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Preliminary layout report

Kupres wind farm

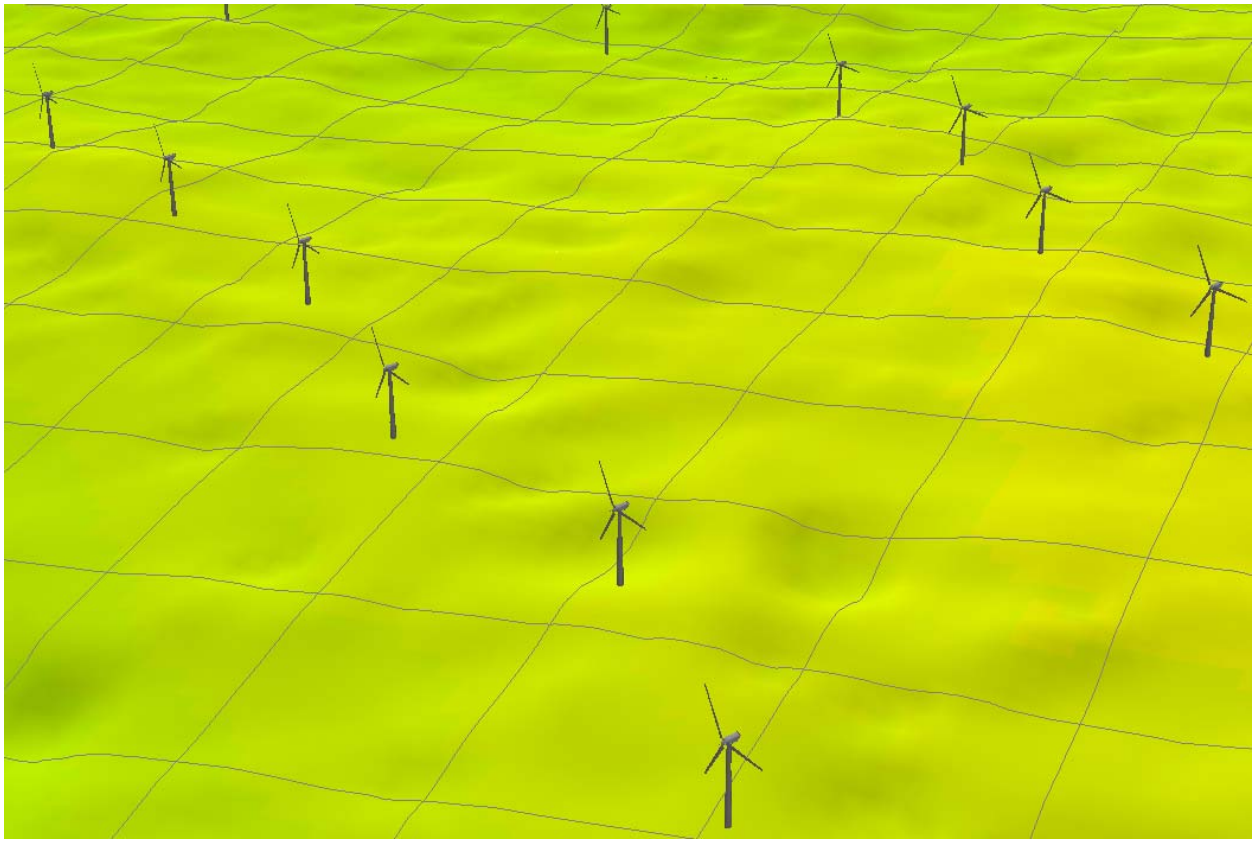
Pakline wind farm

Ljubusa wind farm

Client:

Kamen Dent d.o.o.

Mostar, BiH



June 2009

Document: **Preliminary layout report**
Kupres wind farm
Pakline wind farm
Ljubusa wind farm

Client: Kamen Dent d.o.o.
Kneza Branimira 7
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Clasification: Confidential, Client's discretion

Version: 1.0

Status: Draft

Date: 28th June 2009

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1. LOCATION DESCRIPTION

1.1. Location description and satellite images

Tomislavgrad – city and regional center situated in southern part of BiH on the crossroads connecting Mostar-Bihac-Banja Luka and Split-Sarajevo, with region spreading over 966 km^2, represents geographical and historical connection between Bosnia, Hercegovina and Dalmatia. Neighboring region of Kupres, with 600 km^2 became one of the smallest regions in BiH.

Situated on mountain area of Dinaridi, regions of Tomislavgrad and Kupres experience similar climate regimes, characterized by different, sometimes opposed influences of Mediterranean, continental and mountain climate. That mixture of influences result in warm summers and occasionally very harsh winters. This area is known to be highly windy with continental northern and maritime southern wind resulting in 65 – 70 % windy days during the year.

More potential zones are found meeting the energy demand for wind energy exploitation. In Kupres region the most interesting are hilltops of Borova kosa, Gradina and hill region southwest from the Ravanjsko field, continuing to Pakline and Ljubusa ridges in Tomislavgrad region. Complete area of planed wind farm is detritus with deficient vegetation, due to the cold winters and strong northern wind.

Location of wind farm Kupres is situated on the hilltops of Borova kosa (1368 m), Crljenac (1244 m), Kalpak (1195) and Podovi (1299 m) near the villages Gornji Musici and Gornje Ravno on the north, and hilltops Mala kozjaca (1197 m), Velika kozjaca (1220 m), Vucina (1162 m), Jastrebovac (1277 m) on the southwest from the Ravanjsko field. Access to location is by Tomislavgrad-Rama road that passes trough planed location. Whole area is available with cross country vehicle.

Location of wind farm Pakline continues further to the southwest, situating on the hilltops northeast from the Tomislavgrad. Significant are hilltops Ostra glava (1209 m), Javorina (1202 m), Dubokovac (1247 m), Ostra kosa (1294 m), Ciganluk (1331 m) and Derustica (1282 m) with villages Mokronoge, Lug, Kuk, Sarajlije and Letka in its foothill. Main access to location is by Tomislavgrad-Rama road on its northern part but there are more available paths from around villages passable with cross country vehicle.

Location of wind farm Ljubusa continues further on the south, cca 2 km northeast from villages Oplecani, Srdani, Rascani and Mandino selo, as a continuation of Pakline hill ridges. Significant are hilltops Magljen (1328 m), Ostra glavica (1318 m) and Velika kosa (1342 m). One of the access roads is gravel road from village Srdani passable with cross country vehicle.

Grid connection, considering the planed wind farm capacities has to be carried out on high voltage. Connection to 110 kV power line Tomislavgrad-Rama that passes trough northern part of planed wind farm Pakline and wind farm Kupres is recognized as one of the possible solutions for energy evacuation.

Figure 1-1 Photos of characteristic landscape

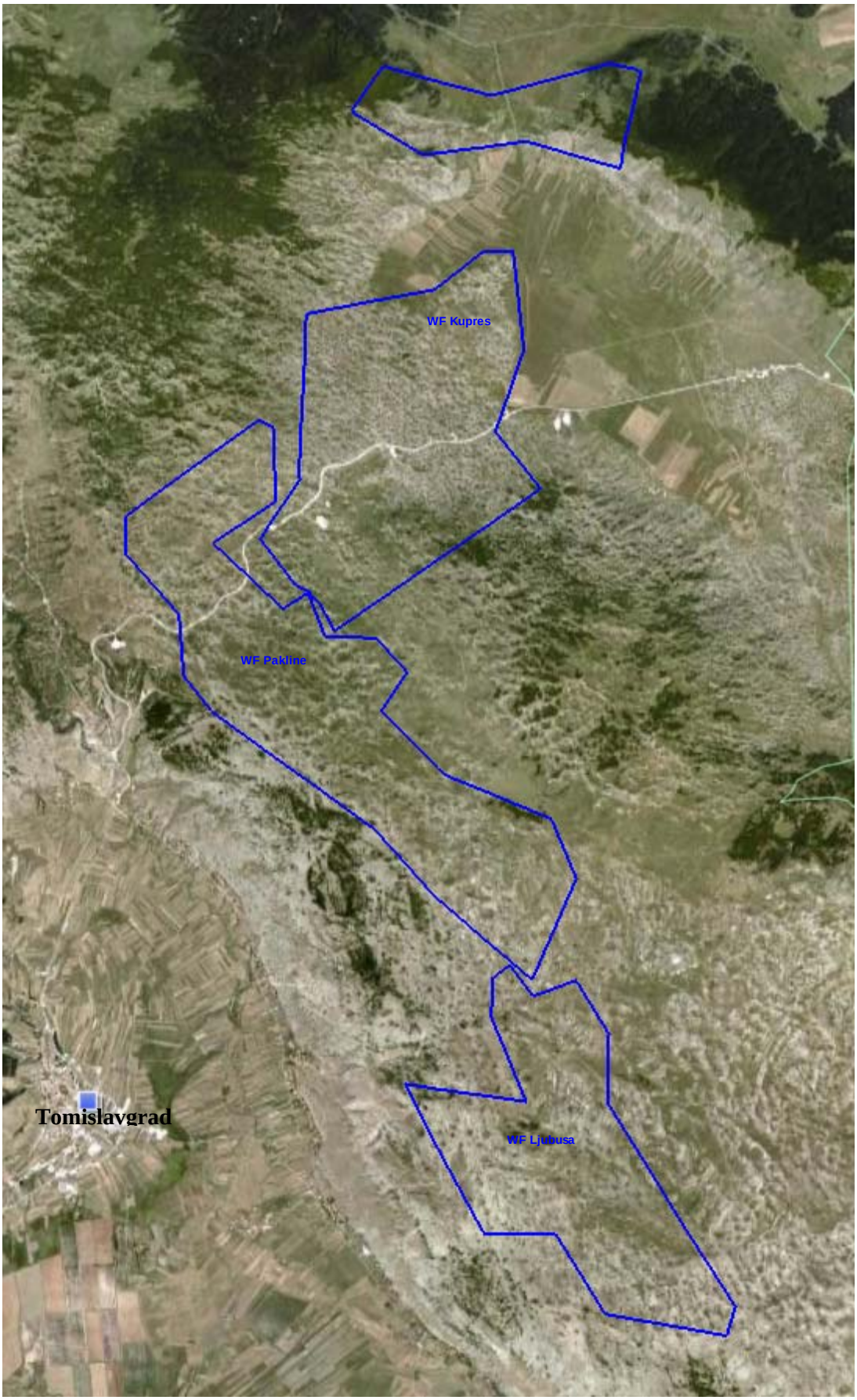

Figure 1-2 Satellite image with locations of wind farms

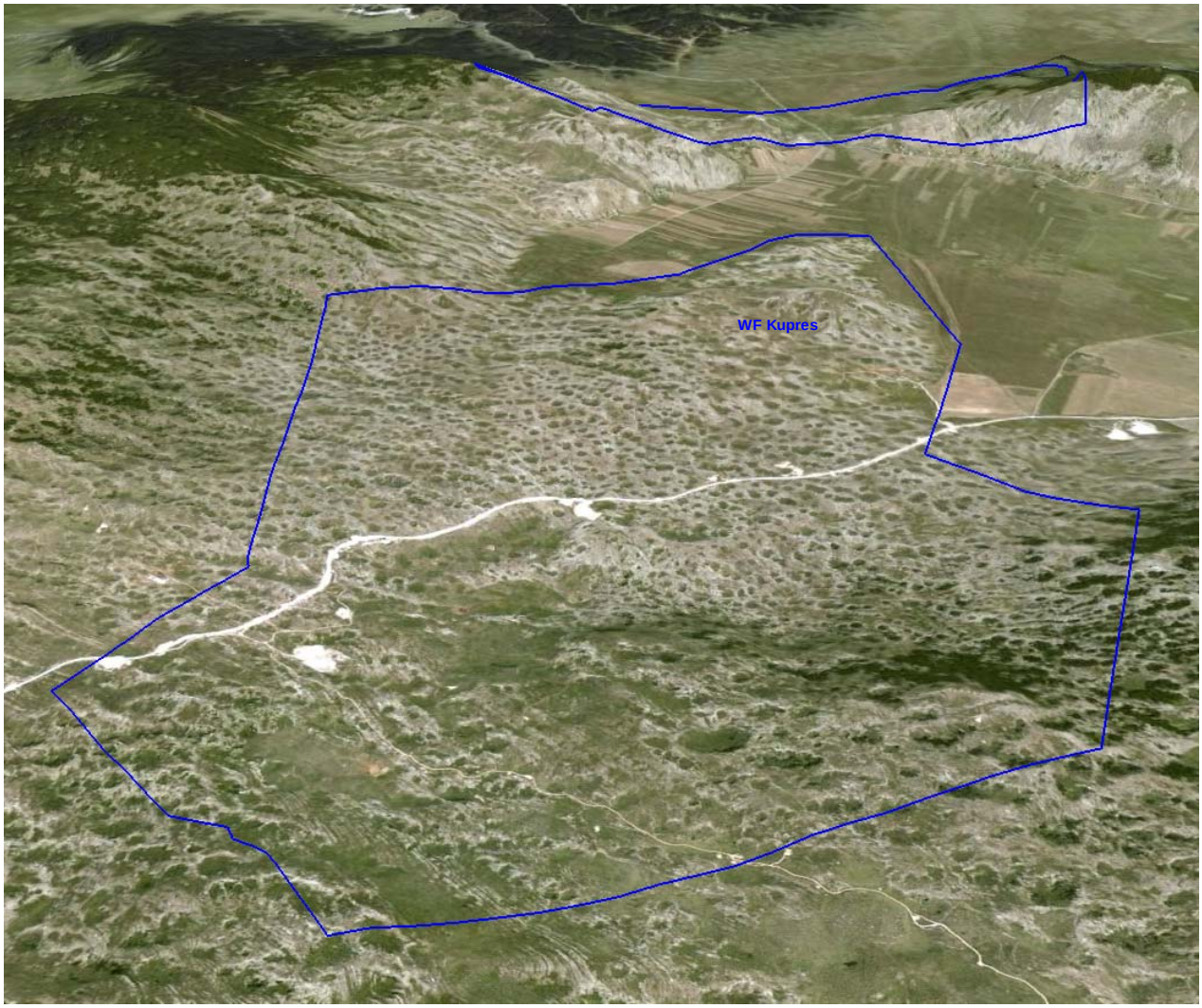

Figure 1-3 Satellite image of WF Kupres location

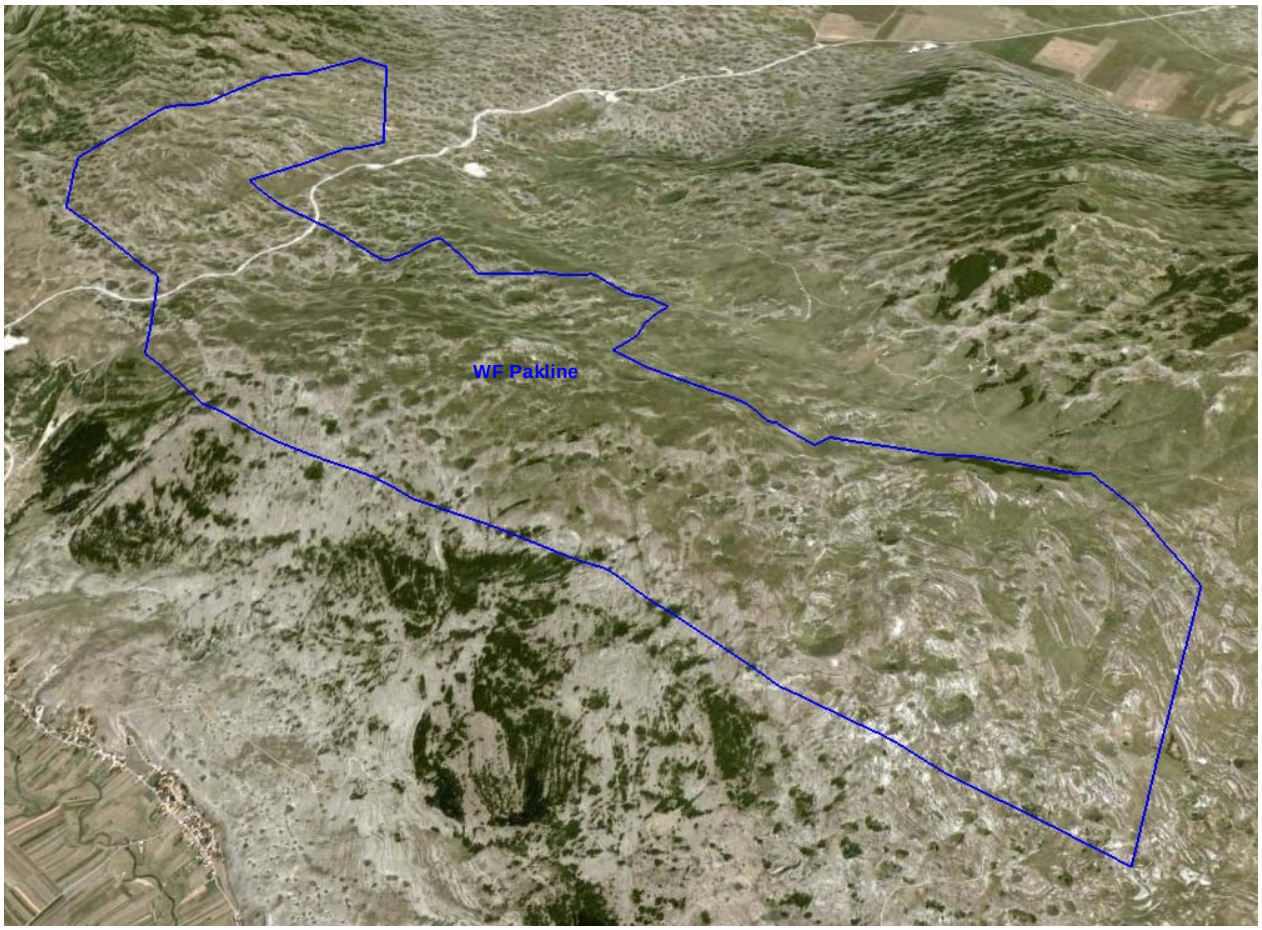

Figure 1-4 Satellite image of WF Pakline location

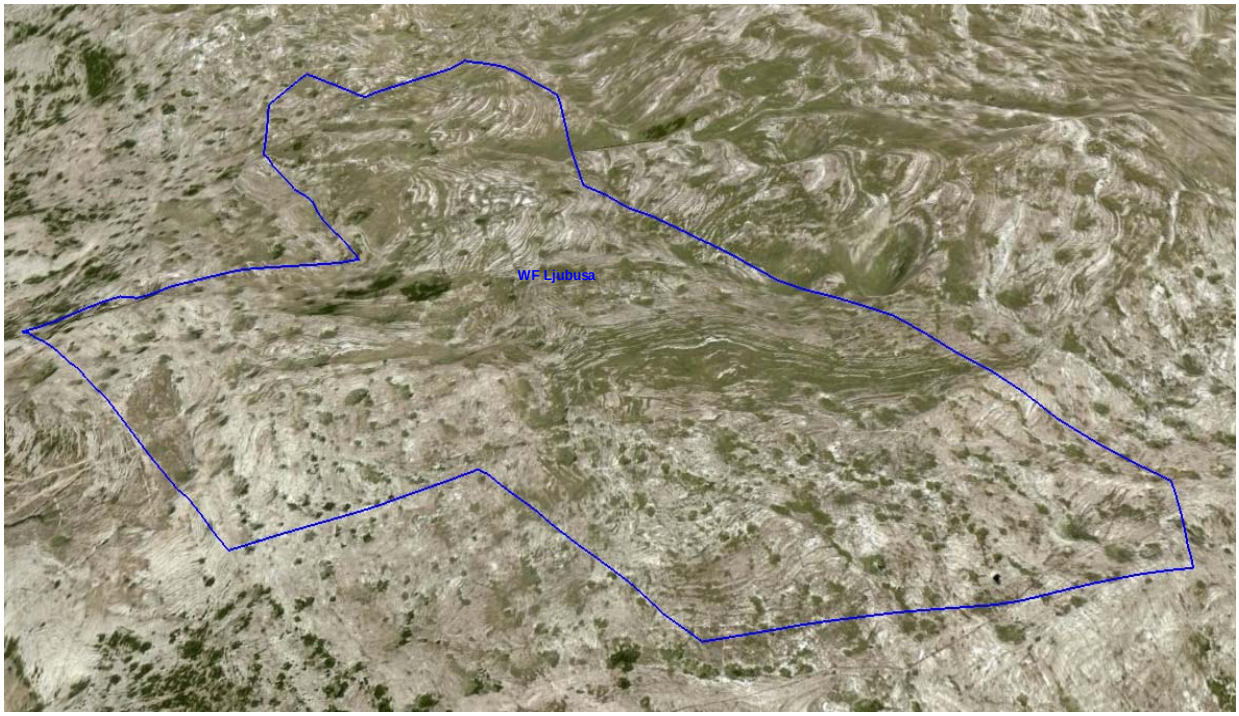

Figure 1-5 Satellite image of WF Ljubusa location

1.2. 3D terrain visualization in ArcGis software

Design of high quality 3D topography model of location is done with following:

- Control and correction of topography contours in 10 meter heights in order to create precise and smooth surface
- Forming a TIN (triangular regular network) using the vectorized contours as input
- Creating a raster surface over TIN allowing color graduation
- Importing significant objects such as geographic grids and infrastructure objects
- Creating terrain cross-sections

Considering the dominant wind direction of approximately 52°, as observed from the wind frequency distribution, cross-sections of planed wind farm areas are extracted from the height graduated map in 3km intervals.

Detailed visual insight in position and topographic characteristics of planed wind farm locations is given trough satellite images, height graduated map and terrain cross-sections.

