_20 MW

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

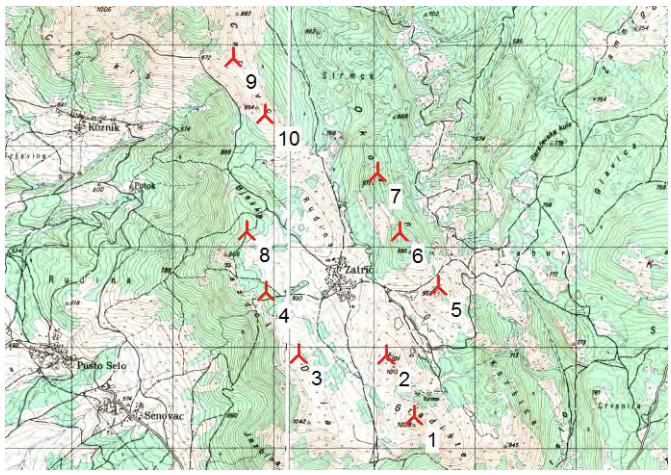
Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.104 kg/m³ to 1.113 kg/m³
Air density relative to standard	90.8 %
Hub altitude above sea level (asl)	1'000.0 m to 1'080.0 m
Annual mean temperature at hub alt.	7.6 °C to 8.1 °C
Pressure at WTGs	889.9 hPa to 898.6 hPa

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



Scale 1:75'000

New WTG

Resource file(s)

N:\WindPRO Data\Projects\Kosovo\Kosovo_2010_neu_Res_200_Nabe_80_1.rsf

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	36'399.2	32'759.3	37'368.3	97.4	18.7	3'275.9	1'638	5.3

¤) *Based on Result-10.0%*

Calculated Annual Energy for each of 10 new WTGs with total 20.0 MW rated power

	WTG type							Power curve		Annual Energy		Park	
	Terrain	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Result [MWh]	Result-10.0% [MWh]	Efficiency [%]	Mean wind speed [m/s]
1	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'934.4	3'541	98.2	5.53
2	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'339.8	3'006	96.1	5.20
3	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	4'096.9	3'687	96.6	5.66
4	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'741.4	3'367	97.0	5.38
5	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	2'824.1	2'542	96.5	4.83
6	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'520.1	3'168	97.0	5.28
7	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'355.3	3'020	97.2	5.17
8	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	3'529.6	3'177	97.0	5.29
9	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	4'057.2	3'651	99.1	5.55
10	A	Yes	REpower	MM 92-2'000	2'000	92.5	80.0	EMD	Level 0 - guaranteed - - 12/2005	4'000.6	3'600	98.8	5.52

WTG siting

		UTM WGS84 Zone: 34 East	North	Z [m]	Row data/Description
1	New	469'985	4'699'397	990.0	REpower MM 92 2000 92.5 !-! hub: 80.0 m (3)
2	New	469'711	4'700'000	979.6	REpower MM 92 2000 92.5 !-! hub: 80.0 m (4)
3	New	468'838	4'700'014	1'000.0	REpower MM 92 2000 92.5 !-! hub: 80.0 m (5)
4	New	468'513	4'700'626	942.9	REpower MM 92 2000 92.5 !-! hub: 80.0 m (6)
5	New	470'224	4'700'685	920.0	REpower MM 92 2000 92.5 !-! hub: 80.0 m (7)
6	New	469'838	4'701'226	967.6	REpower MM 92 2000 92.5 !-! hub: 80.0 m (8)
7	New	469'625	4'701'818	948.5	REpower MM 92 2000 92.5 !-! hub: 80.0 m (9)

To be continued on next page...

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Jaisli / i.jaisli@nek.ch
Calculated:
04.11.2010 14:00/2.7.473

PARK - Main Result

Calculation: Zatriq_20 MW

...continued from previous page

		UTM WGS84 Zone: 34 East	North	Z	Row data/Description
		UTM WGS84 Zone: 34		[m]	
8	New	468'319	4'701'229	950.0	REpower MM 92 2000 92.5 !-! hub: 80.0 m (10)
9	New	468'188	4'702'949	927.4	REpower MM 92 2000 92.5 !-! hub: 80.0 m (11)
10	New	468'500	4'702'391	930.0	REpower MM 92 2000 92.5 !-! hub: 80.0 m (12)