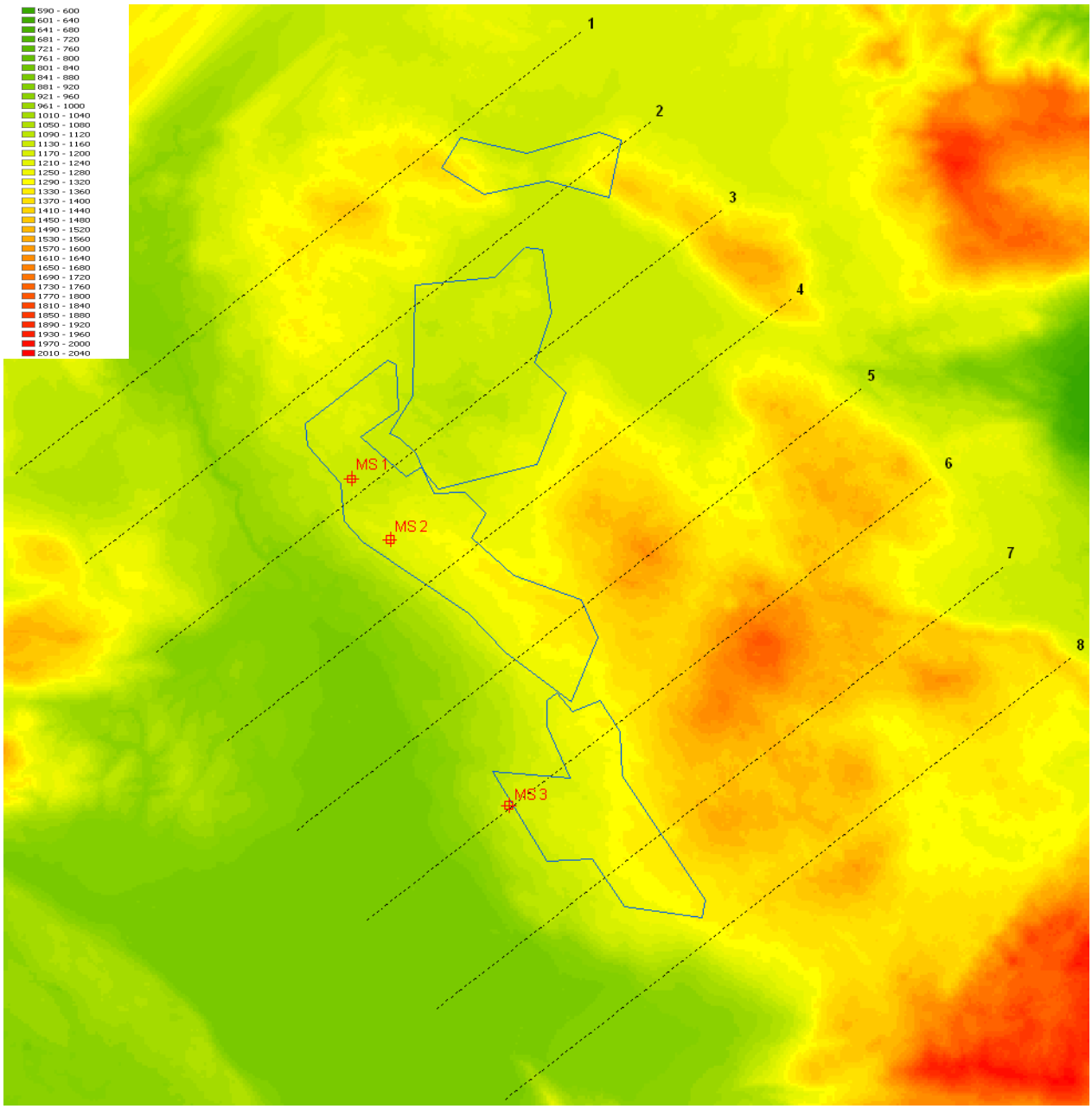

Figure 1-6 Height graduated map of wind farms location with cross-section tracks

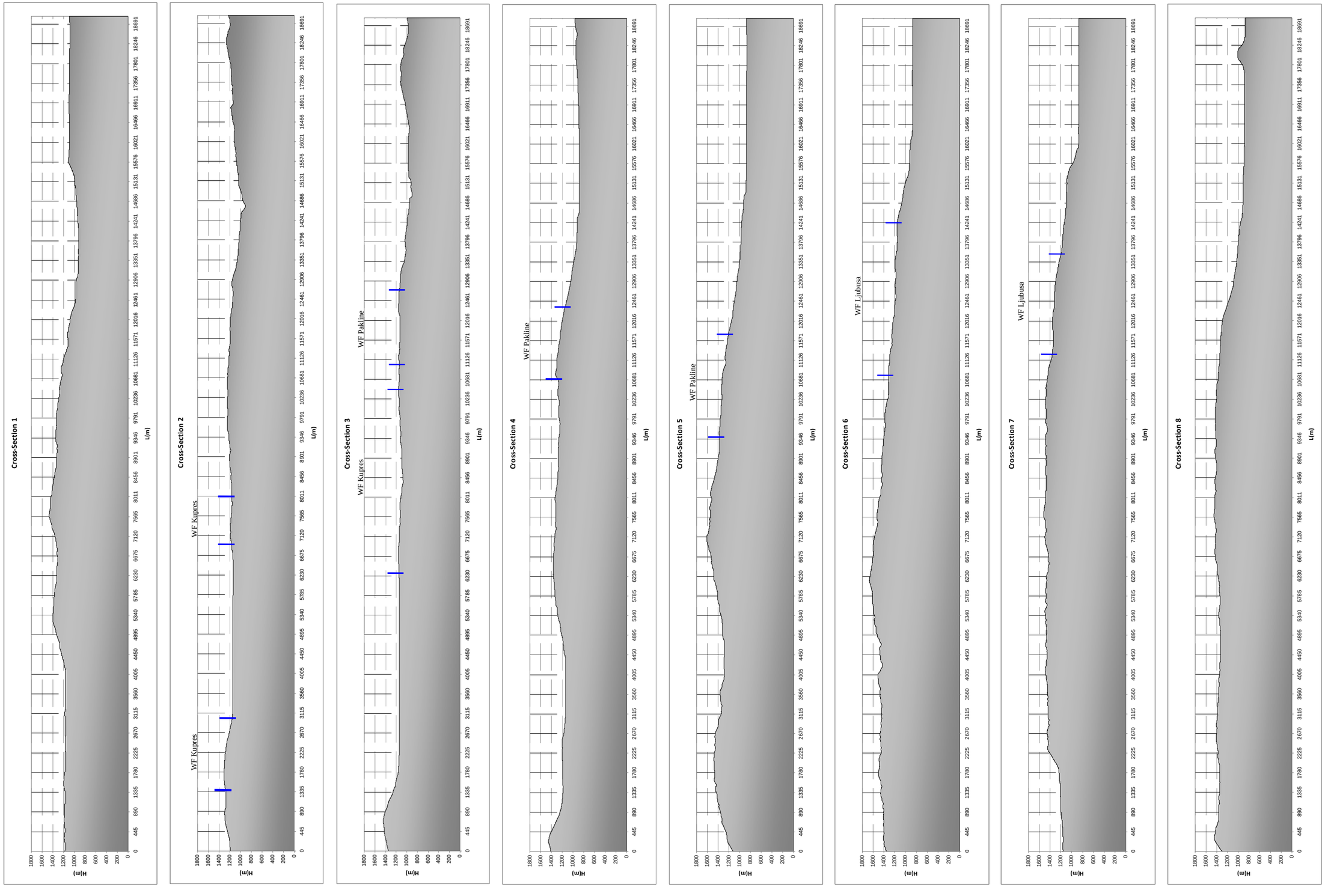

Figure 1-7 Terrain cross-sections

2. SITE MEASUREMENT DATA

For the following analysis, data from wind measurements over three sites are used. Data were delivered to Fractal by Kamen Dent. File format of data is "raw data" (NRG raw files, Wilog raw files) and scaled format.

The meteorological mast MS1 collapsed during the storm, October 2006. Masts MS2 and MS3 are still present at the site locations but are no longer operable.

There is substantial uncertainty in using the collected data, as the sites were not properly maintained and monitored. Also, installation reports for MS2 and MS3 are not available and some analysis parameters (wind vane offsets) are estimated by visual inspection of the masts.

2.1. Site measurement configurations and data quality

MS1

Site measurement configuration is extracted from a installation report (Installation report for locations Pakline and Ravanjska, Fractal d.o.o., Split, August 2007). Data from MS1 were received directly (email) from NRG logger on Fractal email account. The major data uncertainty source are installation effects of tower and surrounding terrain.

General information	
Measurement name	**MS1**
Location name	Pakline
Location description	Pakline is located 8.2 km N-NE from Tomislavgrad town
Location position / height	E: 6440148 N: 6440148 ; 17.25128E 43.79119N /1161
Location magnetic declination	2.5°
Monitoring system	50m tube tower (made by Kamen-dent) / NRG Data Logger

Measurement equipment	
Anemometer 1	NRG #40 – Calibration number #32673
Measurement height/mounting	50m / installed on boom
Anemometer 2	NRG #40 – Calibration number #32674
Measurement height/mounting	25m / installed on boom
Wind Vane 1	NRG #200P
Measurement height/mounting/offset	48m / installed on boom / 45.5°

Data metrics	
Measuring period	16.01.2007 - 18.10.2007 (276 days), without major data gaps
Averaging time	10min

There is a direction gap in data due relatively large wind vane dead band:

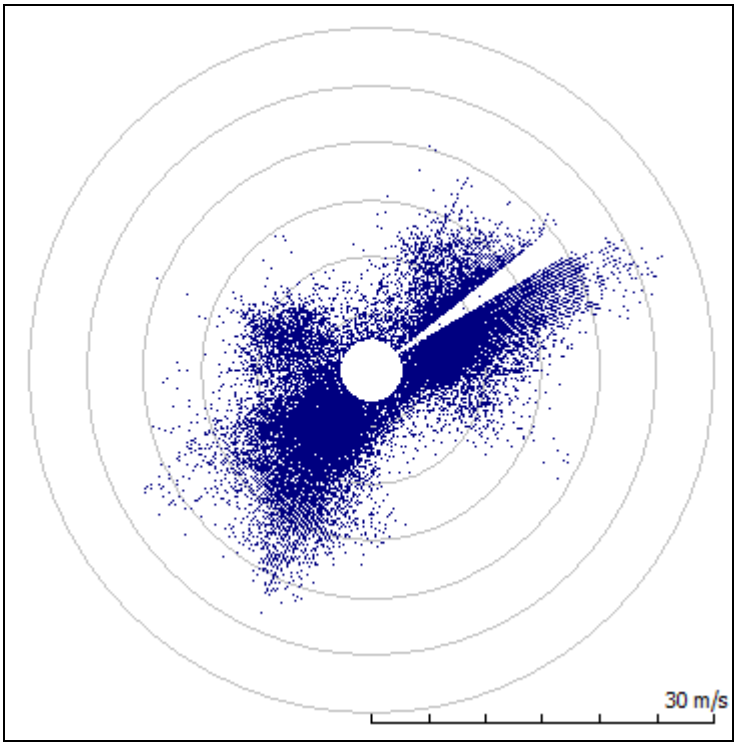

Figure 2-1 Observed wind speed vs. direction data for location MS1

MS2

There is no installation report available for MS2 site. The following site measurement configuration data is reconstructed by Fractal d.o.o. during the site inspection visit, 12.06.2009, and from Wilog raw data files delivered by Kamen Dent. Data collection for MS2 was not monitored by Fractal. Wind vane offsets are estimated by visual inspection of the mast.

Mast MS2 operated for a short period (162days). Because it is located in very close proximity of MS1, it is primarily used to validate the measurements from MS1, and to extend (MCP) analysis data for MS1.

Figure 2-2 MS2 mast

General information	
Measurement name	**MS2**
Location name	Mokronoge
Location description	Mokronoge is located 7.2 km N-NE from Tomislavgrad town
Location position GK ;WGS84 / height	E:6441170 N:4848323 ; 17.26416E 43.77697N /1226m
Location magnetic declination	2.5°
Monitoring system	50m tube tower / NRG Data Logger

Measurement equipment	
Anemometer 1	Thies "First class"
Measurement height/mounting	50m / top mounted
Anemometer 2	Thies "First class"
Measurement height/mounting	30m / installed on boom
Wind Vane 1	Thies "Compact"
Measurement height/mounting/offset	50m / top mounted / -72°
Wind Vane 2	Thies "Compact"
Measurement height/mounting/offset	30m / installed on boom / -35°

Data metrics	
Measuring period	23.12.2006-3.06.2007 (**162 days**), without major data gaps
Averaging time	10min
Other records	Temperature

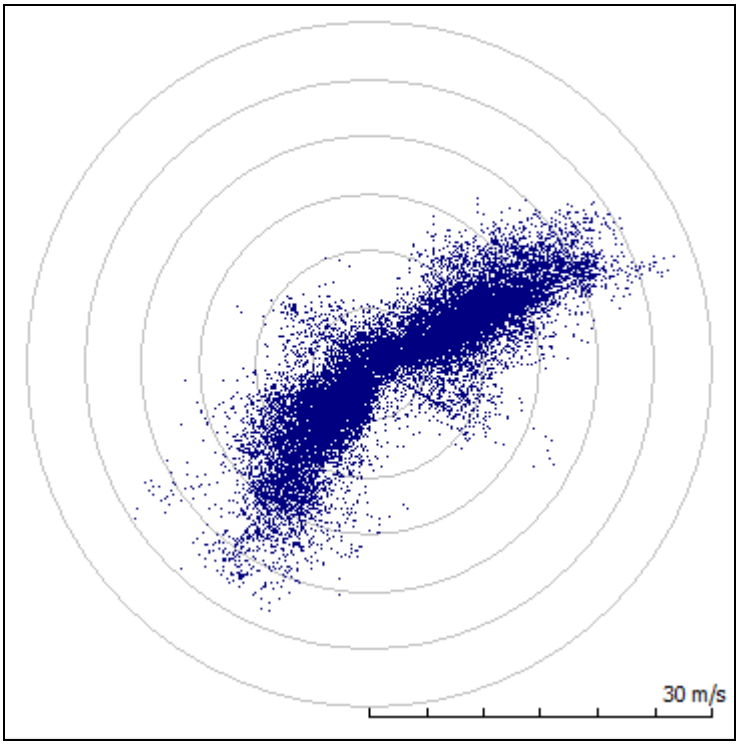

Figure 2-3 Observed wind speed vs. direction data for location MS2

MS3

There is no installation report available for MS3 site. The following site measurement configuration data is reconstructed by Fractal during the site inspection visit, 12.06.2009, and from raw data files delivered by Kamen Dent. Data collection for MS3 was not monitored by Fractal. Wind vane offsets are estimated by visual inspection of the mast.

Figure 2-4 MS3 mast

General information	
Measurement name	**MS3**
Location name	Srdane
Location description	Srdane is located 6.3 km E from Tomislavgrad town
Location position GK ;WGS84 / height	E: 6444313 N:4841294 ; 17.30393E 43.71395N / 1163m
Location magnetic declination	2.5°
Monitoring system	50m tube tower / Wilmers messtechnik - Wilog 306

Measurement equipment	
Anemometer 1	Thies "First class"
Measurement height/mounting	50m / top mounted
Anemometer 2	Thies "First class"
Measurement height/mounting	30m / installed on boom
Anemometer 3	Thies "First class"
Measurement height/mounting	30m / installed on boom
Wind Vane 1	Thies "Compact" / -4.3°
Measurement height/mounting	50m / top mounted
Wind Vane 2	Thies "Compact"
Measurement height/mounting	30m / installed on boom / 5°
Wind Vane 3	Thies "Compact"
Measurement height/mounting	30m / installed on boom /5°

Data metrics	
Measuring period	11.10.2006-1.07.2008 (**453 days**), without major data gaps
Averaging time	10min
Other records	Temperature

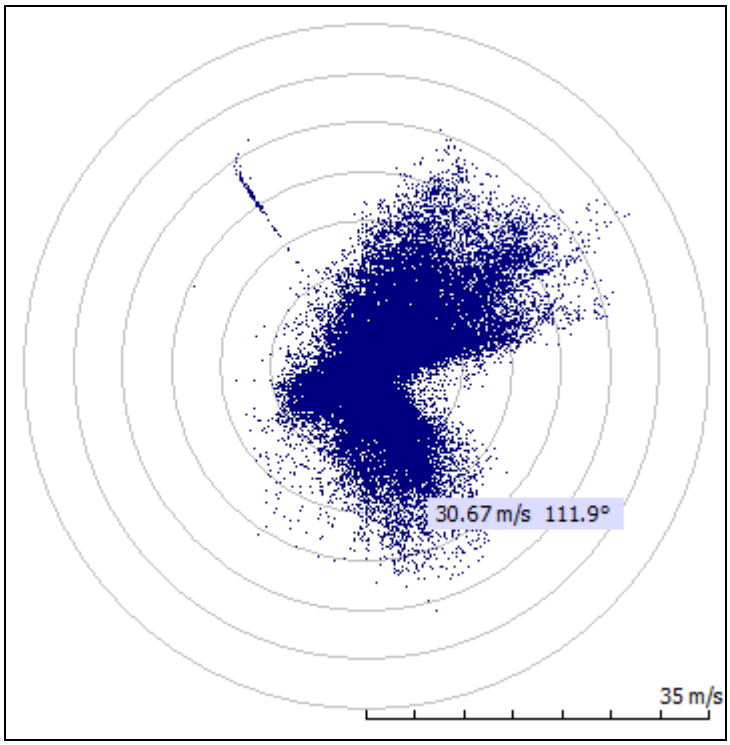

Figure 2-5 Observed wind speed vs. direction data for location MS3

2.2. Wind measurement analysis and report: MS1 (h=50m)

The measurement period for meteorological mast at location MS1 was from 16.01.2007 to 18.10.2007 (276 days).

MCP method (least squares method) is used to derive one year representative wind speed and direction frequency. The first source for MCP were data from the nearby meteorological mast MS2. Using MS2, analysis data are extended only for 24 days (during the windy period and with a very high correlation). For remaining missing periods, MCP derived data from meteorological mast MS3 are used. Turbulence analysis is performed only with original MS1-Pakline data.

Table 2-1 MCP reconstruction of analysis data

Period	Analysis data source	Duration
01.11.2006-31.10.2007		1 year = 8760hours
01.11.2006-22.11.2006	MCP from MS3	52 days
23.12.2006-15.01.2007	MCP from MS2	24 days
16.01.2007-18.10.2007	Original MS1	276 days
19.10.2007-31.10.2007	MCP from MS3	13 days

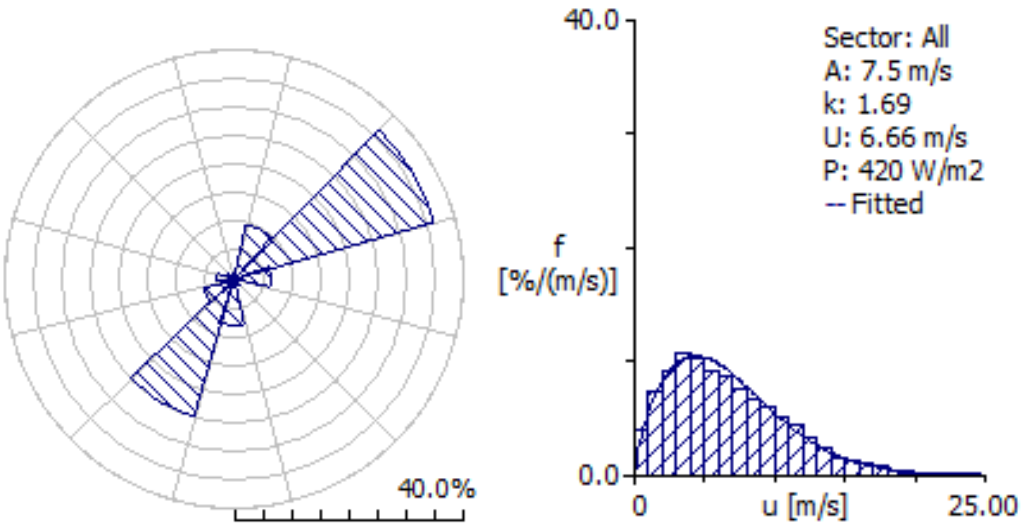

Figure 2-6 Wind Rose (Left) and Weibull Distribution for all directions (Right) for MS1

Table 2-2 MS1 - Observed wind climate - 01.11.2006-31.10.2007

Sector		Wind climate				Power
number	angle [°]	frequency [%]	Weibull-A [m/s]	Weibull-k	mean speed [m/s]	power density [W/m2]
1	0	1.0	5.6	1.53	5.06	210
2	30	9.7	9.2	2.29	8.17	565
3	60	36.1	9.5	2.09	8.42	669
4	90	6.6	4.4	1.61	3.93	91
5	120	0.9	2.5	0.94	2.60	77
6	150	1.5	2.0	1.00	2.04	31
7	180	8.2	5.4	1.30	4.98	259
8	210	25.0	6.6	1.66	5.89	295
9	240	5.8	6.1	1.64	5.45	237
10	270	3.2	5.4	2.08	4.80	125
11	300	1.6	5.2	2.43	4.58	95
12	330	0.5	2.6	1.23	2.42	33
All (emergent)					6.63	420

As depicted, at the MS1 site the wind direction distribution is strongly bipolar in that the wind is from the NE or the SW nearly all of the time.

Average/min/max annual temperature: -8.9/10.2/34.7 °C

Table 2-3 Wind Speed and Direction Frequency Distribution at 50m (U[m/s])

U	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°	All
1.0	116	30	20	49	222	275	51	27	52	61	65	193	38
2.0	143	61	26	101	323	351	125	74	109	117	96	314	73
3.0	143	66	39	166	151	182	141	113	134	122	141	222	92
4.0	91	53	65	258	69	87	155	131	122	135	116	107	108
5.0	73	58	78	195	45	35	125	125	103	126	185	64	103
6.0	53	76	88	74	52	23	84	106	102	138	161	43	92
7.0	60	82	96	43	46	13	68	87	102	107	122	27	86
8.0	66	86	92	38	29	6	47	75	79	89	60	14	76
9.0	87	96	84	32	27	7	39	59	63	60	27	4	67
10.0	91	98	76	14	15	8	32	55	43	25	18	0	59
11.0	30	78	68	15	8	9	30	50	23	10	5	4	51
12.0	17	64	65	7	4	4	31	38	24	4	4	8	44
13.0	9	46	55	4	0	1	27	22	12	1	1	0	33
14.0	9	31	42	1	0	0	16	13	10	1	0	0	24
15.0	4	24	28	1	2	0	10	7	8	1	0	0	16
16.0	3	16	22	0	0	0	9	7	4	1	0	0	12
17.0	1	11	22	0	7	0	3	6	2	0	0	0	11
18.0	4	8	15	0	0	0	3	3	3	0	0	0	8
19.0	0	7	8	0	0	0	3	2	4	0	0	0	4
20.0	0	3	4	0	0	0	0	1	1	0	0	0	2
21.0	0	4	3	0	0	0	0	1	1	0	0	0	2
22.0	0	1	2	0	0	0	0	1	0	0	0	0	1
23.0	0	0	1	0	0	0	0	0	0	0	0	0	0
24.0	0	0	1	0	0	0	0	0	0	0	0	0	0

Note: The frequencies of occurrence in per mille

Turbulence intensity analysis

IEC61400-1 edition 2 defines the characteristic turbulence intensity I_{15} as the mean plus standard deviation of random ten-min measurements. Calculated values are shown in next table.

Table 2-4 Turbulence intensity analysis MS1 (h=50m) 16.01.2007-18.10.2007 (<1 year)

Wind Speed [m/s]	Hours	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity - I_{15}
4	766	0.126	0.076	0.202
5	727	0.116	0.064	0.179
6	670	0.107	0.053	0.160
7	629	0.096	0.048	0.144
8	551	0.092	0.046	0.138
9	471	0.093	0.041	0.133
10	402	0.096	0.038	0.134
11	334	0.095	0.033	0.128
12	277	0.094	0.031	0.126
13	185	0.089	0.031	0.120
14	107	0.093	0.034	0.127
15	70	0.095	0.030	0.125
16	50	0.098	0.026	0.124
17	38	0.092	0.027	0.119
18	22	0.088	0.027	0.115
19	8	0.097	0.035	0.132
20	4	0.085	0.030	0.115
21	5	0.068	0.023	0.092
22	4	0.062	0.015	0.077
23	1	0.064	0.016	0.079
24	1	0.065	0.009	0.075
25	0	0.061	0.001	0.061

2.3. Wind measurement analysis and report: MS3 (h=50m)

The measurement period for meteorological mast at location MS3 was 11.10.2006-1.07.2008 (453 days). To be comparable with data from MS1, one year from 01.11.2006-31.10.2007 is used for analysis.

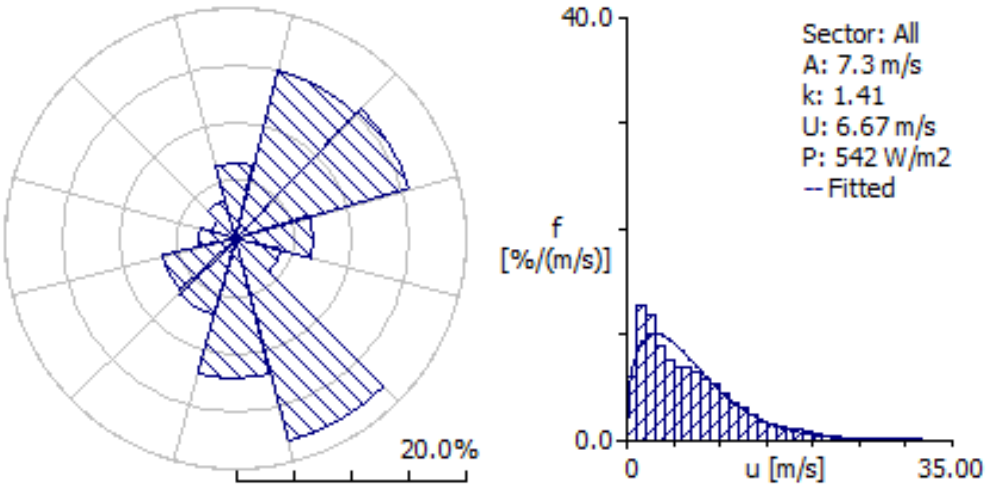

Figure 2-7 Wind Rose (Left) and Weibull Distribution for all directions (Right) for MS3

Table 2-5 MS3 - Observed wind climate - 01.11.2006-31.10.2007

Sector		Wind climate				Power
number	angle [°]	frequency [%]	Weibull-A [m/s]	Weibull-k	Mean speed [m/s]	power density [W/m2]
1	0	6.6	6.9	1.63	6.19	351
2	30	15.0	9.8	1.88	8.73	832
3	60	15.5	11.0	1.81	9.74	1202
4	90	6.7	7.4	1.60	6.62	441
5	120	4.0	3.4	1.01	3.38	138
6	150	18.2	8.0	1.73	7.17	507
7	180	12.0	6.5	1.36	5.93	406
8	210	6.8	4.2	1.31	3.84	117
9	240	6.4	5.3	2.09	4.66	113
10	270	3.2	3.4	1.39	3.11	56
11	300	2.2	2.6	1.23	2.43	34
12	330	3.3	3.7	0.85	4.07	387
All (emergent)					6.68	542

As depicted, at the MS3 site the wind direction distribution is bipolar in that the wind is from the NE or the S-SSE most of the time.

Average/min/max annual temperature is not calculated as no 1-year data are available.

Table 2-6 Wind Speed and Direction Frequency Distribution at 50m (U[m/s])

U	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°	*All*
1.0	44	36	60	129	159	27	31	57	49	115	147	120	59
2.0	121	86	74	112	274	92	114	164	138	274	359	249	126
3.0	120	72	42	76	170	117	160	228	147	184	213	166	119
4.0	114	58	40	63	88	86	115	164	117	131	105	114	89
5.0	76	46	47	77	65	75	100	115	128	82	79	89	76
6.0	75	54	48	60	49	66	74	87	136	75	46	70	68
7.0	75	66	64	80	40	82	60	58	113	54	19	52	69
8.0	74	75	67	65	30	78	56	39	85	49	11	31	64
9.0	66	81	66	58	32	66	47	30	52	24	12	21	56
10.0	64	77	60	73	26	68	45	22	21	9	4	16	53
11.0	43	67	62	52	21	54	45	10	8	2	1	11	44
12.0	34	51	47	45	12	48	39	4	2	1	2	5	35
13.0	30	48	50	31	14	41	31	7	2	0	0	1	31
14.0	19	36	41	25	7	26	21	4	2	1	0	0	23
15.0	17	26	37	17	5	18	16	3	1	0	0	1	18
16.0	11	23	31	13	6	14	10	2	0	0	0	0	14
17.0	8	21	33	7	2	13	10	2	0	0	0	3	13
18.0	5	21	27	4	0	10	10	2	0	0	0	2	11
19.0	2	19	27	2	0	6	6	1	0	0	0	3	9
20.0	1	13	23	2	0	4	4	1	0	0	1	8	7
21.0	1	12	19	1	0	3	3	0	0	0	0	8	6
22.0	1	6	13	3	0	3	2	0	0	0	0	11	4
23.0	0	4	9	2	0	1	0	0	0	0	0	10	3
24.0	0	3	5	0	0	1	0	0	0	0	0	5	1
25.0	0	1	4	2	0	0	0	0	0	0	0	2	1
26.0	0	0	2	1	0	0	0	0	0	0	0	1	0
27.0	0	0	1	0	0	0	0	0	0	0	0	1	0
28.0	0	0	1	0	0	0	0	0	0	0	0	0	0

Note: The frequencies of occurrence in per mille.

Turbulence intensity analysis

IEC61400-1 edition 2 defines the characteristic turbulence intensity I_{15} as the mean plus standard deviation of random ten-min measurements. Calculated values are shown in next table.

Table 2-7 Turbulence intensity analysis MS3 (h=50m) 01.11.2006-31.10.2007

Wind Speed [m/s]	Hours	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity - I_{15}
4	703	0.171	0.103	0.274
5	609	0.154	0.090	0.244
6	592	0.137	0.081	0.218
7	608	0.125	0.067	0.192
8	522	0.119	0.061	0.180
9	467	0.115	0.057	0.172
10	418	0.111	0.053	0.164
11	350	0.108	0.046	0.154
12	279	0.108	0.047	0.155
13	244	0.106	0.049	0.155
14	177	0.107	0.049	0.157
15	133	0.107	0.044	0.152
16	116	0.108	0.044	0.152
17	107	0.106	0.037	0.143
18	93	0.101	0.033	0.134
19	70	0.095	0.029	0.124
20	60	0.091	0.027	0.118
21	46	0.084	0.026	0.110
22	29	0.084	0.026	0.110
23	18	0.075	0.026	0.101
24	9	0.070	0.021	0.091
25	6	0.067	0.024	0.090

The MS3 site has much higher turbulence intensity values than MS1. The increased turbulence level might be due the MS3 placement at the edge of the hill.

3. LAYOUT CALCULATION METHODOLOGY

Analyses is made in two steps, using:

- WAsP software to determine site wind climate conditions from topography and measurement data from reference sites. The map of wind resource over the area is generated in the form of standard WRG file (wind resource grid) containing Weibull distribution parameters for each of direction sectors.
- WindFarmer software for layout optimization, using topography model, observed wind data and wind resource grid data from WAsP.

Layout calculation and optimization is also a influenced by all uncertainties introduced with input data.

3.1. WAsP site wind climate

In order to calculate WRG , the WAsP model considered:

For all sites:

- WASP 9.01 default project parameters.
- Uniform roughness length of 0.03 m.
- Topography: a terrain map with 10m level contours.
- 25m resolution and 80m hub height.

For particular sites:

- Wind farm Kupres measurement data:

  A full year (8,760 hours) of data from MS1(276days) + MCP from MS2(24 days) and MS3(52days).

- Wind farm Pakline measurement data:

  A full year (8,760 hours) of data from MS1 (276days) +MCP from MS2(24 days) and MS3(52days).

- Wind farm Ljubusa measurement data:

  A full year (8,760 hours) of data from MS3.

3.2. Layout optimization using WindFarmer software

- Part of data used in energy calculation is loaded from WAsP in the form of WRG file. Frequency table is associated to correct the error generated by the use of weibull approximation of wind speed and direction distribution in WRG file.
- Other data used in energy calculation purposes, as annual mean temperature, site reference air density and site roughness index, has been derived from collected data or observed during the location visit.

- Data used in turbulence intensity calculations has also been derived from collected data in the form of mean value of turbulence intensity and standard deviation of wind speed standard deviation. Considering that mast MS1, used as a reference site for WF Kupres and WF Pakline, has not completed the whole-year measurement, turbulence has been calculated just as a function of wind speed. For measurement mast MS2 used as reference site for WF Ljubusa, turbulence experienced at mast position has been calculated as a function of both wind speed and direction.
- Restrictions defined for layout optimization consider dwellings, roads and power lines exclusion zones as defined in regulations regarding wind power generator placement.
- Optimization is made by WF taking into account speed-up topography effects and wake effect by Modified Park and Eddy Viscosity Model. Due to its simplicity and faster calculation, Modified Park model has been used during the process of optimization. Advanced Eddy Viscosity model has been used for final energy calculation.
- Also, optimization is partly made manually, changing the number of wind turbines to determine their optimal number due to specific energy yield.
- Turbulence intensity according to IEC 61400-1 Ed2 standard at each turbine position is also considered during the process of optimization in order to stay within wind turbine manufacturer design limits.
- Considering the prevailing wind directions, wake effects and observed turbulence intensity, turbine exclusion zones of min 4D/10D are used.

Complete analyses is made in three separate areas (WF Kupres, WF Pakline and WF Ljubusa), considering mutual wake effect.

Nominal power curve for Siemens SWT-2.3-93 was used for energy calculation, scaled on **selected height of 80m** and appropriate air density.

Cadastre maps are used in WF Pakline and WF Ljubusa areas for final manual wind turbine repositioning, in order to force state-owned land with negligible effect on energy yield.

3.3. Layout report content

Layout of Kupres, Pakline and Ljubusa WF is calculated separately and presented in chapters 4-6. Following data is provided:

- Map from AutoCAD showing the positions of measurement mast and wind farm area on topographic map 1:25000.
- Map from ArcGIS showing the positions of measurement mast and wind farm area on height graduated map.

- Two maps from WAsP showing the wind speed and energy distribution from all sectors over the wind farm area.
- Table consisting the gross and net energy, wake losses, capacity factor and net energy index per unit for each wind turbine.
- Table consisting the number of wind turbines, total net energy, average energy per wind turbine, capacity factor and wake losses.
- Map from WindFarmer showing the wind turbine positions and 4D-10D elliptical separation distances on topographic map 1:25000 with transparent color graduated wind energy distribution and net energy indexes for each wind turbine.
- Turbulence table with estimated design turbulence intensity calculated according to IEC 61400-1 Ed2 standard, showing characteristic turbulence intensity experienced at hub height for each wind turbine.
- Map from WindFarmer showing the wind turbine positions and 4D-10D elliptical separation distances on topographic map 1:25000 with transparent color graduated wind energy distribution and estimated design turbulence intensity calculated according to IEC 61400-1 Ed2 standard for each wind turbine.
- Three-dimensional images from ArcGis showing the wind farm from direction of north, south, east and west.

In Appendix, the following maps are provided for each WF:

- Map from AutoCAD showing wind turbines and measurement mast positions on topographic map along with the table of wind turbine coordinates in Gauss-Kruger projection and altitudes.
- Map from AutoCAD showing wind turbines on cadastre map along with the table consisting cadastre numbers of particles that wind turbines are placed on.

3.4. File list

- This report
- Contours.dwg – AutoCAD file showing vectorized height contours
- MS Excel filtered data used in calculations
- MS Excel table of wind turbine coordinates
- WF_Kupres_Pakline_Ljubusa.dwg – AutoCAD file containing all graphical data used for layout

4. WIND FARM KUPRES LAYOUT

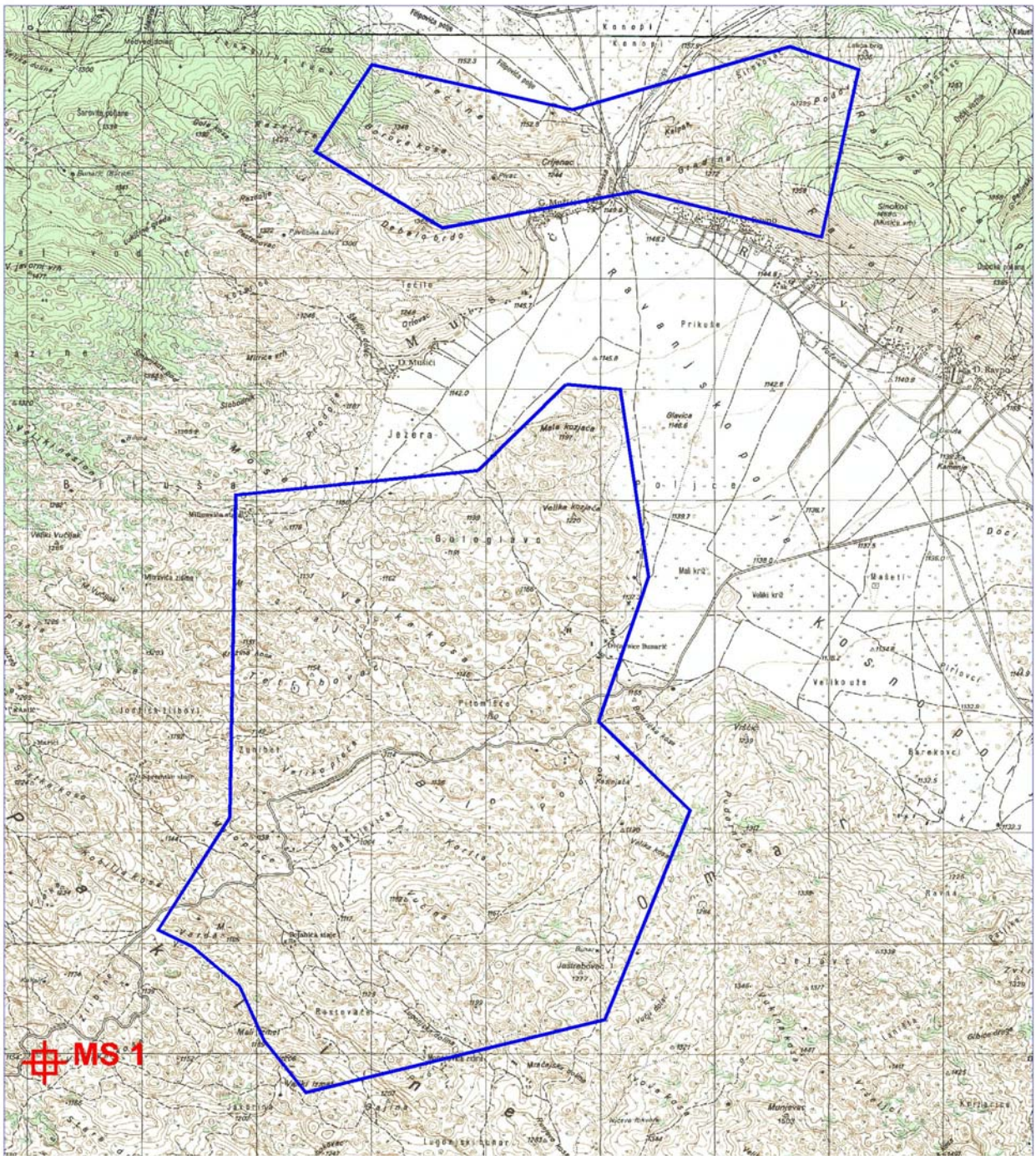

Figure 4-1 Topography map with planed wind farm area and mast position

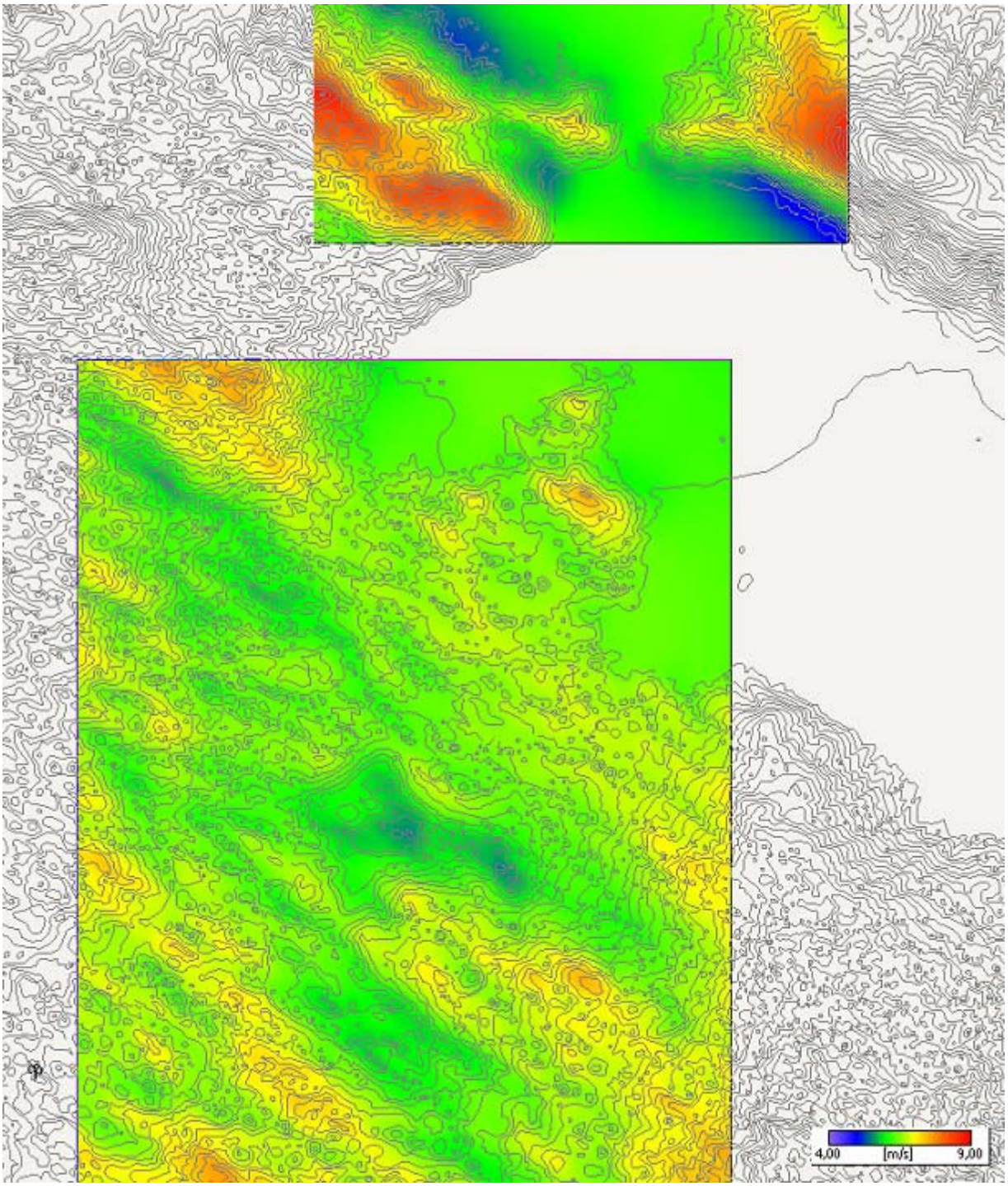

Figure 4-2 Wind speed distribution over the planed wind farm area (WAsP)

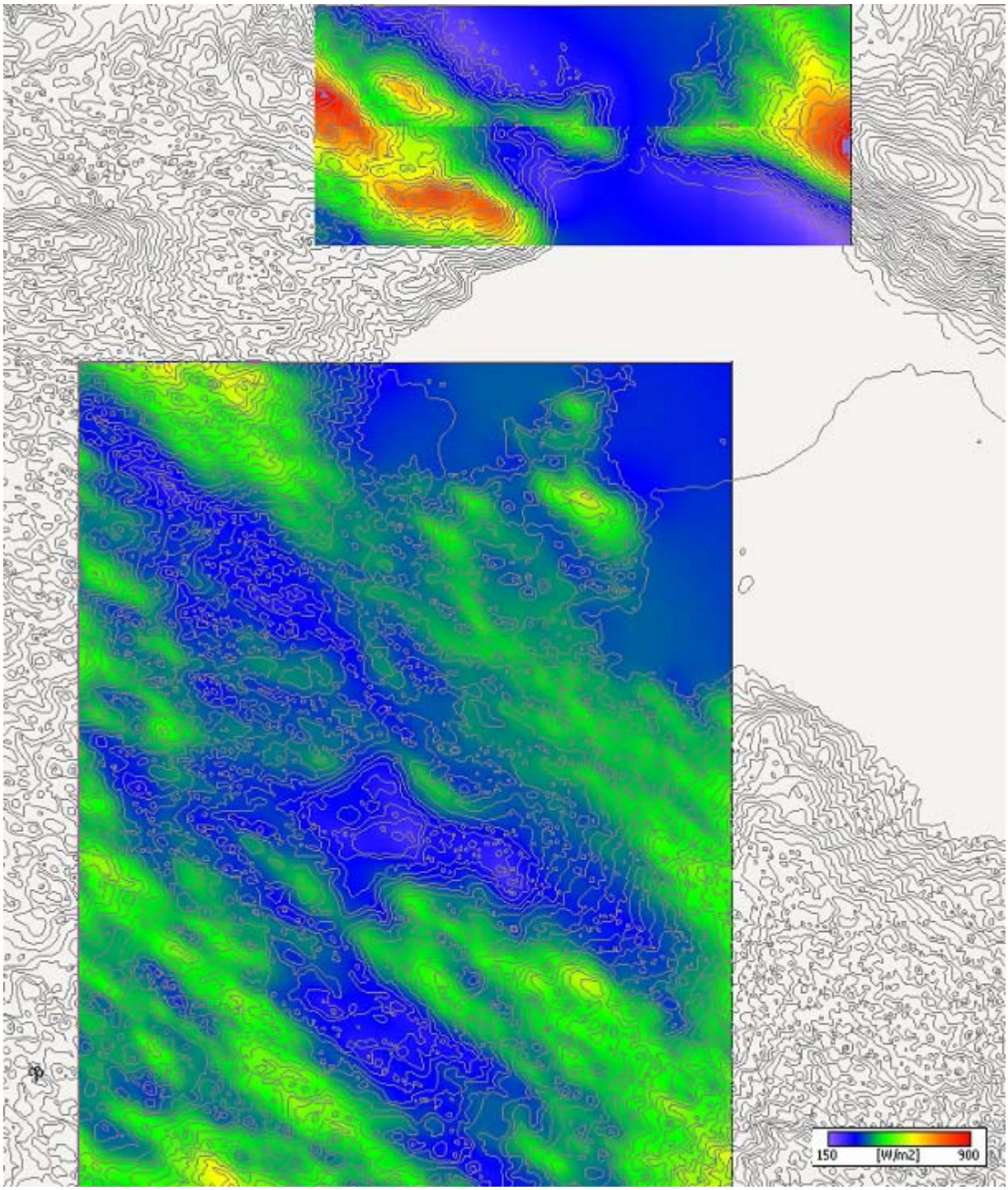

Figure 4-3 Wind energy distribution over the planed wind farm area (WAsP)

Table 4-1 Site specific conditions used in energy yield and fatigue load calculation

WF Kupres	
Site reference ID	MS1
Anual mean temperature (°C)	10,2
Site reference height (m)	1160
Site reference air density	1,085

Layout is designed considering:

- Wind turbine number optimization, restricting the minimum wind turbine production to approximately 90% of average wind farm production.
- Wind turbine position optimization, performed by the criteria of maximum energy production after every change in number of wind turbines.

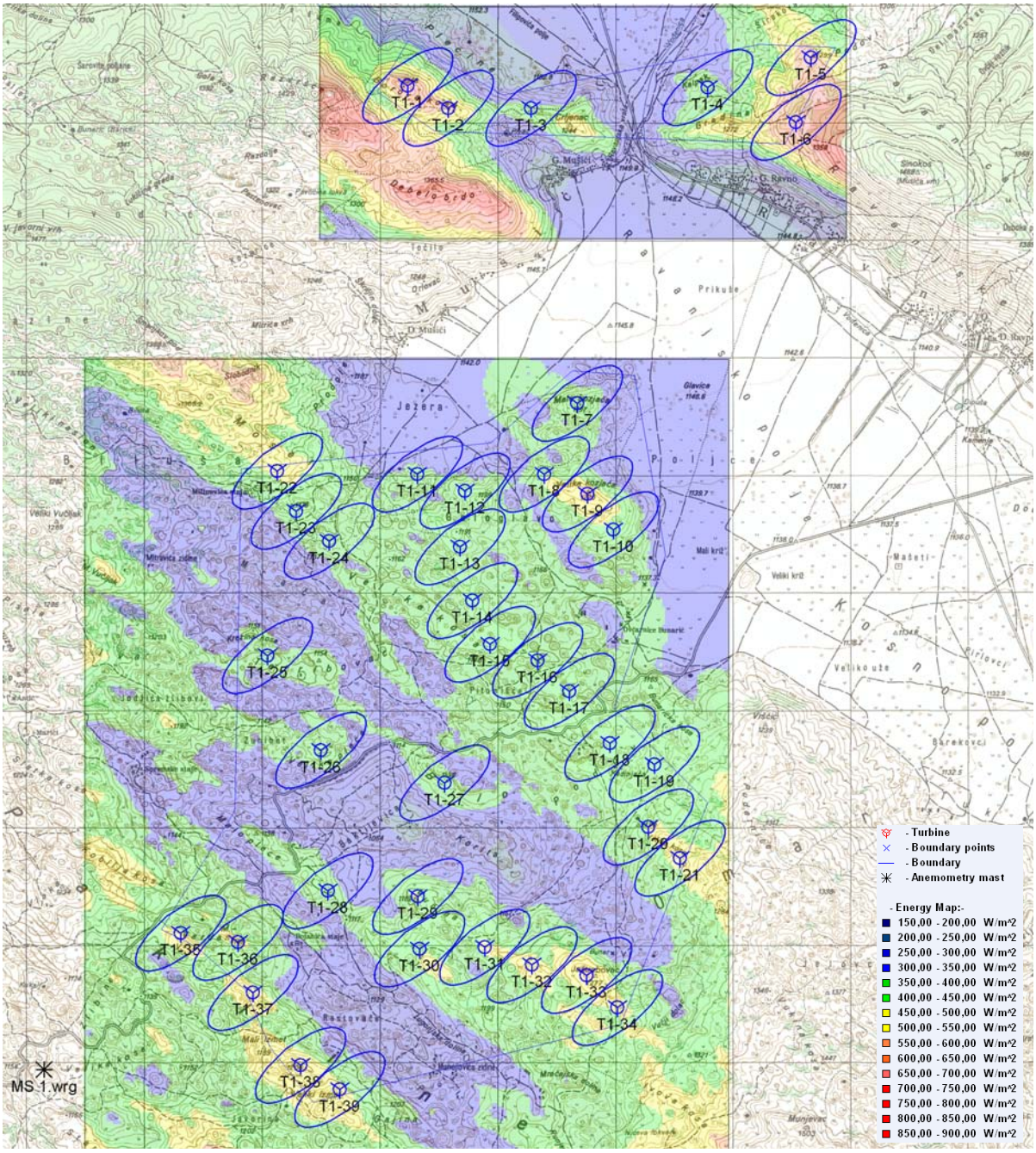

Figure 4-4 Turbine positions with separation distances and wind energy distribution over the planed wind farm area

Table 4-2 Wind turbines and measurement masts positions and altitudes

WT/MS	X (Northing)	Y (Easting)	Altitude (m)
T1-1	4.858.303	6.443.245	1340
T1-2	4.858.110	6.443.592	1297
T1-3	4.858.110	6.444.294	1207
T1-4	4.858.286	6.445.799	1196
T1-5	4.858.541	6.446.675	1299
T1-6	4.857.992	6.446.549	1317
T1-7	4.855.598	6.444.689	1189
T1-8	4.854.996	6.444.407	1179
T1-9	4.854.825	6.444.777	1219
T1-10	4.854.524	6.444.995	1174
T1-11	4.854.996	6.443.327	1151
T1-12	4.854.853	6.443.734	1179
T1-13	4.854.377	6.443.691	1180
T1-14	4.853.920	6.443.798	1170
T1-15	4.853.549	6.443.946	1160
T1-16	4.853.409	6.444.353	1152
T1-17	4.853.146	6.444.621	1160
T1-18	4.852.705	6.444.965	1160
T1-19	4.852.525	6.445.344	1173
T1-20	4.851.991	6.445.292	1206
T1-21	4.851.727	6.445.564	1249
T1-22	4.855.021	6.442.137	1217
T1-23	4.854.679	6.442.299	1170
T1-24	4.854.424	6.442.579	1149
T1-25	4.853.451	6.442.054	1150
T1-26	4.852.646	6.442.508	1149
T1-27	4.852.366	6.443.561	1130
T1-28	4.851.449	6.442.569	1118
T1-29	4.851.401	6.443.331	1159
T1-30	4.850.953	6.443.346	1170
T1-31	4.850.970	6.443.902	1190
T1-32	4.850.818	6.444.302	1235
T1-33	4.850.727	6.444.769	1270
T1-34	4.850.453	6.445.030	1269
T1-35	4.851.090	6.441.314	1162
T1-36	4.851.008	6.441.801	1159
T1-37	4.850.583	6.441.928	1161
T1-38	4.849.964	6.442.333	1200
T1-39	4.849.757	6.442.669	1210
MS1	4.849.928	6.440.154	1160
MS2	4.848.320	6.441.171	1225

Table 4-3 Energy per turbine

No.	Gross energy (GWh)	Wake losses (%)	Net energy (GWh)	Capacity factor (%)	Net energy - index (%)
T1-1	7,937	1,0	7,862	39,0	100
T1-2	7,257	1,6	7,142	35,4	91
T1-3	5,737	1,6	5,643	28,0	72
T1-4	6,017	2,8	5,846	29,0	74
T1-5	7,616	2,2	7,452	37,0	95
T1-6	7,629	1,7	7,497	37,2	95
T1-7	6,605	4,5	6,306	31,3	80
T1-8	6,471	4,6	6,172	30,6	79
T1-9	7,486	3,4	7,235	35,9	92
T1-10	6,513	3,1	6,308	31,3	80
T1-11	5,969	4,6	5,696	28,3	72
T1-12	6,501	6,9	6,052	30,0	77
T1-13	6,389	7,6	5,905	29,3	75
T1-14	6,409	5,8	6,036	29,9	77
T1-15	6,371	4,6	6,080	30,2	77
T1-16	6,292	3,5	6,072	30,1	77
T1-17	6,400	2,6	6,231	30,9	79
T1-18	6,299	2,3	6,154	30,5	78
T1-19	6,287	3,0	6,100	30,3	78
T1-20	6,604	2,8	6,417	31,8	82
T1-21	6,825	2,8	6,630	32,9	84
T1-22	6,924	2,7	6,739	33,4	86
T1-23	6,350	4,4	6,071	30,1	77
T1-24	6,124	8,1	5,628	27,9	72
T1-25	6,000	6,6	5,603	27,8	71
T1-26	6,200	6,6	5,789	28,7	74
T1-27	6,293	6,2	5,901	29,3	75
T1-28	6,144	6,8	5,725	28,4	73
T1-29	6,672	6,5	6,240	31,0	79
T1-30	6,484	6,7	6,049	30,0	77
T1-31	6,674	5,8	6,287	31,2	80
T1-32	6,986	5,1	6,630	32,9	84
T1-33	7,334	3,2	7,102	35,2	90
T1-34	6,767	2,5	6,596	32,7	84
T1-35	6,766	5,6	6,385	31,7	81
T1-36	6,684	8,4	6,120	30,4	78
T1-37	6,829	7,0	6,352	31,5	81
T1-38	7,018	7,0	6,524	32,4	83
T1-39	6,818	7,1	6,335	31,4	81
Avg	6,633	4,6	6,331	31,4	81
Min	5,737	1,0	5,603	27,8	71
Max	7,937	8,4	7,862	39,0	100

Table 4-4 Summary data

WF Kupres	
Number of WT	39
Total net energy (GWh)	247
Average net energy per WT (GWh)	6,331
Capacity factor (%)	31,4
Min/max wake losses (%)	1,0 - 8,4

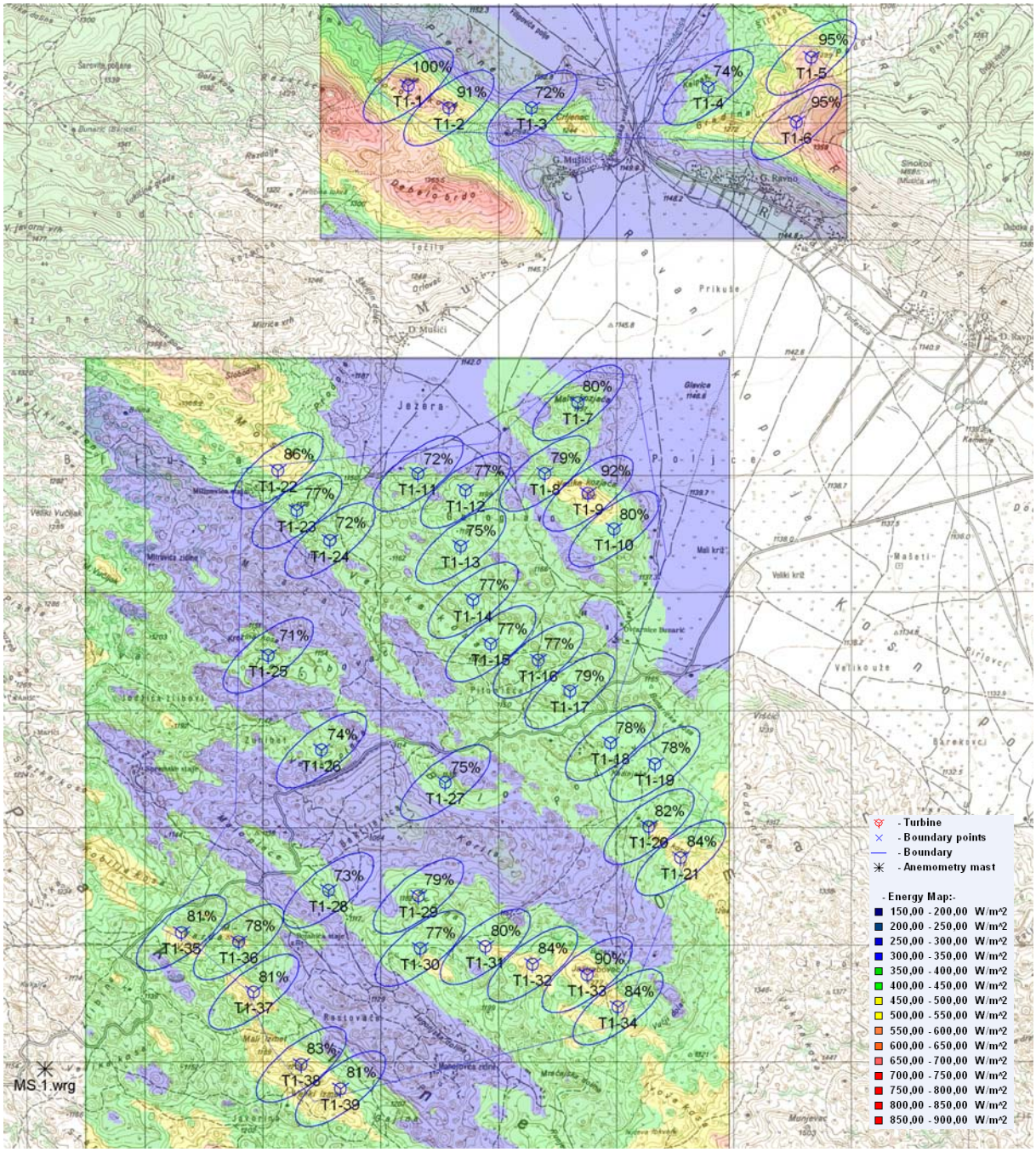

Figure 4-5 Net energy indexes

Table 4-5 Estimated design equivalent turbulence by wind speed (T1-1 - T1-10)

v(m/s)	T1-1	T1-2	T1-3	T1-4	T1-5	T1-6	T1-7	T1-8	T1-9	T1-10
4	0,186	0,190	0,173	0,190	0,150	0,192	0,186	0,187	0,180	0,188
5	0,170	0,191	0,190	0,190	0,200	0,178	0,202	0,206	0,194	0,194
6	0,161	0,186	0,169	0,171	0,185	0,163	0,190	0,190	0,189	0,181
7	0,147	0,170	0,157	0,158	0,169	0,151	0,177	0,177	0,176	0,168
8	0,137	0,156	0,149	0,151	0,155	0,142	0,166	0,168	0,165	0,157
9	0,131	0,146	0,145	0,148	0,148	0,136	0,158	0,160	0,154	0,148
10	0,125	0,137	0,139	0,144	0,142	0,133	0,152	0,154	0,144	0,141
11	0,121	0,130	0,134	0,139	0,139	0,131	0,147	0,147	0,137	0,136
12	0,118	0,124	0,134	0,134	0,136	0,128	0,142	0,142	0,130	0,132
13	0,115	0,118	0,134	0,136	0,131	0,124	0,137	0,137	0,126	0,129
14	0,111	0,115	0,131	0,135	0,127	0,120	0,133	0,134	0,122	0,125
15	0,108	0,116	0,129	0,132	0,122	0,120	0,129	0,131	0,117	0,122
16	0,109	0,114	0,126	0,130	0,123	0,118	0,126	0,128	0,114	0,120
17	0,108	0,111	0,122	0,127	0,121	0,116	0,124	0,125	0,111	0,118
18	0,104	0,110	0,120	0,124	0,118	0,115	0,122	0,124	0,109	0,116
19	0,103	0,108	0,118	0,122	0,115	0,113	0,120	0,124	0,108	0,115
20	0,102	0,106	0,117	0,118	0,112	0,111	0,118	0,122	0,107	0,114
21	0,101	0,104	0,114	0,114	0,108	0,110	0,116	0,120	0,106	0,112
22	0,103	0,103	0,104	0,113	0,104	0,109	0,116	0,119	0,104	0,111
23	0,104	0,102	0,100	0,111	0,100	0,108	0,114	0,114	0,102	0,110
24	0,104	0,101	0,097	0,103	0,099	0,108	0,108	0,109	0,101	0,109
25	0,092	0,077	0,087	0,037	0,081	0,106	0,105	0,095	0,091	0,108

Table 4-6 Estimated design equivalent turbulence by wind speed (T1-11 - T1-20)

v(m/s)	T1-11	T1-12	T1-13	T1-14	T1-15	T1-16	T1-17	T1-18	T1-19	T1-20
4	0,174	0,160	0,160	0,177	0,183	0,188	0,188	0,188	0,190	0,188
5	0,207	0,222	0,206	0,200	0,202	0,203	0,188	0,193	0,214	0,193
6	0,189	0,210	0,195	0,186	0,187	0,194	0,187	0,179	0,201	0,180
7	0,176	0,195	0,183	0,174	0,173	0,179	0,173	0,166	0,185	0,168
8	0,167	0,184	0,173	0,164	0,163	0,167	0,160	0,156	0,172	0,159
9	0,158	0,174	0,166	0,157	0,155	0,157	0,150	0,148	0,162	0,153
10	0,150	0,166	0,160	0,152	0,148	0,148	0,142	0,141	0,154	0,147
11	0,145	0,160	0,155	0,146	0,142	0,141	0,136	0,135	0,148	0,141
12	0,140	0,155	0,151	0,142	0,137	0,135	0,131	0,131	0,144	0,136
13	0,136	0,152	0,148	0,139	0,133	0,130	0,127	0,127	0,140	0,131
14	0,133	0,149	0,145	0,136	0,129	0,127	0,123	0,124	0,135	0,127
15	0,130	0,145	0,142	0,133	0,126	0,125	0,121	0,122	0,132	0,125
16	0,128	0,142	0,138	0,130	0,124	0,123	0,119	0,121	0,129	0,122
17	0,127	0,139	0,135	0,128	0,122	0,121	0,117	0,119	0,125	0,121
18	0,124	0,136	0,133	0,126	0,121	0,119	0,116	0,117	0,124	0,119
19	0,122	0,134	0,132	0,124	0,119	0,117	0,114	0,115	0,122	0,117
20	0,120	0,133	0,131	0,123	0,117	0,116	0,113	0,113	0,119	0,115
21	0,119	0,130	0,129	0,121	0,116	0,115	0,112	0,112	0,117	0,114
22	0,118	0,127	0,126	0,119	0,114	0,113	0,111	0,111	0,116	0,113
23	0,117	0,128	0,124	0,117	0,113	0,111	0,110	0,110	0,113	0,111
24	0,109	0,129	0,123	0,117	0,112	0,110	0,109	0,110	0,110	0,108
25	0,050	0,113	0,115	0,112	0,108	0,000	0,108	0,000	0,000	0,106

Table 4-7 Estimated design equivalent turbulence by wind speed (T1-21 - T1-30)

v(m/s)	T1-21	T1-22	T1-23	T1-24	T1-25	T1-26	T1-27	T1-28	T1-29	T1-30
4	0,187	0,177	0,173	0,169	0,163	0,138	0,165	0,139	0,165	0,122
5	0,193	0,195	0,194	0,208	0,192	0,190	0,198	0,203	0,205	0,207
6	0,186	0,181	0,182	0,198	0,177	0,175	0,182	0,184	0,196	0,186
7	0,173	0,167	0,169	0,184	0,166	0,164	0,170	0,172	0,182	0,172
8	0,161	0,156	0,159	0,172	0,157	0,155	0,161	0,162	0,171	0,163
9	0,150	0,148	0,152	0,164	0,150	0,148	0,154	0,154	0,161	0,155
10	0,141	0,142	0,146	0,157	0,145	0,143	0,148	0,148	0,154	0,149
11	0,135	0,138	0,140	0,151	0,140	0,139	0,144	0,143	0,149	0,143
12	0,130	0,134	0,136	0,147	0,136	0,135	0,140	0,138	0,145	0,136
13	0,126	0,131	0,131	0,144	0,133	0,132	0,136	0,134	0,143	0,131
14	0,122	0,128	0,129	0,141	0,130	0,129	0,133	0,131	0,141	0,127
15	0,119	0,125	0,126	0,138	0,128	0,127	0,131	0,128	0,138	0,125
16	0,117	0,122	0,125	0,136	0,126	0,125	0,129	0,126	0,134	0,122
17	0,115	0,119	0,123	0,134	0,124	0,123	0,126	0,125	0,130	0,120
18	0,113	0,117	0,120	0,131	0,123	0,121	0,125	0,123	0,127	0,118
19	0,112	0,114	0,118	0,129	0,121	0,119	0,123	0,121	0,125	0,117
20	0,111	0,114	0,117	0,127	0,120	0,118	0,121	0,119	0,126	0,116
21	0,109	0,113	0,116	0,126	0,118	0,117	0,120	0,118	0,124	0,113
22	0,108	0,110	0,114	0,125	0,117	0,116	0,119	0,117	0,118	0,111
23	0,107	0,108	0,114	0,125	0,115	0,115	0,118	0,116	0,118	0,111
24	0,106	0,108	0,114	0,125	0,103	0,113	0,117	0,115	0,118	0,109
25	0,074	0,104	0,112	0,105	0,093	0,103	0,107	0,094	0,108	0,105

Table 4-8 Estimated design equivalent turbulence by wind speed (T1-31 - T1-39)

v(m/s)	T1-31	T1-32	T1-33	T1-34	T1-35	T1-36	T1-37	T1-38	T1-39
4	0,168	0,170	0,181	0,187	0,163	0,160	0,151	0,162	0,167
5	0,213	0,200	0,186	0,190	0,203	0,206	0,208	0,204	0,196
6	0,192	0,196	0,183	0,184	0,188	0,199	0,201	0,195	0,195
7	0,178	0,181	0,171	0,171	0,173	0,185	0,186	0,181	0,181
8	0,167	0,169	0,160	0,159	0,162	0,175	0,175	0,168	0,168
9	0,157	0,158	0,151	0,148	0,153	0,165	0,166	0,156	0,156
10	0,147	0,148	0,142	0,140	0,146	0,157	0,159	0,148	0,148
11	0,140	0,140	0,135	0,133	0,140	0,151	0,154	0,140	0,141
12	0,135	0,134	0,129	0,128	0,134	0,147	0,150	0,134	0,135
13	0,130	0,129	0,124	0,124	0,130	0,144	0,147	0,129	0,131
14	0,127	0,125	0,120	0,121	0,126	0,141	0,143	0,125	0,127
15	0,125	0,122	0,117	0,118	0,124	0,138	0,138	0,122	0,124
16	0,123	0,120	0,115	0,116	0,121	0,135	0,136	0,120	0,121
17	0,122	0,118	0,113	0,115	0,119	0,132	0,131	0,119	0,118
18	0,119	0,116	0,112	0,113	0,117	0,130	0,127	0,118	0,117
19	0,116	0,114	0,111	0,112	0,115	0,127	0,126	0,116	0,116
20	0,114	0,112	0,110	0,110	0,114	0,126	0,125	0,113	0,114
21	0,113	0,110	0,107	0,109	0,112	0,124	0,121	0,111	0,113
22	0,112	0,109	0,106	0,108	0,111	0,121	0,119	0,110	0,111
23	0,111	0,108	0,105	0,107	0,110	0,120	0,118	0,108	0,109
24	0,109	0,107	0,104	0,106	0,109	0,120	0,115	0,107	0,108
25	0,104	0,101	0,102	0,104	0,108	0,119	0,110	0,106	0,106

Table 4-9 Summary turbulence data (15m/s)

WF Kupres		
	WT position	I_{15_eff}
Min	1	0,108
Max	12	0,145
Avrg		0,127

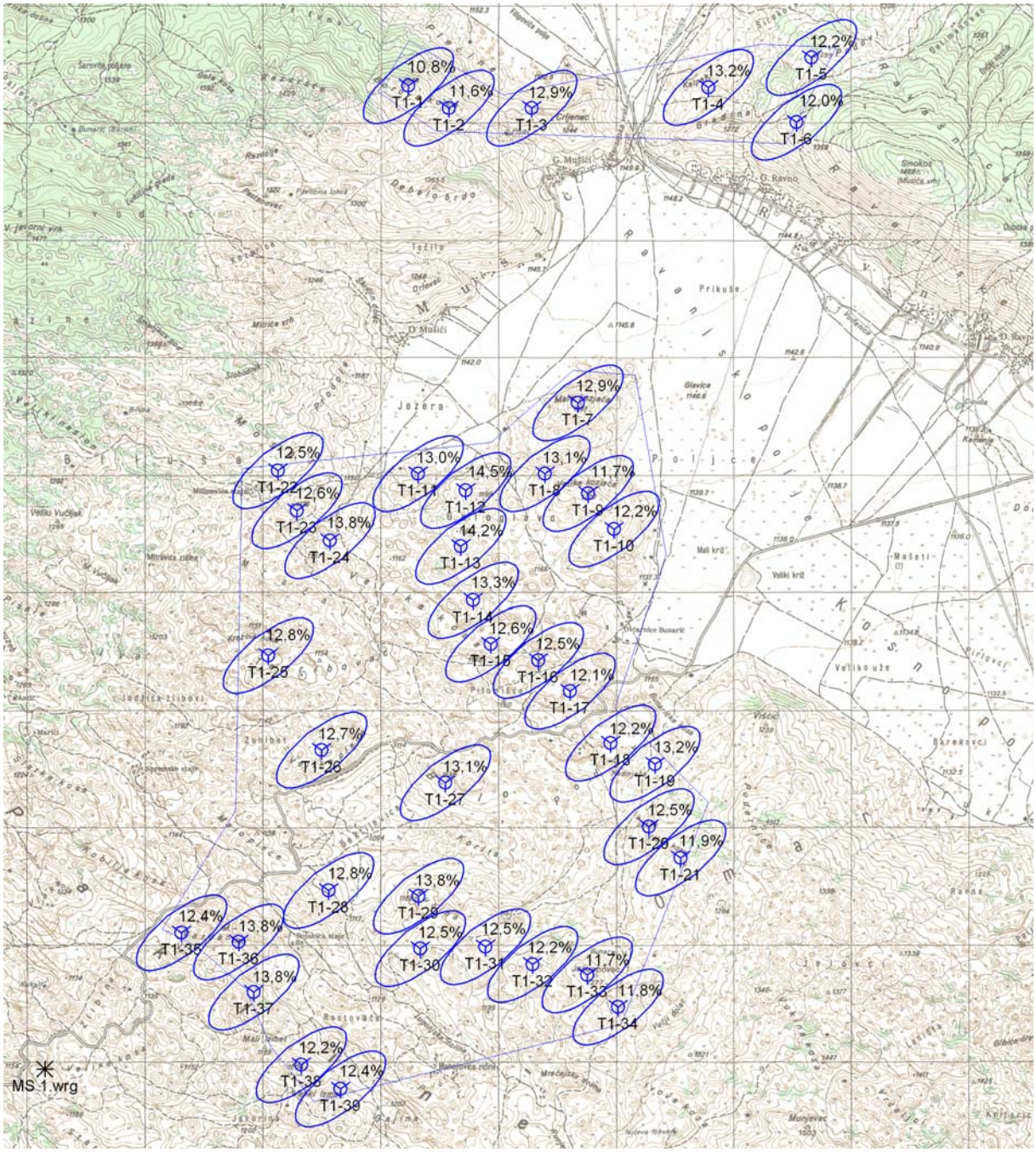

Figure 4-6 Estimated design equivalent turbulence (I_{15_eff}) according to IEC 61400-1 Ed2 standard

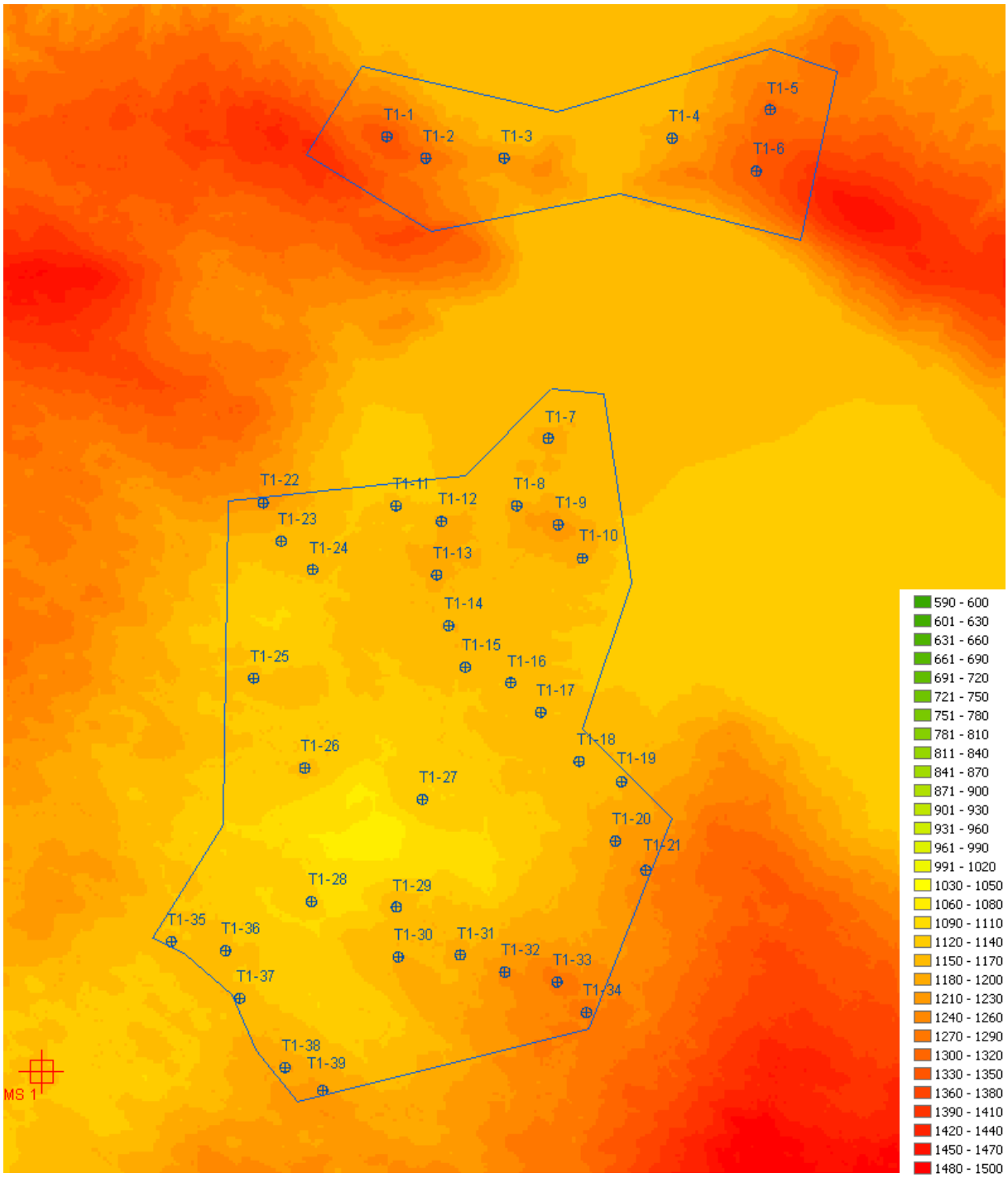

Figure 4-7 Wind turbine positions on height graduated map

5. WIND FARM PAKLINE LAYOUT

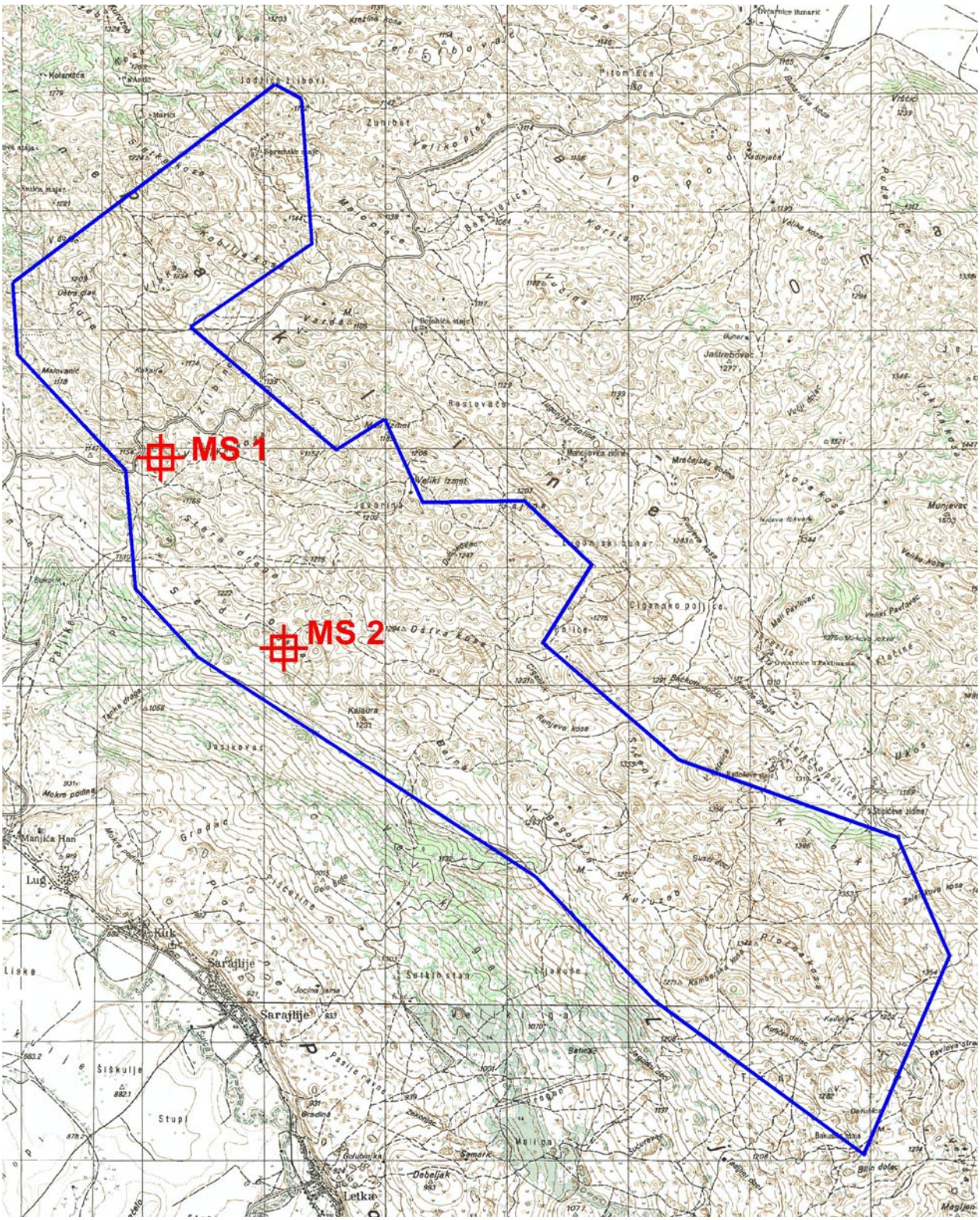

Figure 5-1 Topography map with planed wind farm area and mast position

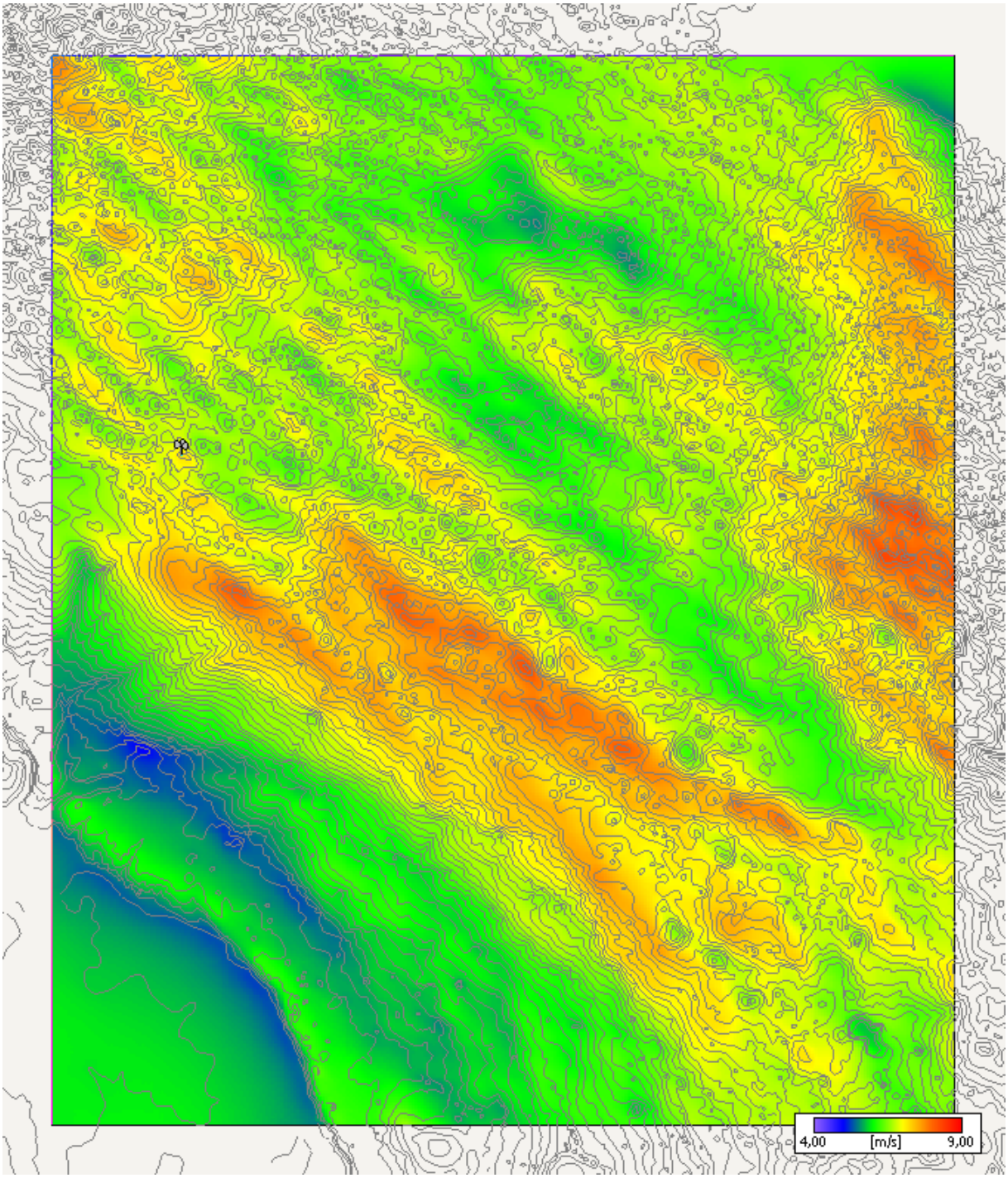

Figure 5-2 Wind speed distribution over the planed wind farm area (WAsP)

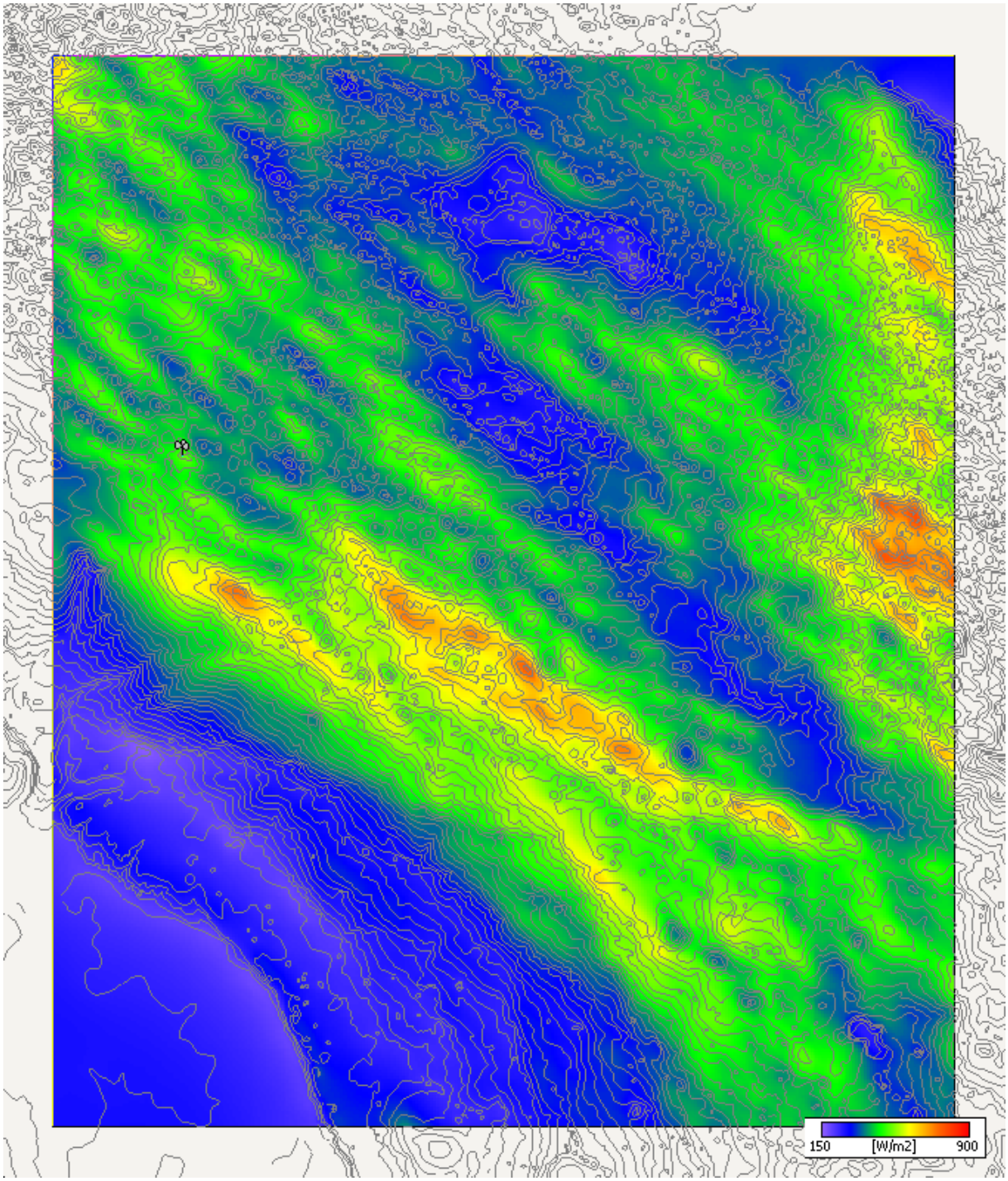

Figure 5-3 Wind energy distribution over the planed wind farm area (WAsP)

Table 5-1 – Site specific conditions used in energy yeald and fatigue load calculation

WF Pakline	
Site reference ID	MS1
Anual mean temperature (°C)	10,2
Site reference height (m)	1160
Site reference air density	1,085

Layout is designed considering:

- Wind turbine number optimization, restricting the minimum wind turbine production to approximately 90% of average wind farm production, but also considering the high energy of this site maximally using the available area..
- Wind turbine position optimization, performed by the criteria of maximum energy production after every change in number of wind turbines.

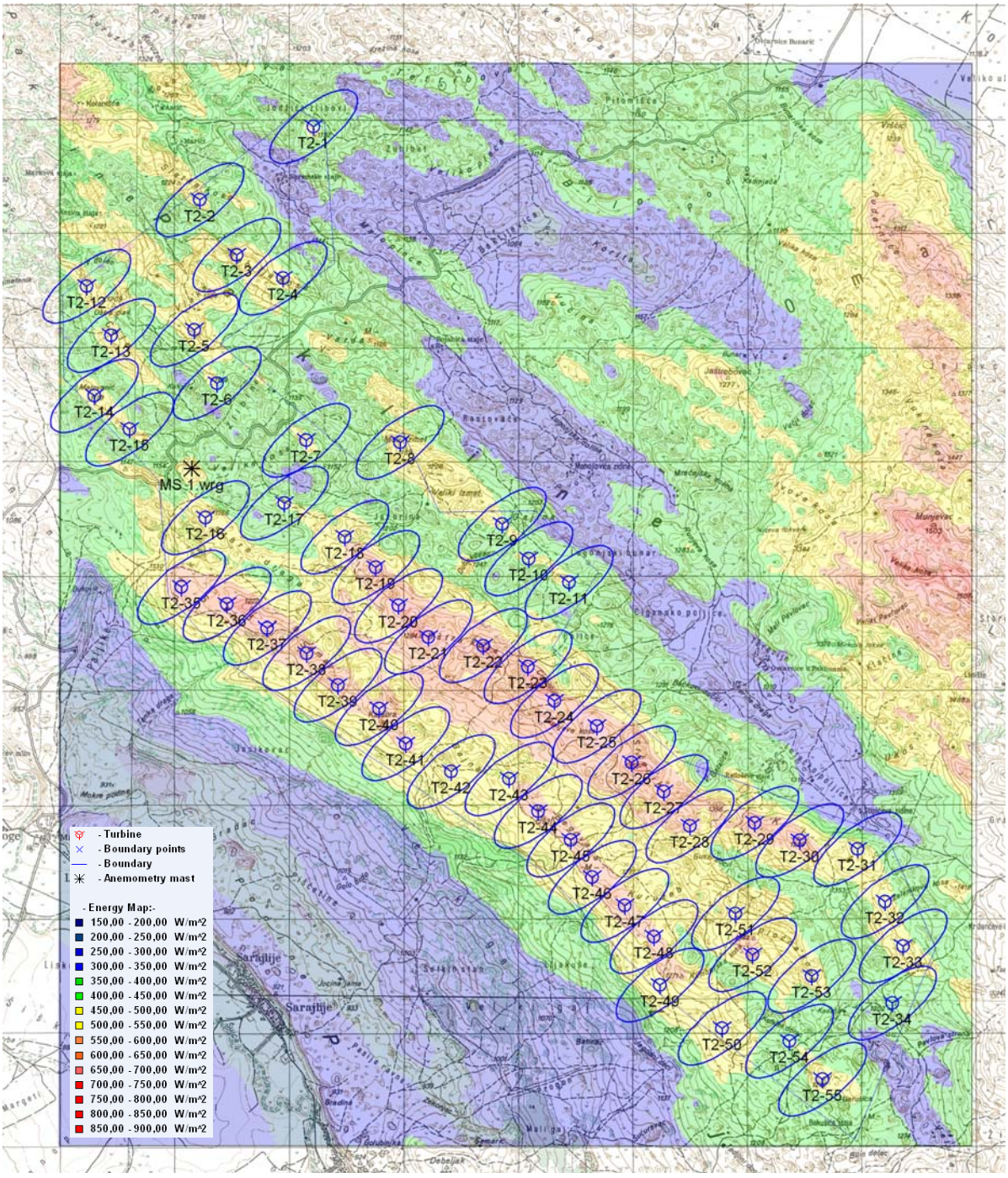

Figure 5-4 Turbine positions with separation distances and wind energy distribution over the planed wind farm area

Table 5-2 Wind turbines and measurement masts positions and altitudes

WT/MS	X (Northing)	Y (Easting)	Altitude (m)
T2-1	4.852.923	6.441.219	1189
T2-2	4.852.283	6.440.224	1200
T2-3	4.851.800	6.440.546	1216
T2-4	4.851.595	6.440.951	1189
T2-5	4.851.142	6.440.175	1206
T2-6	4.850.675	6.440.375	1162
T2-7	4.850.174	6.441.156	1160
T2-8	4.850.158	6.441.978	1181
T2-9	4.849.439	6.442.869	1213
T2-10	4.849.135	6.443.102	1236
T2-11	4.848.931	6.443.452	1250
T2-12	4.851.526	6.439.235	1200
T2-13	4.851.095	6.439.448	1197
T2-14	4.850.566	6.439.304	1169
T2-15	4.850.271	6.439.611	1150
T2-16	4.849.497	6.440.274	1160
T2-17	4.849.622	6.440.964	1150
T2-18	4.849.328	6.441.491	1209
T2-19	4.849.062	6.441.764	1246
T2-20	4.848.727	6.441.963	1271
T2-21	4.848.454	6.442.222	1290
T2-22	4.848.377	6.442.704	1309
T2-23	4.848.195	6.443.094	1305
T2-24	4.847.896	6.443.325	1310
T2-25	4.847.673	6.443.696	1330
T2-26	4.847.355	6.444.001	1349
T2-27	4.847.100	6.444.284	1330
T2-28	4.846.800	6.444.511	1330
T2-29	4.846.827	6.445.078	1379
T2-30	4.846.671	6.445.472	1389
T2-31	4.846.597	6.445.976	1390
T2-32	4.846.135	6.446.218	1379
T2-33	4.845.748	6.446.376	1370
T2-34	4.845.249	6.446.283	1320
T2-35	4.848.888	6.440.064	1170
T2-36	4.848.738	6.440.461	1198
T2-37	4.848.532	6.440.815	1205
T2-38	4.848.313	6.441.157	1220
T2-39	4.848.034	6.441.431	1216
T2-40	4.847.826	6.441.793	1230
T2-41	4.847.520	6.442.025	1215
T2-42	4.847.275	6.442.422	1219
T2-43	4.847.212	6.442.930	1250
T2-44	4.846.929	6.443.182	1260
T2-45	4.846.675	6.443.467	1260
T2-46	4.846.351	6.443.656	1260
T2-47	4.846.104	6.443.943	1266
T2-48	4.845.829	6.444.198	1269
T2-49	4.845.404	6.444.247	1239
T2-50	4.845.028	6.444.794	1258
T2-51	4.846.033	6.444.910	1319
T2-52	4.845.672	6.445.060	1328
T2-53	4.845.484	6.445.577	1330
T2-54	4.844.913	6.445.382	1270
T2-55	4.844.581	6.445.670	1280
MS1	4.849.928	6.440.154	1160
MS2	4.848.320	6.441.171	1225

Table 5-3 Energy per turbine

No.	Gross energy (GWh)	Wake losses (%)	Net energy (GWh)	Capacity factor (%)	Net energy - index (%)
T2-1	6,717	6,9	6,251	31,0	80
T2-2	6,658	5,6	6,283	31,2	80
T2-3	7,098	5,8	6,689	33,2	86
T2-4	6,920	5,9	6,512	32,3	83
T2-5	7,041	7,3	6,530	32,4	84
T2-6	6,716	5,9	6,320	31,3	81
T2-7	6,829	9,6	6,173	30,6	79
T2-8	6,946	7,4	6,432	31,9	82
T2-9	6,628	6,1	6,223	30,9	80
T2-10	6,610	5,6	6,240	31,0	80
T2-11	6,578	5,1	6,244	31,0	80
T2-12	6,909	3,7	6,651	33,0	85
T2-13	6,930	6,6	6,471	32,1	83
T2-14	6,927	5,2	6,570	32,6	84
T2-15	6,832	5,6	6,449	32,0	83
T2-16	7,049	7,5	6,517	32,3	83
T2-17	6,649	8,3	6,100	30,3	78
T2-18	7,119	8,4	6,519	32,3	84
T2-19	7,596	8,1	6,980	34,6	89
T2-20	7,931	7,5	7,339	36,4	94
T2-21	8,021	7,9	7,386	36,6	95
T2-22	8,008	6,2	7,515	37,3	96
T2-23	7,896	3,6	7,612	37,8	98
T2-24	7,844	3,6	7,562	37,5	97
T2-25	7,825	3,6	7,544	37,4	97
T2-26	8,106	3,7	7,807	38,7	100
T2-27	7,710	3,4	7,449	37,0	95
T2-28	7,346	3,9	7,057	35,0	90
T2-29	7,822	3,3	7,566	37,5	97
T2-30	7,836	3,8	7,537	37,4	97
T2-31	6,978	2,9	6,777	33,6	87
T2-32	6,863	3,5	6,624	32,9	85
T2-33	7,007	3,4	6,766	33,6	87
T2-34	6,293	3,9	6,051	30,0	78
T2-35	7,563	5,1	7,176	35,6	92
T2-36	7,746	4,7	7,378	36,6	95
T2-37	7,648	4,5	7,303	36,2	94
T2-38	7,632	5,4	7,216	35,8	92
T2-39	7,521	5,7	7,092	35,2	91
T2-40	7,487	5,2	7,096	35,2	91
T2-41	7,374	4,3	7,060	35,0	90
T2-42	7,145	4,7	6,806	33,8	87
T2-43	7,149	4,5	6,825	33,9	87
T2-44	7,409	3,9	7,118	35,3	91
T2-45	7,374	4,1	7,070	35,1	91
T2-46	7,508	4,9	7,142	35,4	91
T2-47	7,528	4,6	7,182	35,6	92
T2-48	7,415	6,0	6,972	34,6	89
T2-49	7,196	5,6	6,790	33,7	87
T2-50	6,999	5,9	6,588	32,7	84
T2-51	7,094	5,4	6,710	33,3	86
T2-52	7,359	6,3	6,898	34,2	88
T2-53	7,080	7,8	6,525	32,4	84
T2-54	6,606	6,6	6,168	30,6	79
T2-55	6,909	3,6	6,658	33,0	85
Avg	7,236	5,4	6,846	34,0	88
Min	6,293	2,9	6,051	30,0	78
Max	8,106	9,6	7,807	38,7	100

Table 5-4 Summary data

WF Pakline	
Number of WT	55
Total net energy (GWh)	377
Average net energy per WT (GWh)	6,846
Capacity factor (%)	34,0
Min/max wake losses (%)	2,9 - 9,6

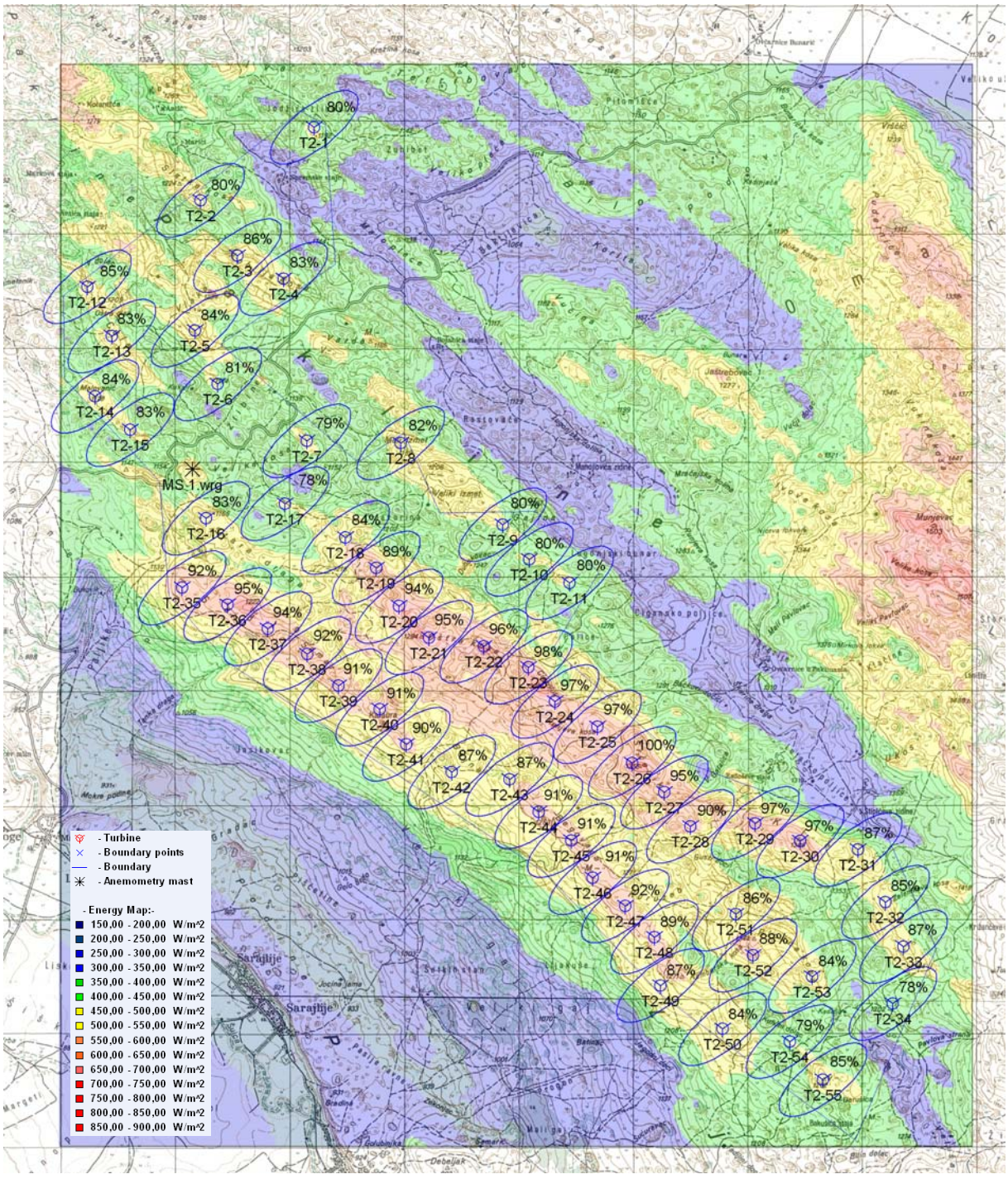

Figure 5-5 Net energy indexes

Table 5-5 Estimated design equivalent turbulence by wind speed (T2-1 – T2-10)

v(m/s)	T2-1	T2-2	T2-3	T2-4	T2-5	T2-6	T2-7	T2-8	T2-9	T2-10
4	0,160	0,167	0,152	0,139	0,172	0,182	0,151	0,160	0,171	0,177
5	0,190	0,187	0,188	0,193	0,200	0,192	0,214	0,193	0,193	0,197
6	0,175	0,170	0,178	0,180	0,183	0,176	0,196	0,180	0,177	0,183
7	0,161	0,154	0,163	0,164	0,168	0,161	0,180	0,166	0,160	0,168
8	0,152	0,145	0,150	0,150	0,157	0,151	0,168	0,156	0,149	0,156
9	0,146	0,139	0,144	0,141	0,151	0,145	0,161	0,150	0,142	0,148
10	0,144	0,137	0,138	0,135	0,147	0,142	0,157	0,146	0,138	0,143
11	0,140	0,134	0,137	0,131	0,144	0,139	0,153	0,141	0,135	0,139
12	0,136	0,130	0,132	0,126	0,139	0,134	0,148	0,133	0,130	0,133
13	0,132	0,127	0,127	0,122	0,136	0,131	0,144	0,129	0,126	0,128
14	0,132	0,125	0,123	0,119	0,131	0,129	0,141	0,123	0,125	0,128
15	0,133	0,128	0,123	0,120	0,134	0,131	0,141	0,127	0,125	0,127
16	0,130	0,125	0,123	0,119	0,132	0,129	0,139	0,126	0,122	0,124
17	0,127	0,122	0,119	0,116	0,128	0,125	0,135	0,122	0,119	0,123
18	0,125	0,120	0,117	0,114	0,126	0,123	0,132	0,120	0,118	0,122
19	0,123	0,118	0,116	0,113	0,124	0,122	0,130	0,118	0,116	0,119
20	0,121	0,116	0,115	0,111	0,122	0,120	0,128	0,115	0,114	0,116
21	0,119	0,115	0,112	0,110	0,121	0,119	0,126	0,113	0,112	0,114
22	0,118	0,114	0,110	0,108	0,120	0,117	0,124	0,112	0,110	0,110
23	0,117	0,113	0,109	0,107	0,118	0,115	0,123	0,111	0,109	0,108
24	0,117	0,113	0,109	0,107	0,115	0,115	0,122	0,110	0,108	0,107
25	0,117	0,112	0,107	0,106	0,114	0,113	0,107	0,108	0,106	0,103

Table 5-6 Estimated design equivalent turbulence by wind speed (T2-11 – T2-20)

v(m/s)	T2-11	T2-12	T2-13	T2-14	T2-15	T2-16	T2-17	T2-18	T2-19	T2-20
4	0,184	0,191	0,183	0,191	0,191	0,178	0,168	0,159	0,145	0,161
5	0,200	0,185	0,215	0,194	0,193	0,206	0,203	0,198	0,196	0,195
6	0,190	0,167	0,195	0,180	0,185	0,188	0,186	0,185	0,189	0,183
7	0,174	0,152	0,179	0,167	0,170	0,172	0,171	0,169	0,174	0,169
8	0,161	0,141	0,167	0,158	0,159	0,160	0,161	0,157	0,160	0,155
9	0,151	0,135	0,159	0,154	0,151	0,153	0,156	0,150	0,150	0,146
10	0,144	0,132	0,154	0,151	0,147	0,148	0,153	0,145	0,143	0,140
11	0,138	0,131	0,151	0,148	0,144	0,145	0,149	0,143	0,139	0,136
12	0,133	0,126	0,146	0,142	0,139	0,141	0,143	0,138	0,135	0,133
13	0,128	0,124	0,141	0,138	0,136	0,137	0,139	0,134	0,130	0,129
14	0,128	0,120	0,135	0,134	0,133	0,133	0,138	0,129	0,126	0,125
15	0,126	0,124	0,136	0,136	0,136	0,133	0,138	0,131	0,123	0,121
16	0,123	0,123	0,134	0,134	0,133	0,132	0,136	0,130	0,124	0,122
17	0,121	0,118	0,130	0,129	0,129	0,128	0,132	0,127	0,122	0,121
18	0,120	0,117	0,127	0,126	0,128	0,125	0,129	0,124	0,119	0,119
19	0,118	0,115	0,124	0,125	0,125	0,123	0,128	0,123	0,117	0,117
20	0,116	0,113	0,122	0,124	0,123	0,121	0,127	0,120	0,115	0,115
21	0,114	0,112	0,120	0,123	0,122	0,119	0,126	0,118	0,113	0,113
22	0,110	0,111	0,119	0,122	0,120	0,117	0,124	0,117	0,112	0,111
23	0,109	0,110	0,118	0,119	0,119	0,113	0,122	0,115	0,111	0,109
24	0,107	0,110	0,117	0,115	0,119	0,111	0,115	0,113	0,109	0,108
25	0,097	0,107	0,110	0,108	0,110	0,111	0,106	0,110	0,106	0,104

Table 5-7 Estimated design equivalent turbulence by wind speed (T2-21 – T2-30)

v(m/s)	T2-21	T2-22	T2-23	T2-24	T2-25	T2-26	T2-27	T2-28	T2-29	T2-30
4	0,145	0,178	0,171	0,185	0,185	0,166	0,183	0,177	0,184	0,178
5	0,206	0,199	0,192	0,192	0,191	0,187	0,196	0,206	0,190	0,198
6	0,197	0,189	0,187	0,180	0,186	0,178	0,187	0,184	0,183	0,192
7	0,180	0,174	0,172	0,165	0,171	0,164	0,171	0,167	0,167	0,174
8	0,166	0,161	0,157	0,153	0,156	0,152	0,156	0,155	0,154	0,160
9	0,155	0,152	0,146	0,143	0,144	0,141	0,145	0,146	0,144	0,150
10	0,146	0,145	0,137	0,135	0,136	0,134	0,137	0,140	0,137	0,141
11	0,141	0,139	0,132	0,130	0,130	0,129	0,132	0,134	0,131	0,135
12	0,136	0,134	0,127	0,126	0,125	0,125	0,127	0,129	0,125	0,129
13	0,131	0,130	0,123	0,122	0,122	0,121	0,123	0,124	0,121	0,124
14	0,126	0,125	0,119	0,118	0,117	0,116	0,118	0,120	0,116	0,119
15	0,122	0,122	0,115	0,115	0,114	0,112	0,114	0,120	0,114	0,115
16	0,122	0,123	0,113	0,115	0,113	0,111	0,113	0,118	0,114	0,114
17	0,120	0,121	0,113	0,114	0,112	0,110	0,113	0,116	0,113	0,113
18	0,118	0,119	0,112	0,113	0,110	0,110	0,110	0,113	0,111	0,110
19	0,116	0,118	0,110	0,109	0,109	0,108	0,109	0,112	0,110	0,109
20	0,114	0,116	0,107	0,107	0,107	0,107	0,107	0,110	0,108	0,107
21	0,113	0,113	0,106	0,106	0,106	0,104	0,106	0,109	0,106	0,105
22	0,111	0,111	0,105	0,105	0,104	0,103	0,104	0,107	0,104	0,104
23	0,109	0,110	0,104	0,104	0,103	0,101	0,103	0,105	0,103	0,102
24	0,108	0,109	0,103	0,101	0,101	0,099	0,101	0,104	0,101	0,101
25	0,104	0,105	0,096	0,094	0,097	0,096	0,098	0,102	0,099	0,099

Table 5-8 Estimated design equivalent turbulence by wind speed (T2-31 – T2-40)

v(m/s)	T2-31	T2-32	T2-33	T2-34	T2-35	T2-36	T2-37	T2-38	T2-39	T2-40
4	0,190	0,188	0,190	0,188	0,166	0,169	0,163	0,164	0,165	0,163
5	0,184	0,197	0,203	0,199	0,196	0,199	0,193	0,195	0,195	0,194
6	0,178	0,178	0,194	0,183	0,183	0,189	0,189	0,191	0,189	0,189
7	0,163	0,162	0,178	0,168	0,167	0,174	0,173	0,175	0,174	0,174
8	0,151	0,151	0,165	0,161	0,155	0,161	0,159	0,162	0,162	0,160
9	0,143	0,143	0,157	0,156	0,149	0,150	0,149	0,153	0,153	0,150
10	0,136	0,138	0,151	0,153	0,143	0,142	0,142	0,146	0,148	0,143
11	0,130	0,135	0,148	0,148	0,140	0,136	0,137	0,143	0,144	0,140
12	0,125	0,131	0,144	0,142	0,135	0,129	0,130	0,137	0,138	0,135
13	0,121	0,128	0,139	0,137	0,130	0,125	0,126	0,133	0,134	0,131
14	0,119	0,126	0,135	0,137	0,125	0,120	0,121	0,129	0,130	0,126
15	0,120	0,126	0,133	0,137	0,124	0,121	0,122	0,128	0,130	0,126
16	0,119	0,124	0,132	0,132	0,124	0,120	0,121	0,128	0,130	0,125
17	0,116	0,121	0,128	0,128	0,123	0,119	0,120	0,126	0,128	0,123
18	0,114	0,119	0,125	0,127	0,121	0,118	0,119	0,124	0,126	0,121
19	0,112	0,117	0,123	0,127	0,118	0,115	0,116	0,122	0,123	0,119
20	0,110	0,116	0,121	0,126	0,115	0,112	0,113	0,119	0,120	0,116
21	0,108	0,115	0,120	0,124	0,114	0,109	0,111	0,116	0,118	0,115
22	0,107	0,114	0,117	0,122	0,114	0,107	0,109	0,114	0,117	0,114
23	0,106	0,112	0,115	0,116	0,113	0,107	0,108	0,113	0,114	0,110
24	0,105	0,110	0,115	0,110	0,112	0,105	0,107	0,104	0,105	0,105
25	0,102	0,105	0,111	0,102	0,110	0,103	0,100	0,102	0,098	0,099

Table 5-9 Estimated design equivalent turbulence by wind speed (T2-41 – T2-50)

v(m/s)	T2-41	T2-42	T2-43	T2-44	T2-45	T2-46	T2-47	T2-48	T2-49	T2-50
4	0,168	0,174	0,170	0,173	0,172	0,169	0,169	0,169	0,190	0,187
5	0,188	0,199	0,199	0,199	0,203	0,192	0,196	0,207	0,192	0,201
6	0,174	0,188	0,187	0,187	0,192	0,180	0,190	0,200	0,178	0,183
7	0,160	0,170	0,172	0,172	0,177	0,166	0,175	0,184	0,165	0,167
8	0,148	0,158	0,161	0,160	0,163	0,154	0,160	0,169	0,155	0,157
9	0,141	0,150	0,153	0,151	0,153	0,147	0,149	0,160	0,150	0,151
10	0,135	0,144	0,147	0,145	0,147	0,141	0,141	0,153	0,146	0,147
11	0,132	0,139	0,143	0,142	0,143	0,139	0,137	0,150	0,144	0,145
12	0,128	0,134	0,138	0,136	0,138	0,135	0,132	0,146	0,137	0,139
13	0,124	0,129	0,134	0,132	0,134	0,131	0,127	0,142	0,134	0,136
14	0,120	0,125	0,130	0,128	0,130	0,127	0,123	0,140	0,130	0,132
15	0,121	0,127	0,131	0,128	0,128	0,125	0,119	0,137	0,131	0,133
16	0,121	0,126	0,130	0,128	0,129	0,127	0,122	0,137	0,131	0,132
17	0,119	0,123	0,127	0,126	0,127	0,125	0,121	0,135	0,128	0,128
18	0,117	0,120	0,125	0,124	0,124	0,123	0,117	0,130	0,125	0,125
19	0,115	0,118	0,122	0,122	0,122	0,121	0,115	0,126	0,123	0,124
20	0,113	0,116	0,120	0,119	0,120	0,118	0,113	0,124	0,121	0,122
21	0,111	0,114	0,118	0,117	0,118	0,116	0,112	0,124	0,119	0,121
22	0,110	0,113	0,117	0,115	0,116	0,114	0,111	0,122	0,118	0,120
23	0,107	0,108	0,115	0,115	0,114	0,113	0,110	0,118	0,116	0,117
24	0,101	0,103	0,106	0,103	0,111	0,111	0,108	0,116	0,115	0,115
25	0,099	0,098	0,097	0,098	0,102	0,108	0,105	0,114	0,108	0,115

Table 5-10 Estimated design equivalent turbulence by wind speed (T2-51 – T2-55)

v(m/s)	T2-51	T2-52	T2-53	T2-54	T2-55
4	0,181	0,173	0,183	0,185	0,190
5	0,204	0,204	0,214	0,199	0,189
6	0,185	0,187	0,195	0,184	0,179
7	0,170	0,171	0,179	0,170	0,164
8	0,158	0,158	0,167	0,161	0,152
9	0,151	0,150	0,159	0,155	0,145
10	0,146	0,145	0,154	0,152	0,141
11	0,144	0,142	0,151	0,148	0,139
12	0,139	0,138	0,146	0,143	0,133
13	0,135	0,134	0,142	0,138	0,131
14	0,131	0,129	0,137	0,137	0,126
15	0,132	0,127	0,138	0,138	0,129
16	0,131	0,127	0,136	0,135	0,128
17	0,128	0,125	0,133	0,131	0,123
18	0,125	0,121	0,130	0,129	0,121
19	0,123	0,119	0,128	0,127	0,119
20	0,121	0,118	0,126	0,126	0,118
21	0,120	0,116	0,124	0,125	0,117
22	0,119	0,114	0,122	0,123	0,115
23	0,115	0,112	0,121	0,119	0,114
24	0,110	0,111	0,120	0,118	0,112
25	0,108	0,109	0,116	0,114	0,110

Table 5-11 Summary turbulence data (15m/s)

WF Pakline		
	WT position	I_{15_eff}
Min	26	0,112
Max	7	0,141
Avrg		0,127

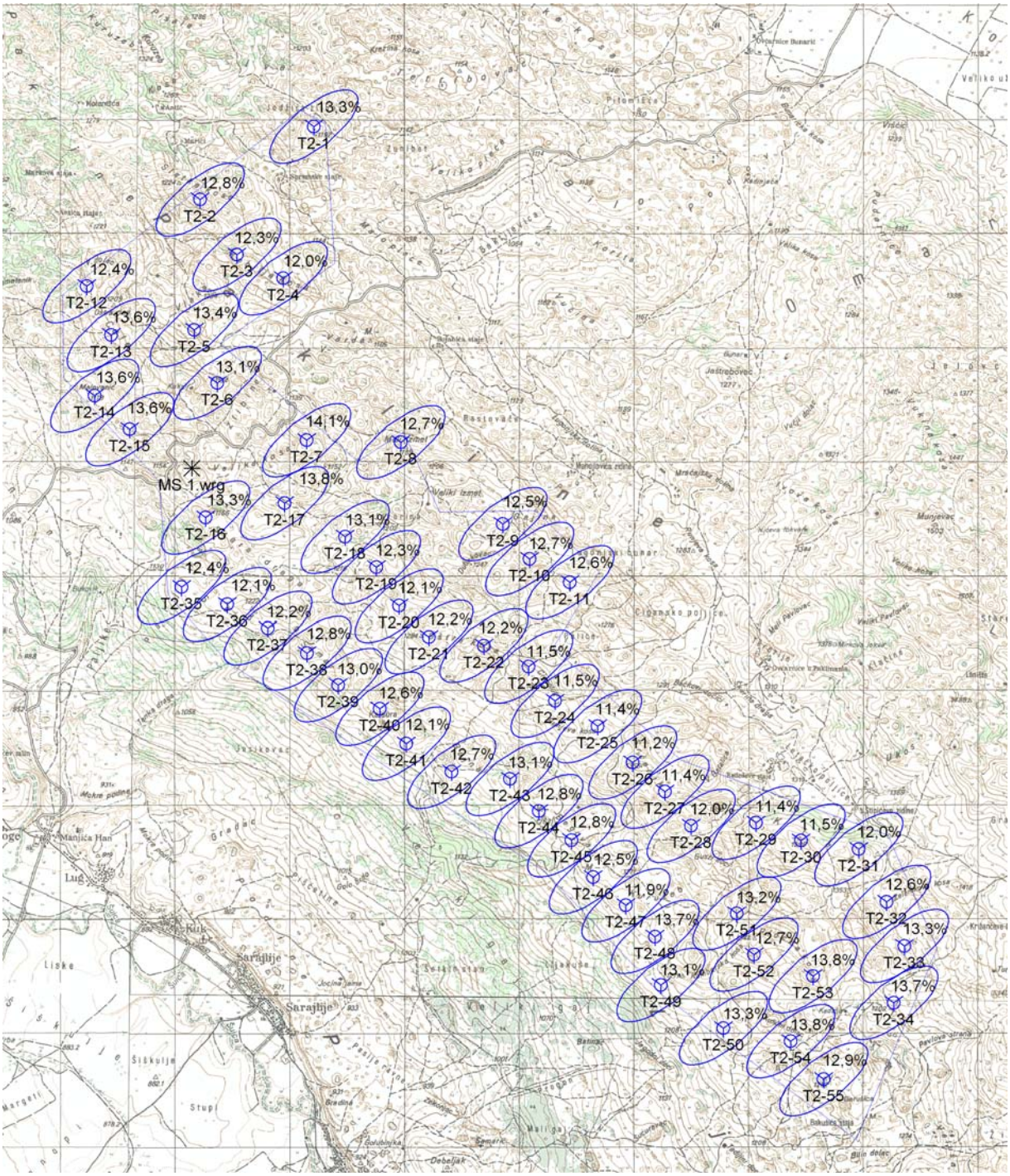

Figure 5-6 Estimated design equivalent turbulence (I_{15_eff}) according to IEC 61400-1 Ed2 standard

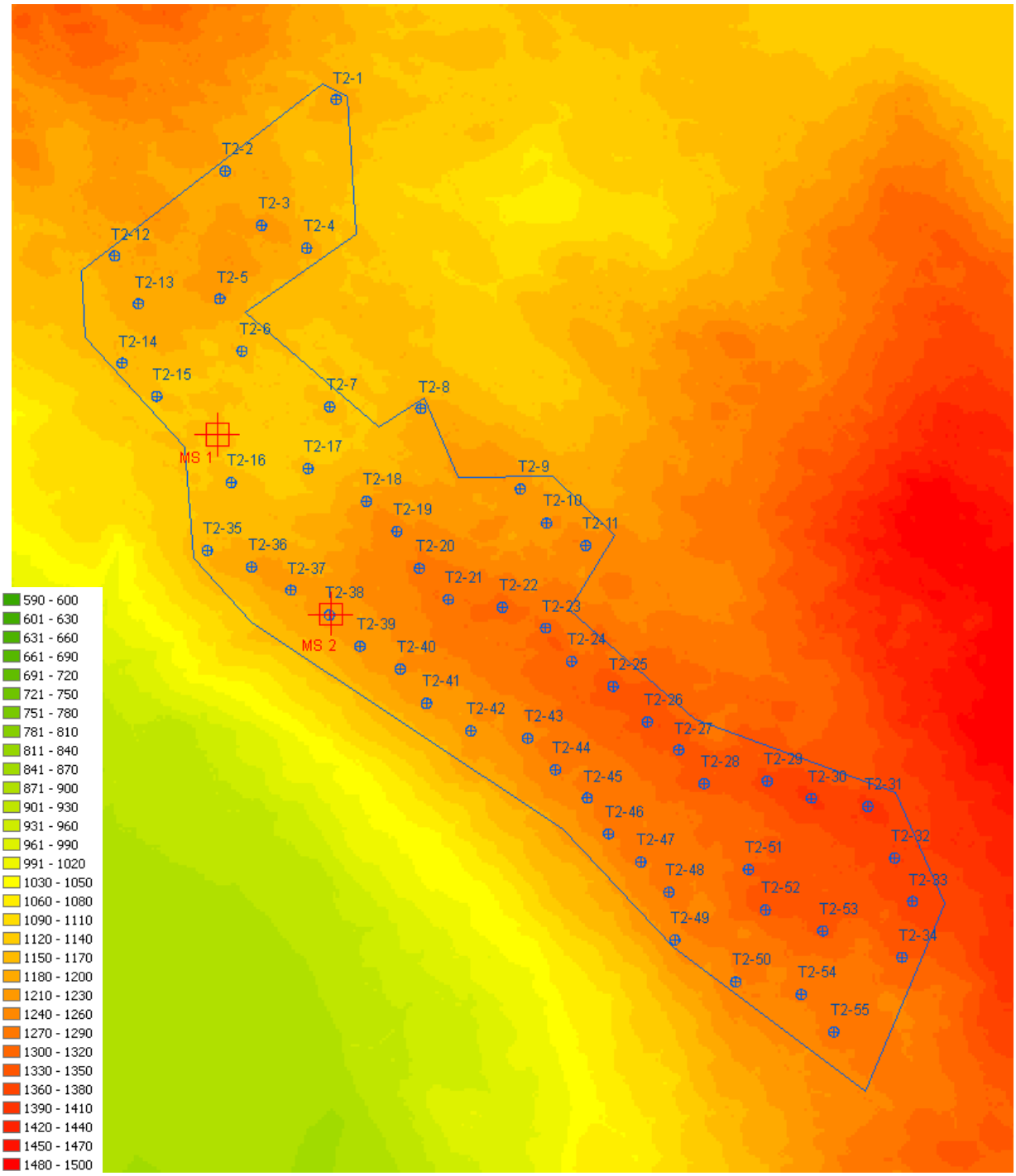

Figure 5-7 Wind turbine positions on height graduated map

6. WIND FARM LJUBUSA LAYOUT

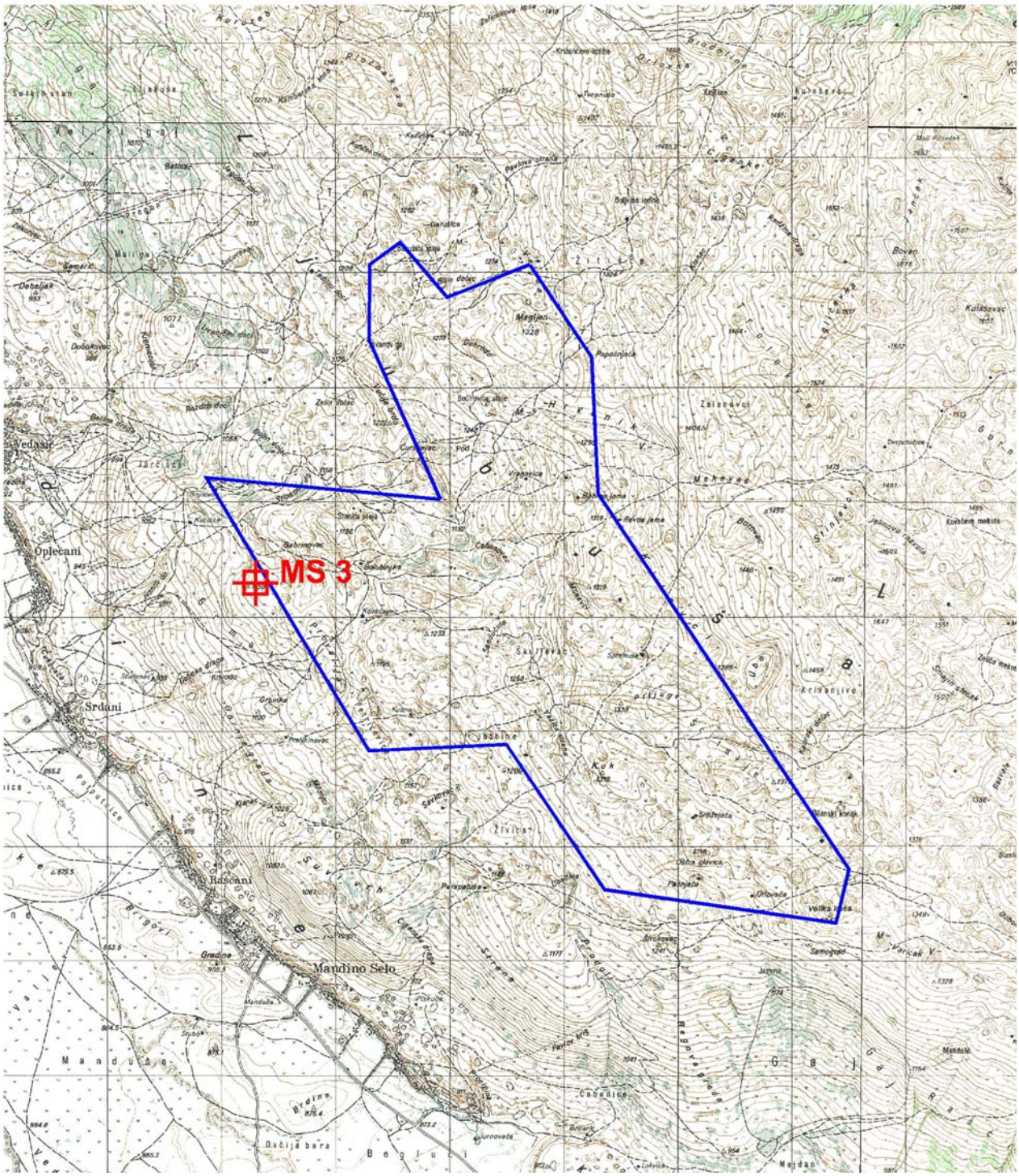

Figure 6-1 Topography map with planed wind farm area and mast position

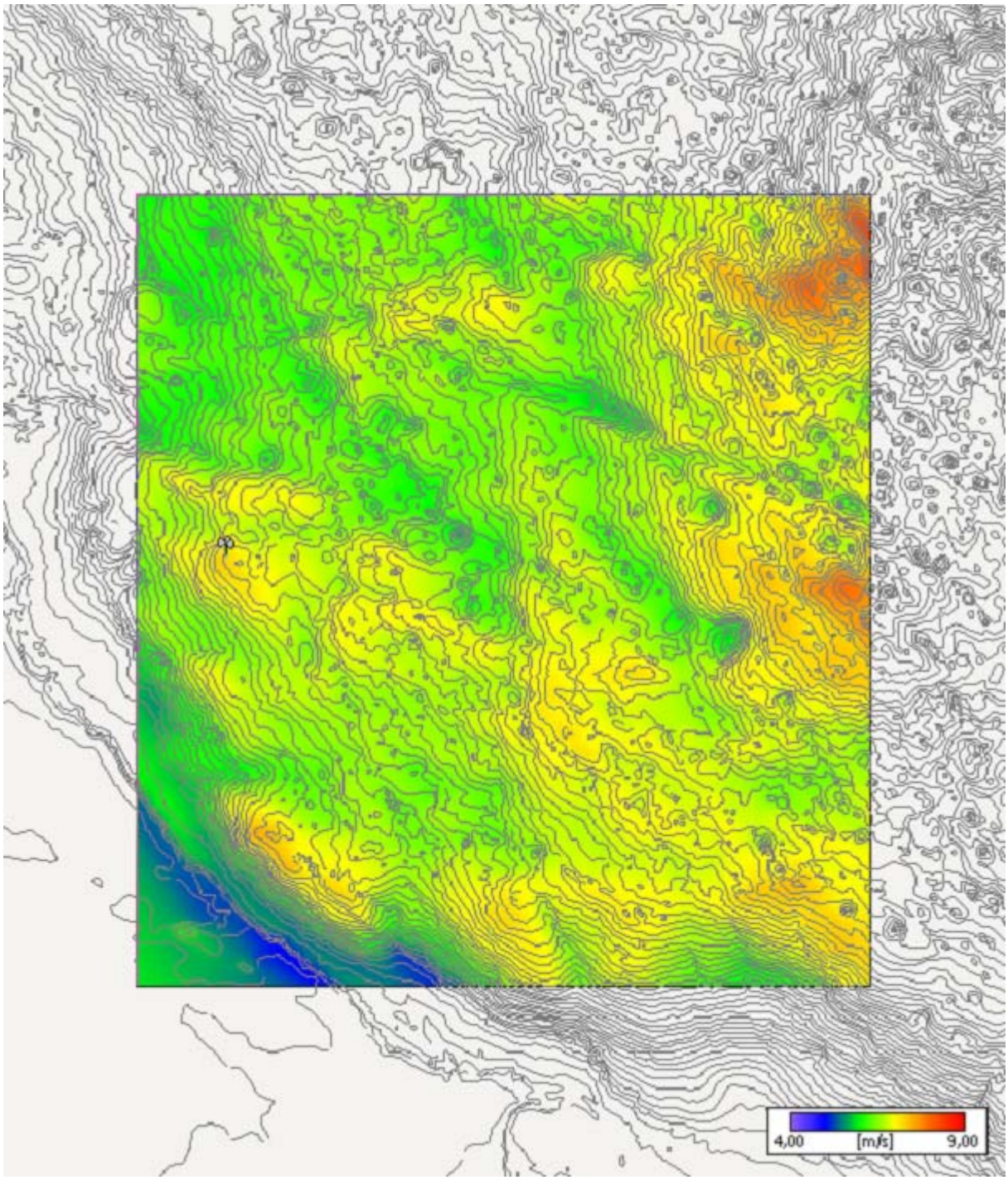

Figure 6-2 Wind speed distribution over the planed wind farm area (WAsP)

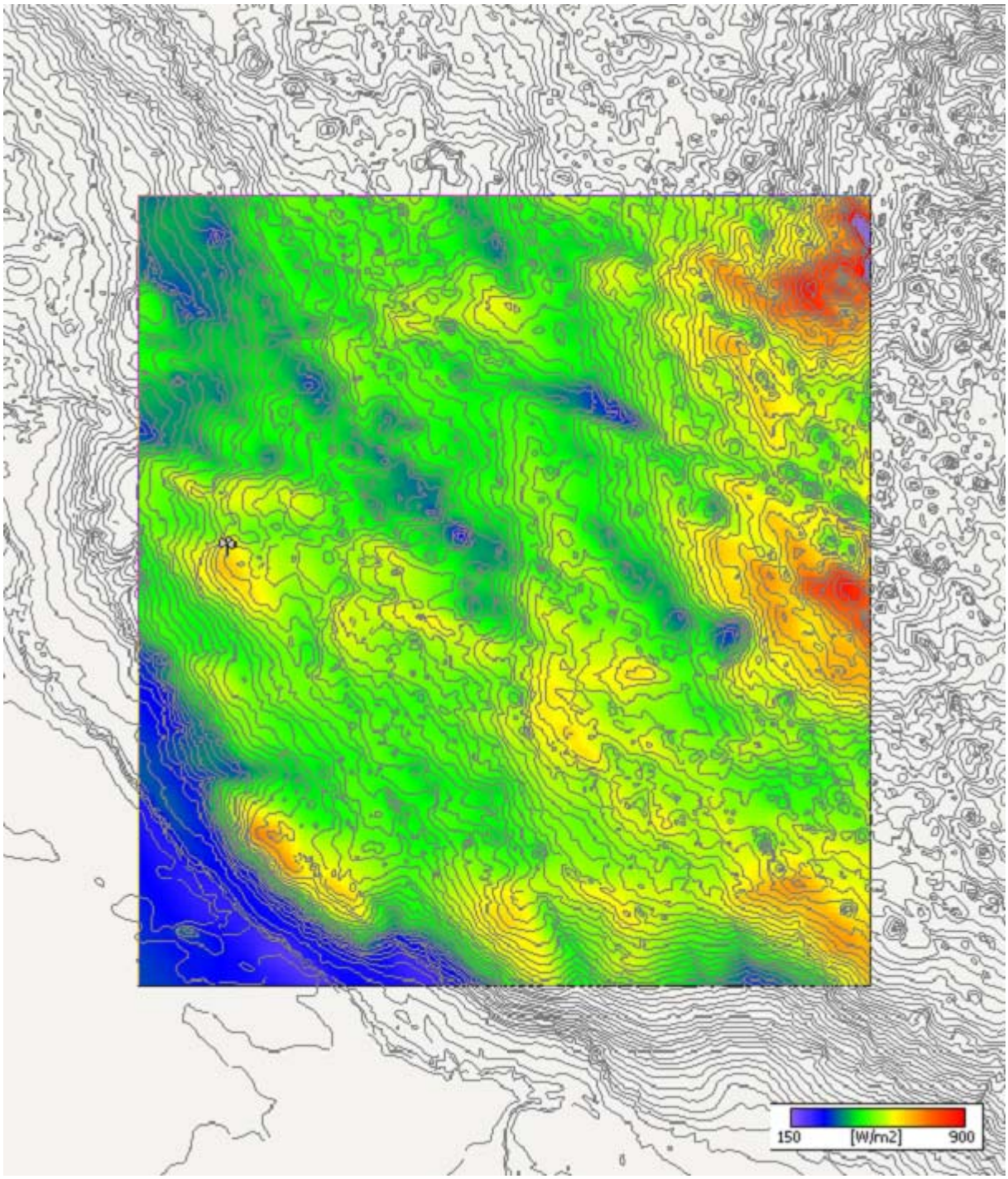

Figure 6-3 Wind energy distribution over the planed wind farm area (WAsP)

Table 6-1 Site specific conditions used in energy yeald and fatigue load calculation

WF Ljubusa	
Site reference ID	MS3
Anual mean temperature (°C)	10,2
Site reference height (m)	1160
Site reference air density	1,085

Layout is designed considering:

- Wind turbine number optimization, restricting the minimum wind turbine production to approximately 90% of average wind farm production. Considering the high turbulence intensity observed on this site, number and layout of turbines was optimized to stay within wind turbine manufacturer limits.
- Wind turbine position optimization, performed by the criteria of maximum energy production after every change in number of wind turbines.

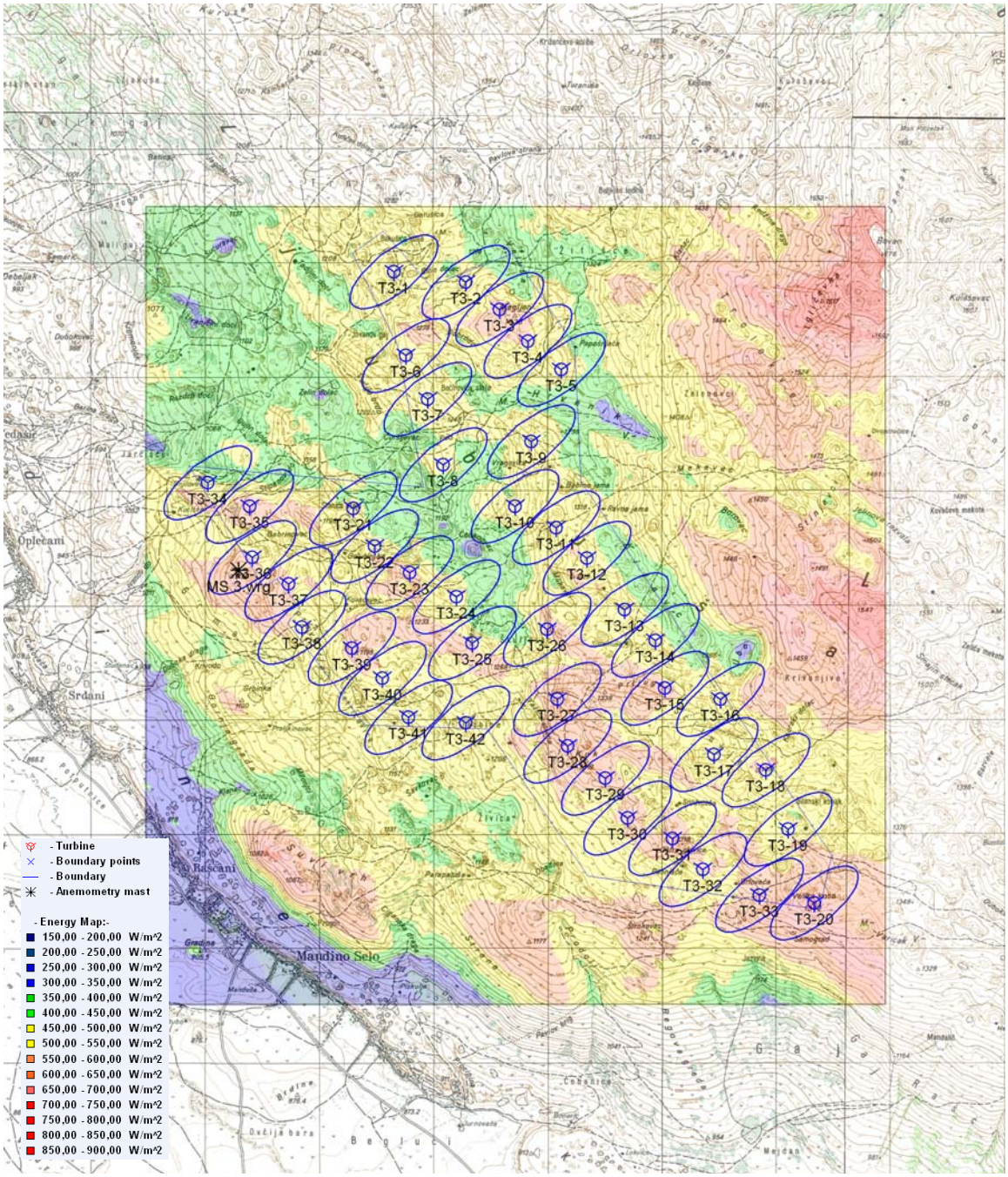

Figure 6-4 Turbine positions with separation distances and wind energy distribution over the planed wind farm area

Table 6-2 Wind turbines and measurement masts positions and altitudes

WT/MS	X (Northing)	Y (Easting)	Altitude (m)
T3-1	4.843.908	6.445.671	1249
T3-2	4.843.818	6.446.299	1282
T3-3	4.843.578	6.446.597	1319
T3-4	4.843.298	6.446.844	1319
T3-5	4.843.052	6.447.136	1310
T3-6	4.843.174	6.445.774	1249
T3-7	4.842.794	6.445.967	1242
T3-8	4.842.219	6.446.102	1228
T3-9	4.842.421	6.446.874	1282
T3-10	4.841.856	6.446.732	1269
T3-11	4.841.669	6.447.093	1300
T3-12	4.841.400	6.447.361	1318
T3-13	4.840.950	6.447.690	1330
T3-14	4.840.682	6.447.962	1340
T3-15	4.840.266	6.448.045	1360
T3-16	4.840.169	6.448.531	1359
T3-17	4.839.683	6.448.475	1341
T3-18	4.839.548	6.448.930	1366
T3-19	4.839.030	6.449.125	1324
T3-20	4.838.386	6.449.354	1339
T3-21	4.841.838	6.445.312	1190
T3-22	4.841.505	6.445.502	1197
T3-23	4.841.274	6.445.807	1230
T3-24	4.841.062	6.446.217	1230
T3-25	4.840.658	6.446.356	1240
T3-26	4.840.778	6.447.013	1298
T3-27	4.840.168	6.447.102	1308
T3-28	4.839.757	6.447.194	1300
T3-29	4.839.479	6.447.523	1308
T3-30	4.839.127	6.447.717	1292
T3-31	4.838.950	6.448.112	1305
T3-32	4.838.678	6.448.376	1289
T3-33	4.838.454	6.448.873	1299
T3-34	4.842.060	6.444.037	1099
T3-35	4.841.854	6.444.407	1158
T3-36	4.841.409	6.444.427	1152
T3-37	4.841.176	6.444.748	1171
T3-38	4.840.798	6.444.864	1154
T3-39	4.840.613	6.445.302	1195
T3-40	4.840.351	6.445.570	1191
T3-41	4.840.010	6.445.796	1178
T3-42	4.839.962	6.446.301	1208
MS3	4.841.295	6.444.308	1160

Table 6-3 Energy per turbine

No.	Gross energy (GWh)	Wake losses (%)	Net energy (GWh)	Capacity factor (%)	Net energy - index (%)
T2-1	5,971	4,9	5,680	28,2	82
T2-2	5,937	3,7	5,719	28,4	83
T2-3	6,431	5,4	6,084	30,2	88
T2-4	6,322	4,2	6,058	30,1	88
T2-5	5,925	2,2	5,795	28,7	84
T2-6	6,140	8,4	5,623	27,9	81
T2-7	5,982	7,1	5,558	27,6	80
T2-8	5,865	5,9	5,517	27,4	80
T2-9	5,890	6,0	5,537	27,5	80
T2-10	6,025	4,6	5,746	28,5	83
T2-11	6,117	5,2	5,801	28,8	84
T2-12	6,137	4,5	5,858	29,1	85
T2-13	6,074	5,4	5,749	28,5	83
T2-14	6,027	5,4	5,704	28,3	82
T2-15	6,616	5,3	6,266	31,1	91
T2-16	6,152	4,2	5,892	29,2	85
T2-17	6,174	4,9	5,874	29,1	85
T2-18	6,374	3,6	6,142	30,5	89
T2-19	6,036	2,7	5,873	29,1	85
T2-20	6,942	0,4	6,917	34,3	100
T2-21	6,000	10,3	5,381	26,7	78
T2-22	6,016	6,9	5,601	27,8	81
T2-23	6,442	6,9	6,000	29,8	87
T2-24	6,041	8,7	5,517	27,4	80
T2-25	6,254	5,5	5,910	29,3	85
T2-26	6,368	6,5	5,955	29,5	86
T2-27	6,581	7,5	6,090	30,2	88
T2-28	6,602	5,5	6,238	30,9	90
T2-29	6,590	7,5	6,093	30,2	88
T2-30	6,451	3,6	6,217	30,8	90
T2-31	6,578	5,8	6,198	30,7	90
T2-32	6,343	2,9	6,159	30,6	89
T2-33	6,495	3,1	6,295	31,2	91
T2-34	5,971	4,6	5,699	28,3	82
T2-35	6,540	6,2	6,135	30,4	89
T2-36	6,346	5,8	5,976	29,6	86
T2-37	6,427	8,2	5,897	29,3	85
T2-38	6,159	4,6	5,875	29,1	85
T2-39	6,495	6,3	6,087	30,2	88
T2-40	6,276	8,2	5,764	28,6	83
T2-41	5,994	4,6	5,719	28,4	83
T2-42	6,009	4,0	5,768	28,6	83
Avg	6,241	5,4	5,904	29,3	85
Min	5,865	0,4	5,381	26,7	78
Max	6,942	10,3	6,917	34,3	100

Table 6-4 Summary data

WF Ljubusa	
Number of WT	42
Total net energy (GWh)	248
Average net energy per WT (GWh)	5,904
Capacity factor (%)	29,3
Min/max wake losses (%)	0,4 - 10,3

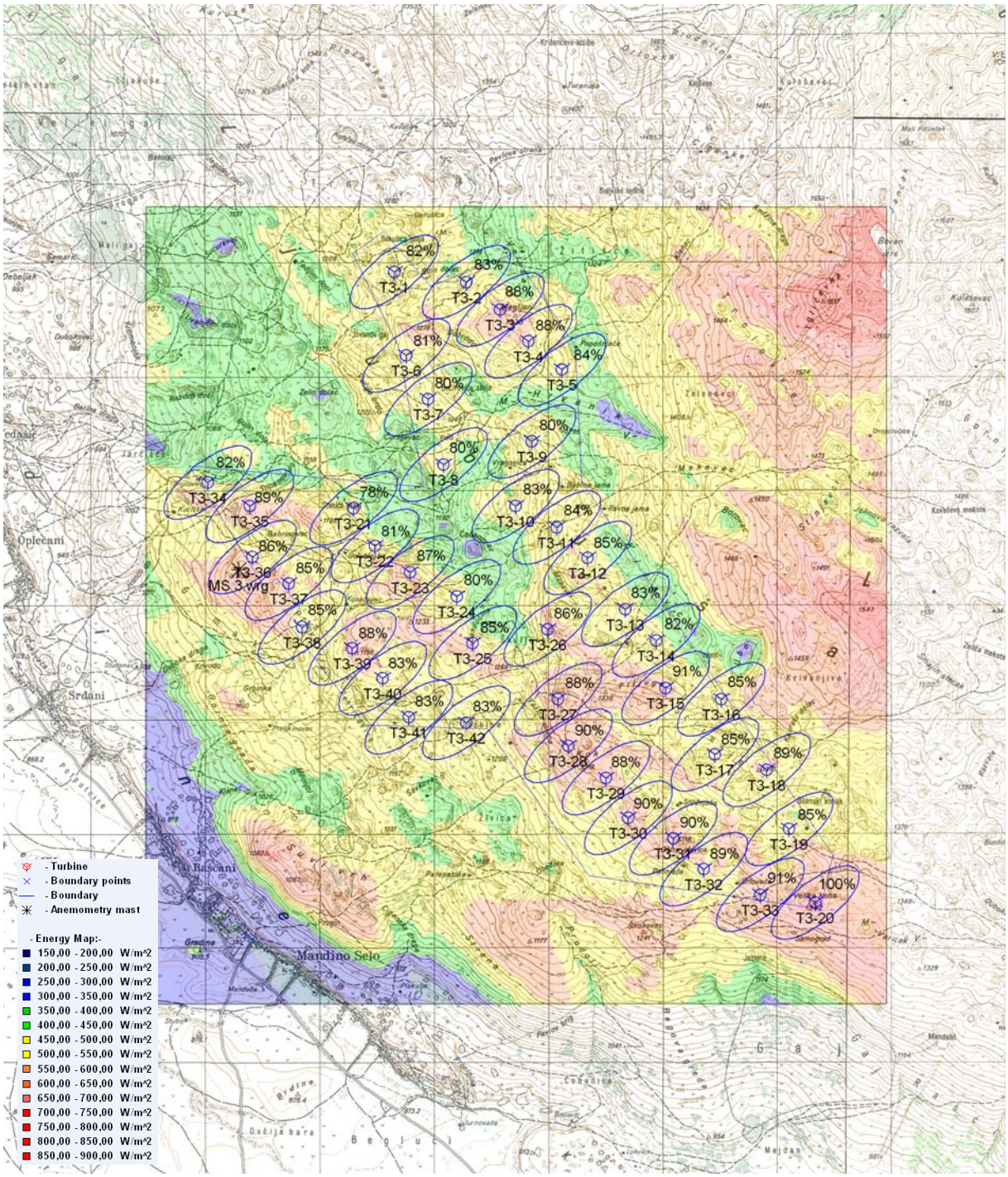

Figure 6-5 Net energy indexes

Table 6-5 Estimated design equivalent turbulence by wind speed (T3-1 – T3-10)

v(m/s)	T3-1	T3-2	T3-3	T3-4	T3-5	T3-6	T3-7	T3-8	T3-9	T3-10
4	0,269	0,280	0,271	0,275	0,283	0,251	0,250	0,260	0,272	0,271
5	0,294	0,286	0,278	0,277	0,288	0,281	0,291	0,293	0,296	0,290
6	0,274	0,278	0,292	0,290	0,290	0,265	0,280	0,281	0,280	0,285
7	0,235	0,231	0,247	0,246	0,238	0,239	0,242	0,236	0,237	0,236
8	0,213	0,211	0,220	0,222	0,216	0,217	0,222	0,217	0,216	0,216
9	0,201	0,201	0,208	0,210	0,201	0,206	0,211	0,205	0,202	0,200
10	0,186	0,187	0,197	0,196	0,184	0,196	0,197	0,192	0,187	0,187
11	0,175	0,178	0,187	0,181	0,173	0,187	0,180	0,180	0,175	0,176
12	0,176	0,179	0,181	0,175	0,179	0,184	0,179	0,182	0,176	0,178
13	0,186	0,182	0,180	0,179	0,180	0,183	0,184	0,190	0,182	0,182
14	0,180	0,179	0,178	0,174	0,176	0,188	0,183	0,183	0,177	0,176
15	0,176	0,170	0,173	0,170	0,155	0,174	0,174	0,172	0,171	0,160
16	0,155	0,155	0,165	0,156	0,144	0,168	0,154	0,153	0,151	0,147
17	0,146	0,150	0,160	0,150	0,141	0,160	0,151	0,149	0,147	0,143
18	0,141	0,145	0,155	0,146	0,140	0,156	0,148	0,147	0,144	0,141
19	0,137	0,142	0,150	0,143	0,139	0,153	0,147	0,145	0,141	0,138
20	0,135	0,140	0,146	0,142	0,138	0,150	0,145	0,143	0,139	0,137
21	0,134	0,137	0,144	0,141	0,138	0,148	0,145	0,142	0,137	0,135
22	0,135	0,135	0,142	0,140	0,136	0,146	0,143	0,142	0,136	0,134
23	0,134	0,132	0,139	0,138	0,135	0,144	0,139	0,140	0,133	0,133
24	0,135	0,132	0,136	0,135	0,123	0,140	0,136	0,142	0,132	0,135
25	0,137	0,109	0,128	0,107	0,062	0,132	0,124	0,121	0,128	0,108

Table 6-6 Estimated design equivalent turbulence by wind speed (T3-11 – T3-20)

v(m/s)	T3-11	T3-12	T3-13	T3-14	T3-15	T3-16	T3-17	T3-18	T3-19	T3-20
4	0,271	0,276	0,278	0,284	0,264	0,281	0,273	0,277	0,280	0,256
5	0,288	0,284	0,282	0,274	0,281	0,274	0,284	0,271	0,296	0,263
6	0,287	0,283	0,277	0,280	0,273	0,273	0,276	0,255	0,278	0,260
7	0,246	0,248	0,236	0,249	0,254	0,236	0,246	0,247	0,233	0,235
8	0,218	0,220	0,215	0,222	0,224	0,211	0,221	0,210	0,214	0,202
9	0,205	0,205	0,205	0,210	0,212	0,199	0,207	0,194	0,202	0,189
10	0,192	0,191	0,194	0,199	0,199	0,187	0,194	0,184	0,186	0,178
11	0,182	0,173	0,183	0,190	0,187	0,183	0,184	0,175	0,172	0,166
12	0,179	0,168	0,180	0,182	0,181	0,186	0,182	0,170	0,175	0,156
13	0,181	0,170	0,181	0,182	0,184	0,185	0,189	0,168	0,178	0,161
14	0,178	0,175	0,181	0,181	0,181	0,176	0,179	0,174	0,176	0,163
15	0,174	0,167	0,172	0,171	0,175	0,155	0,170	0,162	0,164	0,161
16	0,163	0,154	0,160	0,161	0,157	0,153	0,151	0,153	0,145	0,152
17	0,156	0,145	0,156	0,157	0,147	0,147	0,147	0,144	0,142	0,130
18	0,150	0,142	0,152	0,154	0,142	0,145	0,143	0,141	0,139	0,127
19	0,146	0,140	0,148	0,150	0,139	0,143	0,140	0,139	0,137	0,124
20	0,143	0,139	0,145	0,148	0,136	0,141	0,138	0,137	0,135	0,123
21	0,140	0,139	0,143	0,147	0,134	0,139	0,137	0,135	0,133	0,121
22	0,137	0,138	0,142	0,145	0,134	0,137	0,137	0,134	0,130	0,120
23	0,134	0,137	0,140	0,142	0,134	0,136	0,133	0,132	0,129	0,120
24	0,130	0,135	0,136	0,140	0,134	0,123	0,133	0,131	0,131	0,117
25	0,129	0,116	0,123	0,131	0,132	0,110	0,107	0,120	0,112	0,094

Table 6-7 Estimated design equivalent turbulence by wind speed (T3-21 – T3-30)

v(m/s)	T3-21	T3-22	T3-23	T3-24	T3-25	T3-26	T3-27	T3-28	T3-29	T3-30
4	0,238	0,241	0,205	0,235	0,232	0,251	0,243	0,243	0,241	0,243
5	0,282	0,295	0,283	0,283	0,298	0,282	0,278	0,277	0,281	0,287
6	0,266	0,291	0,290	0,285	0,287	0,269	0,268	0,277	0,282	0,283
7	0,238	0,247	0,245	0,243	0,247	0,238	0,245	0,249	0,250	0,246
8	0,219	0,228	0,215	0,221	0,228	0,214	0,217	0,223	0,222	0,223
9	0,211	0,216	0,202	0,209	0,216	0,200	0,204	0,208	0,209	0,210
10	0,201	0,199	0,188	0,197	0,200	0,191	0,195	0,197	0,199	0,200
11	0,195	0,179	0,175	0,192	0,187	0,180	0,185	0,185	0,189	0,183
12	0,192	0,180	0,173	0,191	0,194	0,175	0,179	0,176	0,182	0,172
13	0,192	0,184	0,177	0,193	0,189	0,176	0,177	0,175	0,180	0,173
14	0,191	0,181	0,177	0,187	0,186	0,183	0,181	0,178	0,182	0,179
15	0,179	0,173	0,171	0,172	0,166	0,176	0,175	0,173	0,177	0,173
16	0,172	0,152	0,153	0,164	0,154	0,168	0,169	0,165	0,171	0,162
17	0,168	0,149	0,144	0,161	0,151	0,149	0,155	0,149	0,161	0,145
18	0,163	0,147	0,141	0,157	0,148	0,146	0,151	0,146	0,158	0,142
19	0,159	0,147	0,139	0,154	0,145	0,144	0,148	0,142	0,153	0,141
20	0,156	0,146	0,138	0,151	0,144	0,141	0,144	0,140	0,148	0,141
21	0,154	0,145	0,136	0,149	0,143	0,139	0,141	0,138	0,146	0,140
22	0,152	0,143	0,135	0,147	0,139	0,138	0,139	0,136	0,144	0,140
23	0,149	0,140	0,134	0,143	0,137	0,137	0,137	0,135	0,141	0,140
24	0,147	0,136	0,133	0,136	0,127	0,136	0,135	0,134	0,138	0,138
25	0,136	0,123	0,132	0,118	0,109	0,135	0,128	0,129	0,127	0,132

Table 6-8 Estimated design equivalent turbulence by wind speed (T3-31 – T3-40)

v(m/s)	T3-31	T3-32	T3-33	T3-34	T3-35	T3-36	T3-37	T3-38	T3-39	T3-40
4	0,256	0,262	0,265	0,271	0,239	0,250	0,236	0,256	0,235	0,240
5	0,278	0,282	0,285	0,277	0,271	0,284	0,284	0,293	0,279	0,288
6	0,272	0,291	0,288	0,274	0,275	0,278	0,285	0,289	0,277	0,294
7	0,254	0,247	0,240	0,224	0,248	0,248	0,253	0,246	0,248	0,251
8	0,220	0,221	0,217	0,205	0,214	0,222	0,224	0,227	0,220	0,227
9	0,205	0,209	0,208	0,194	0,200	0,207	0,212	0,214	0,207	0,216
10	0,195	0,195	0,194	0,181	0,189	0,195	0,200	0,200	0,196	0,202
11	0,183	0,180	0,183	0,174	0,180	0,183	0,190	0,184	0,186	0,190
12	0,180	0,177	0,184	0,179	0,176	0,180	0,188	0,184	0,182	0,188
13	0,178	0,181	0,194	0,184	0,177	0,178	0,188	0,187	0,181	0,189
14	0,181	0,181	0,183	0,177	0,179	0,184	0,188	0,182	0,183	0,187
15	0,175	0,173	0,179	0,159	0,172	0,173	0,180	0,169	0,176	0,180
16	0,165	0,150	0,154	0,147	0,163	0,160	0,165	0,152	0,166	0,165
17	0,155	0,146	0,148	0,143	0,150	0,150	0,161	0,148	0,158	0,162
18	0,152	0,143	0,142	0,140	0,147	0,146	0,157	0,145	0,154	0,158
19	0,148	0,142	0,139	0,138	0,144	0,142	0,154	0,143	0,150	0,154
20	0,145	0,141	0,137	0,136	0,141	0,139	0,151	0,142	0,146	0,152
21	0,142	0,140	0,136	0,135	0,139	0,138	0,148	0,142	0,144	0,150
22	0,141	0,140	0,137	0,134	0,137	0,137	0,147	0,141	0,142	0,149
23	0,139	0,139	0,133	0,134	0,135	0,136	0,145	0,138	0,140	0,146
24	0,137	0,137	0,128	0,131	0,132	0,134	0,142	0,136	0,138	0,142
25	0,135	0,126	0,118	0,078	0,130	0,134	0,138	0,109	0,136	0,137

Table 6-9 Estimated design equivalent turbulence by wind speed (T2-41 – T2-42)

v(m/s)	T3-41	T3-42
4	0,252	0,247
5	0,288	0,292
6	0,289	0,283
7	0,247	0,237
8	0,228	0,218
9	0,216	0,204
10	0,201	0,190
11	0,187	0,185
12	0,190	0,192
13	0,197	0,190
14	0,187	0,185
15	0,176	0,160
16	0,156	0,153
17	0,150	0,149
18	0,147	0,146
19	0,146	0,144
20	0,146	0,143
21	0,147	0,141
22	0,147	0,137
23	0,146	0,135
24	0,146	0,110
25	0,101	0,097

Table 6-10 Summary turbulence data (15m/s)

WF Kupres		
	WT position	I_{15_eff}
Min	5	0,155
Max	40	0,180
Avrg		0,171

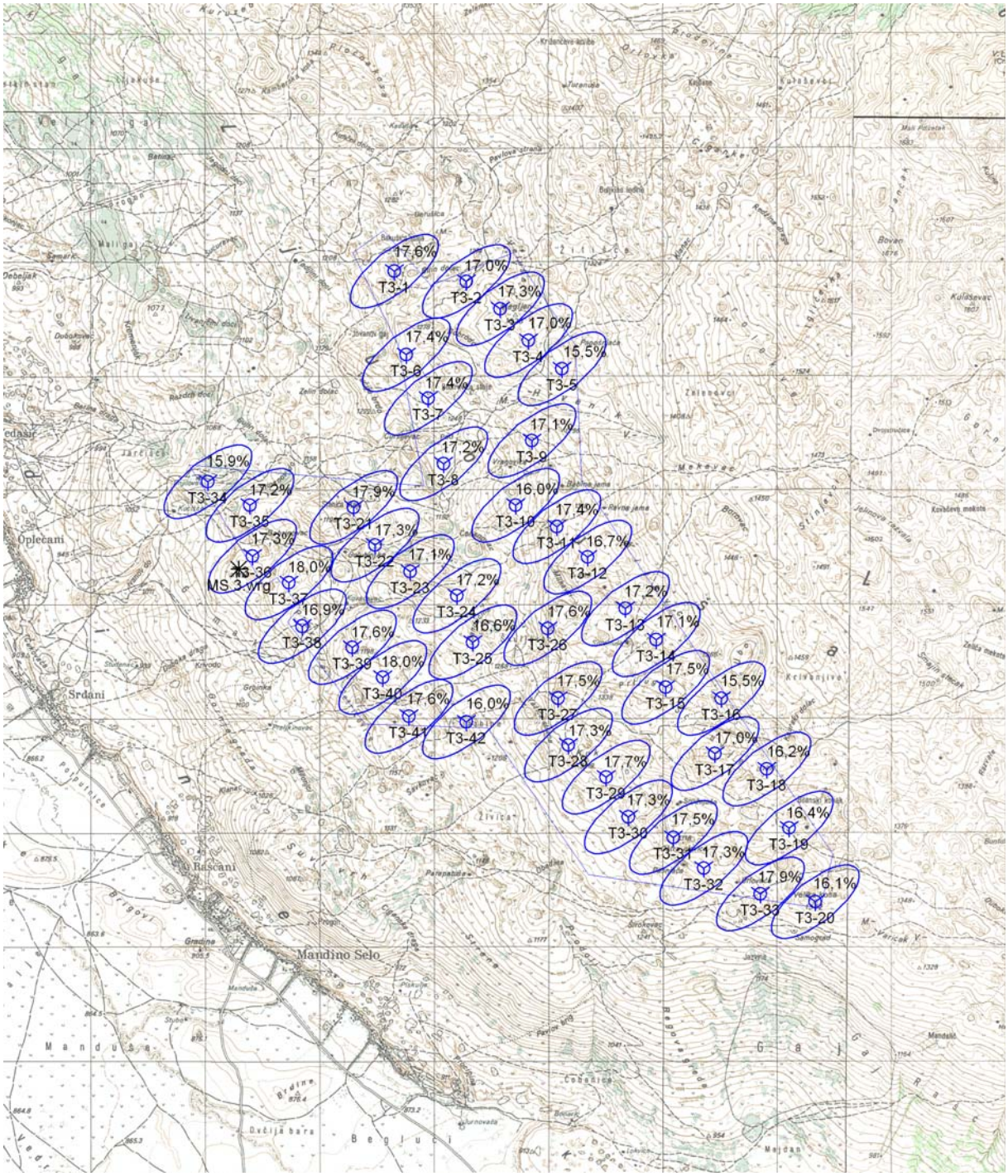

Figure 6-6 Estimated design equivalent turbulence (I_{15_eff}) according to IEC 61400-1 Ed2 standard

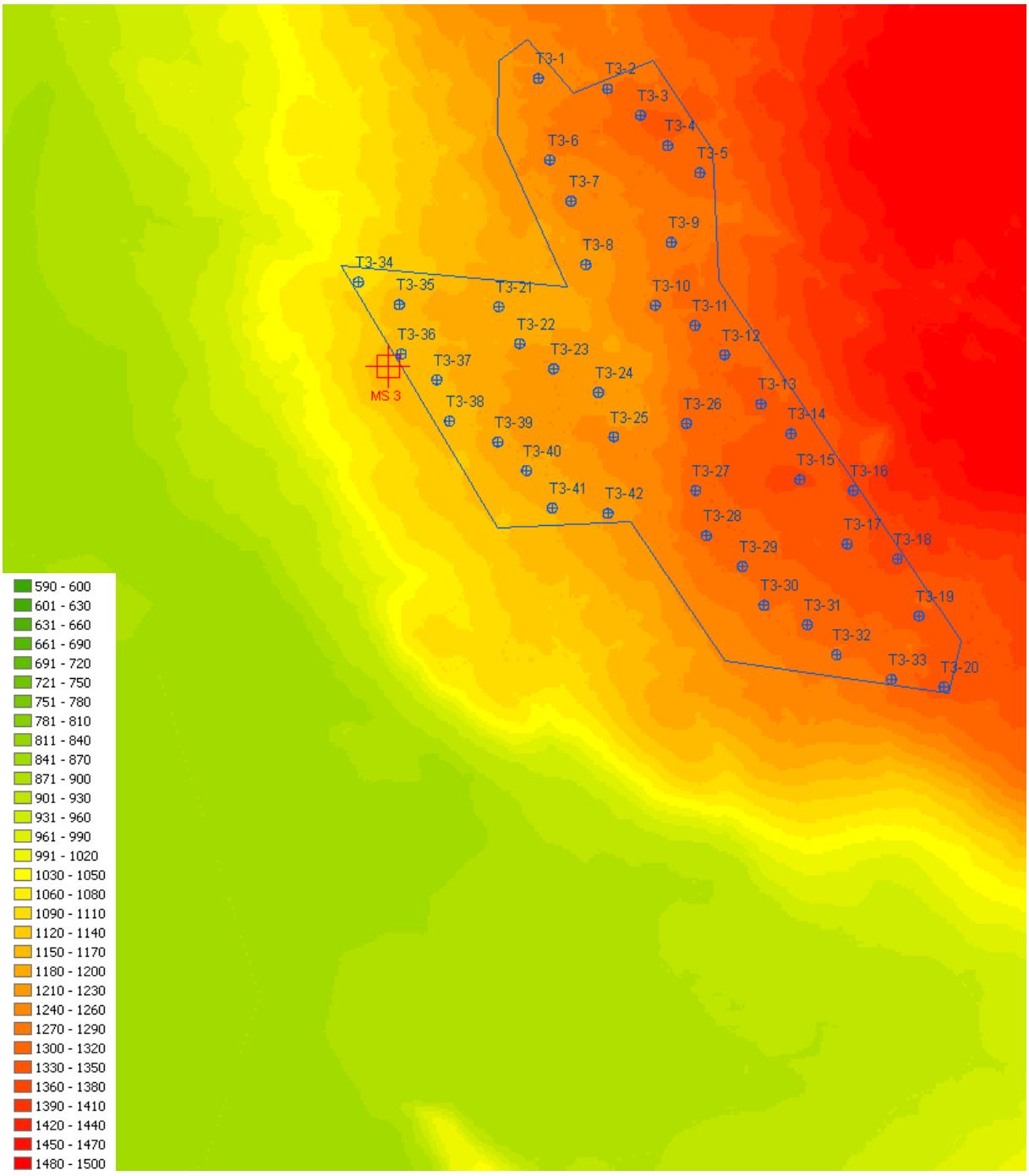

Figure 6-7 Wind turbine positions on height graduated map

7. SUMMARY DATA

Table 7-1 Summary energy report

WF Kupres			WF Pakline			WF Ljubusa		
No.	Net energy		No.	Net energy		No.	Net energy	
	(GWh)	c.f. (%)		(GWh)	c.f. (%)		(GWh)	c.f. (%)
T1-1	7,862	39,0	T2-1	6,251	31,0	T3-1	5,680	28,2
T1-2	7,142	35,4	T2-2	6,283	31,2	T3-2	5,719	28,4
T1-3	5,643	28,0	T2-3	6,689	33,2	T3-3	6,084	30,2
T1-4	5,846	29,0	T2-4	6,512	32,3	T3-4	6,058	30,1
T1-5	7,452	37,0	T2-5	6,530	32,4	T3-5	5,795	28,7
T1-6	7,497	37,2	T2-6	6,320	31,3	T3-6	5,623	27,9
T1-7	6,306	31,3	T2-7	6,173	30,6	T3-7	5,558	27,6
T1-8	6,172	30,6	T2-8	6,432	31,9	T3-8	5,517	27,4
T1-9	7,235	35,9	T2-9	6,223	30,9	T3-9	5,537	27,5
T1-10	6,308	31,3	T2-10	6,240	31,0	T3-10	5,746	28,5
T1-11	5,696	28,3	T2-11	6,244	31,0	T3-11	5,801	28,8
T1-12	6,052	30,0	T2-12	6,651	33,0	T3-12	5,858	29,1
T1-13	5,905	29,3	T2-13	6,471	32,1	T3-13	5,749	28,5
T1-14	6,036	29,9	T2-14	6,570	32,6	T3-14	5,704	28,3
T1-15	6,080	30,2	T2-15	6,449	32,0	T3-15	6,266	31,1
T1-16	6,072	30,1	T2-16	6,517	32,3	T3-16	5,892	29,2
T1-17	6,231	30,9	T2-17	6,100	30,3	T3-17	5,874	29,1
T1-18	6,154	30,5	T2-18	6,519	32,3	T3-18	6,142	30,5
T1-19	6,100	30,3	T2-19	6,980	34,6	T3-19	5,873	29,1
T1-20	6,417	31,8	T2-20	7,339	36,4	T3-20	6,917	34,3
T1-21	6,630	32,9	T2-21	7,386	36,6	T3-21	5,381	26,7
T1-22	6,739	33,4	T2-22	7,515	37,3	T3-22	5,601	27,8
T1-23	6,071	30,1	T2-23	7,612	37,8	T3-23	6,000	29,8
T1-24	5,628	27,9	T2-24	7,562	37,5	T3-24	5,517	27,4
T1-25	5,603	27,8	T2-25	7,544	37,4	T3-25	5,910	29,3
T1-26	5,789	28,7	T2-26	7,807	38,7	T3-26	5,955	29,5
T1-27	5,901	29,3	T2-27	7,449	37,0	T3-27	6,090	30,2
T1-28	5,725	28,4	T2-28	7,057	35,0	T3-28	6,238	30,9
T1-29	6,240	31,0	T2-29	7,566	37,5	T3-29	6,093	30,2
T1-30	6,049	30,0	T2-30	7,537	37,4	T3-30	6,217	30,8
T1-31	6,287	31,2	T2-31	6,777	33,6	T3-31	6,198	30,7
T1-32	6,630	32,9	T2-32	6,624	32,9	T3-32	6,159	30,6
T1-33	7,102	35,2	T2-33	6,766	33,6	T3-33	6,295	31,2
T1-34	6,596	32,7	T2-34	6,051	30,0	T3-34	5,699	28,3
T1-35	6,385	31,7	T2-35	7,176	35,6	T3-35	6,135	30,4
T1-36	6,120	30,4	T2-36	7,378	36,6	T3-36	5,976	29,6
T1-37	6,352	31,5	T2-37	7,303	36,2	T3-37	5,897	29,3
T1-38	6,524	32,4	T2-38	7,216	35,8	T3-38	5,875	29,1
T1-39	6,335	31,4	T2-39	7,092	35,2	T3-39	6,087	30,2
			T2-40	7,096	35,2	T3-40	5,764	28,6
			T2-41	7,060	35,0	T3-41	5,719	28,4
			T2-42	6,806	33,8	T3-42	5,768	28,6
			T2-43	6,825	33,9			
			T2-44	7,118	35,3			
			T2-45	7,070	35,1			
			T2-46	7,142	35,4			
			T2-47	7,182	35,6			
			T2-48	6,972	34,6			
			T2-49	6,790	33,7			
			T2-50	6,588	32,7			
			T2-51	6,710	33,3			
			T2-52	6,898	34,2			
			T2-53	6,525	32,4			
			T2-54	6,168	30,6			
			T2-55	6,658	33,0			
Net energy			Net energy			Net energy		
(GWh)		c.f. (%)	(GWh)		c.f. (%)	(GWh)		c.f. (%)
247		31,4	377		34,0	248		29,3

Table 7-2 Wind turbines sorted by net energy

No.	Net energy (GWh)
T1-1	7,862
T2-26	7,807
T2-23	7,612
T2-29	7,566
T2-24	7,562
T2-25	7,544
T2-30	7,537
T2-22	7,515
T1-6	7,497
T1-5	7,452
T2-27	7,449
T2-21	7,386
T2-36	7,378
T2-20	7,339
T2-37	7,303
T1-9	7,235
T2-38	7,216
T2-47	7,182
T2-35	7,176
T1-2	7,142
T2-46	7,142
T2-44	7,118
T1-33	7,102
T2-40	7,096
T2-39	7,092
T2-45	7,070
T2-41	7,060
T2-28	7,057
T2-19	6,980
T2-48	6,972
T3-20	6,917
T2-52	6,898
T2-43	6,825
T2-42	6,806
T2-49	6,790
T2-31	6,777
T2-33	6,766
T1-22	6,739
T2-51	6,710
T2-3	6,689
T2-55	6,658
T2-12	6,651
T1-21	6,630
T1-32	6,630
T2-32	6,624
T1-34	6,596

No.	Net energy (GWh)
T2-50	6,588
T2-14	6,570
T2-5	6,530
T2-53	6,525
T1-38	6,524
T2-18	6,519
T2-16	6,517
T2-4	6,512
T2-13	6,471
T2-15	6,449
T2-8	6,432
T1-20	6,417
T1-35	6,385
T1-37	6,352
T1-39	6,335
T2-6	6,320
T1-10	6,308
T1-7	6,306
T3-33	6,295
T1-31	6,287
T2-2	6,283
T3-15	6,266
T2-1	6,251
T2-11	6,244
T1-29	6,240
T2-10	6,240
T3-28	6,238
T1-17	6,231
T2-9	6,223
T3-30	6,217
T3-31	6,198
T2-7	6,173
T1-8	6,172
T2-54	6,168
T3-32	6,159
T1-18	6,154
T3-18	6,142
T3-35	6,135
T1-36	6,120
T1-19	6,100
T2-17	6,100
T3-29	6,093
T3-27	6,090
T3-39	6,087
T3-3	6,084

No.	Net energy (GWh)
T1-15	6,080
T1-16	6,072
T1-23	6,071
T3-4	6,058
T1-12	6,052
T2-34	6,051
T1-30	6,049
T1-14	6,036
T3-23	6,000
T3-36	5,976
T3-26	5,955
T3-25	5,910
T1-13	5,905
T1-27	5,901
T3-37	5,897
T3-16	5,892
T3-38	5,875
T3-17	5,874
T3-19	5,873
T3-12	5,858
T1-4	5,846
T3-11	5,801
T3-5	5,795
T1-26	5,789
T3-42	5,768
T3-40	5,764
T3-13	5,749
T3-10	5,746
T1-28	5,725
T3-2	5,719
T3-41	5,719
T3-14	5,704
T3-34	5,699
T1-11	5,696
T3-1	5,680
T1-3	5,643
T1-24	5,628
T3-6	5,623
T1-25	5,603
T3-22	5,601
T3-7	5,558
T3-9	5,537
T3-8	5,517
T3-24	5,517
T3-21	5,381

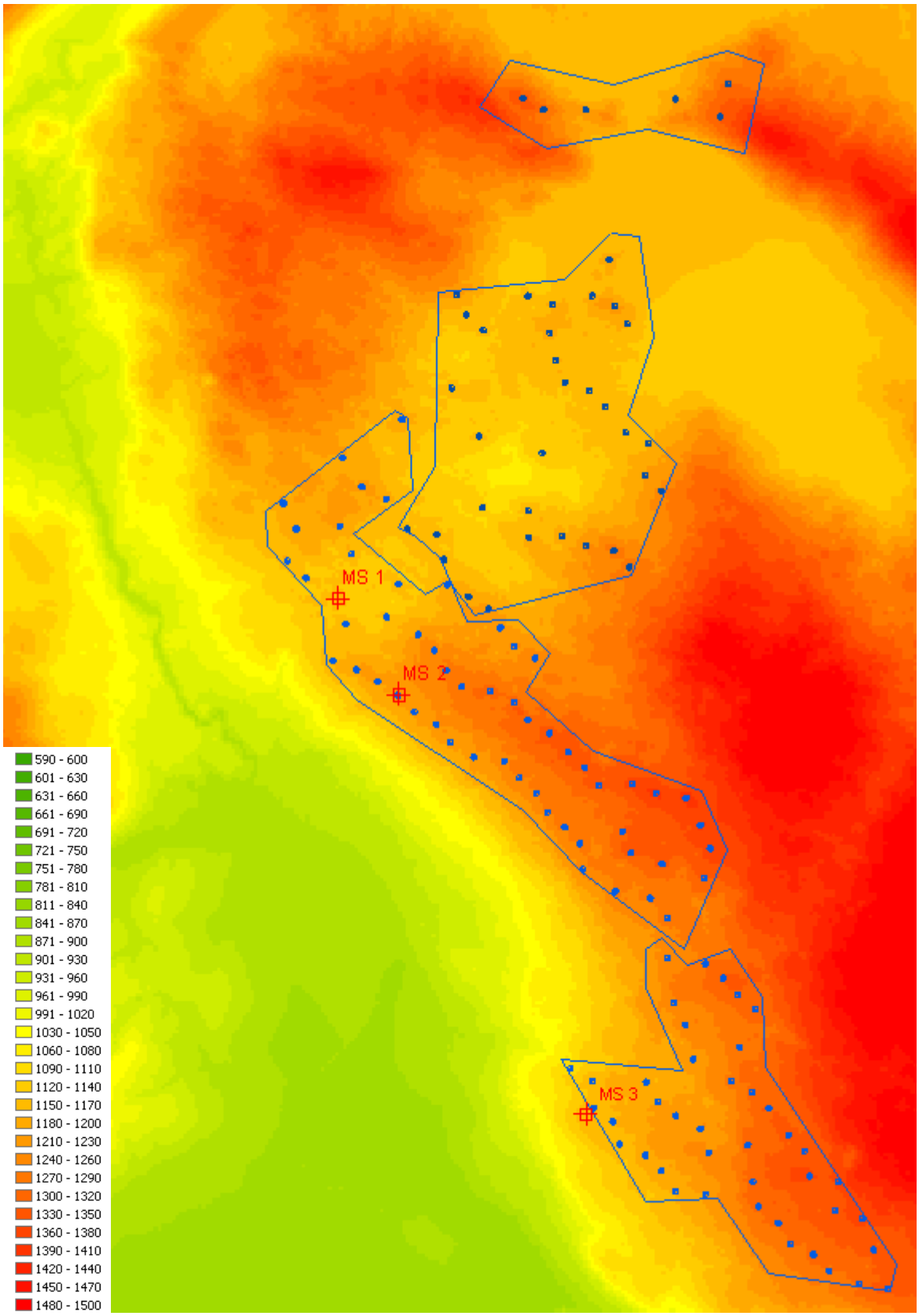

Figure 7-1 Wind turbine positions on height graduated map

APPENDIX - DRAWINGS

1. WF Kupres – wind turbine and measurement mast positions on topography map
2. WF Pakline – wind turbine and measurement mast positions on topography map
3. WF Pakline – wind turbine positions on cadastre map
4. WF Ljubusa – wind turbine and measurement mast positions on topography map
5. WF Ljubusa – wind turbine positions on cadastre map