REPORT

PRE-FEASIBILITY STUDY FOR CONSTRUCTION OF WIND FARM IN THE AREA OF CHERNI VRUH VILLAGE, KAMENO MUNICIPALITY, BOURGAS REGION

Contracting party: Alpha Star OOD
Contractor: ESD-Bulgaria Ltd.

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CONTENT

ABBREVIATIONS

V	- Volt
kV	- Kilovolt
kW	- Kilowatt
MW	- Megawatt
kWh	- Kilowatt hour
MWh	- Megawatt hour
m	- Meter
km	- Kilometer
h	- Altitude
m/s	- Meter per second
m^2	- Square meter
W/m^2	- Watt per square meter
MWh/y	- Megawatt hour per year
BGN/kW	- Bulgarian Leva per kilowatt
BGN/kWh	- Bulgarian Leva per kilowatt hour
BGN/MWh	- Bulgarian Leva per megawatt hour
EUR/kW	- EUR per kilowatt
dBA	- Decibel
kN/m^2	- Kilo Newton per square meter
RES	- Renewable Energy Sources
EU	- European Union
NEC	- National Electricity Company
SWERC	- State Water and Energy Regulation Committee
NPV	- Net Present Value
IRR	- Internal Rate of return
PBP	- Pay back period
WP	- Wind Park
P	- Capacity
CF	- Capacity Factor
FEH	- Total effective operation hours of the generator
Ea	- Energy Attenuation
Pn	- Nominal Capacity Load
m.a.g.l.	- Meter above ground level

The current report is developed on the basis of Contract dated 28th January 2009.

All the activities in the pre-feasibility study are performed in accordance with the requirement of "Regulation №16–27 from 22 January 2008 for the terms and conditions for assessment of the available and the provisioned resource potential for electricity production from Renewable Energy Sources and/or Alternative Energy Sources".

1. Description of the investment proposal

The Contracting party provisions to construct wind farm on the territory of Cherni Vruh village, Kameno Municipality, Bourgas Region. The generators are provisioned to be with unit capacity ranging between 2-3 MW. The origin of the wind generators is provisioned to be European.

2. Assessment of the area

Subject of the current assessment is an area, preliminary selected by the Contracting Party. The Contracting Party has provided the Contractor with the plan from the Agricultural Land Committee – see Appendix 1.

The assessment of the areas will be based on the following criteria:

- Area;
- Accessibility;
- Existence of power grid;
- Orography;
- Geographic co-ordinates.

The physical and geographical characteristics of the area are as follows:

The area of Wind Farm "Cherni Vrah" (the name is conventional), subject to examination (*Figures 1 and* 2), is located in the land of Cherni Vrah village, Kameno Municipality, Bourgas administrative region.

Note: Further in the text the specific site will be marked with the initials Wind Farm – ChV.

The land is with predominant altitude of 100 m and represents part of a hill with altitude of 150 meters, located at about 2 km on the North from the site. The North wind direction flow reduces the wind speed and respectfully the energy flow. Therefore, the height of the generators, provisioned to be installed is 80-95 m above the ground level and the influence of the hill will be minor.

The area is situated in the region of "Kush Bunar" and has an irregular geometric form, consisting of 4 plots with the following numbers: 016**34**, 016**35**, 016**36** with total area of 60 000 square meters and plot 016**26** with total are of 16 000 square meters (see *Figure 1* – the borders of the sites are colored with green color). The original charts of the areas are provided in the Appendix 1.

Figure 1: Site overview

2.1. Properties: 016034, 016035, 016036 and 016026

- ***Area*** – The total area of the site is 76 000 square meters**,** according to the land distribution plan, provided by the Agricultural land committee and is situated on the territory of Cherni Vruh village, Kameno Municipality (see *Figure 1*).
- ***Accessibility*** – the site accessible through earth road. It is provisioned that during the summer the area will be accessible for large clearance loads and construction mechanization (*Figure 2*).

Figure 2: Existing roads

- ***Availability of grid connection*** – *Figure 3*

Figure 3: Existing 20 kV greed

The opportunities for grid connection of wind generators are as follows:

- the power transmission line is situated on the North. The distance to the transmission line is 950 m, measured on the road from the North-West angle of the small plot;
- the transmission line situated on the North, but following the water channel, surrounding the areas on the East – distance of 950 m too;
- on the East, through the field, at the foot of the hill to transmission line situated at 750m at about 500 m on the West, through the field at the foot of the hill a high voltage layout was passing, but currently the is lack of poles;
- power transmission line on the South at about 4,5 km;

From the listed above possibilities, the most suitable option is connection to the existing transmission line situated on the North of the plots, utilizing the existing road.

- ***Orography*** **–** The area is plain with low-stem bushes. See *Figure 4*.

Figure 4

- ***Geographic co-ordinates***

The geographical co-ordinates for different properties are shown on *Table 1.*

Table 1

№	Properties	Geographical Co-ordinates	
1	016034	42°27'12.2408"	27°19'38.3887"
		42°27'18.2020"	27°19'41.4806"
		42°27'16.8071"	27°19'46.3857"
		42°27'15.5873"	27°19'45.9687"
		42°27'12.1554"	27°19'41.9329"
		42°27'11.3914"	27°19'39.8098"
		42°27'12.0498"	27°19'38.5228"
2	016035	42°27'13.8808"	27°19'33.9157"
		42°27'19.5215"	27°19'36.8412"
		42°27'18.2728"	27°19'41.2313"
		42°27'18.2431"	27°19'41.3368"
		42°27'18.2020"	27°19'41.4806"
		42°27'12.2408"	27°19'38.3887"
		42°27'13.5193"	27°19'37.4904"
		42°27'14.9296"	27°19'36.4042"
		42°27'13.9151"	27°19'33.9941"
3	016036	42°27'13.6937"	27°19'32.0988"
		42°27'17.3407"	27°19'30.6524"
		42°27'17.6776"	27°19'28.5994"
		42°27'18.1304"	27°19'28.6000"
		42°27'20.1781"	27°19'33.6778"
		42°27'20.3638"	27°19'33.8789"
		42°27'19.5215"	27°19'36.8412"
		42°27'13.8808"	27°19'33.9157"
		42°27'13.5082"	27°19'33.0685"
		42°27'13.3969"	27°19'32.5259"
4	016026	42°27'24.82"	27°19'49.09"
		42°27'27.69"	27°19'39.01"
		42°27'28.36"	27°19'39.34"
		42°27'29.44"	27°19'39.60"
		42°27'26.39"	27°19'50.35"
		42°27'25.01"	27°19'49.15"

Figure 5 presents topographical map, where the location of the site is indicated.

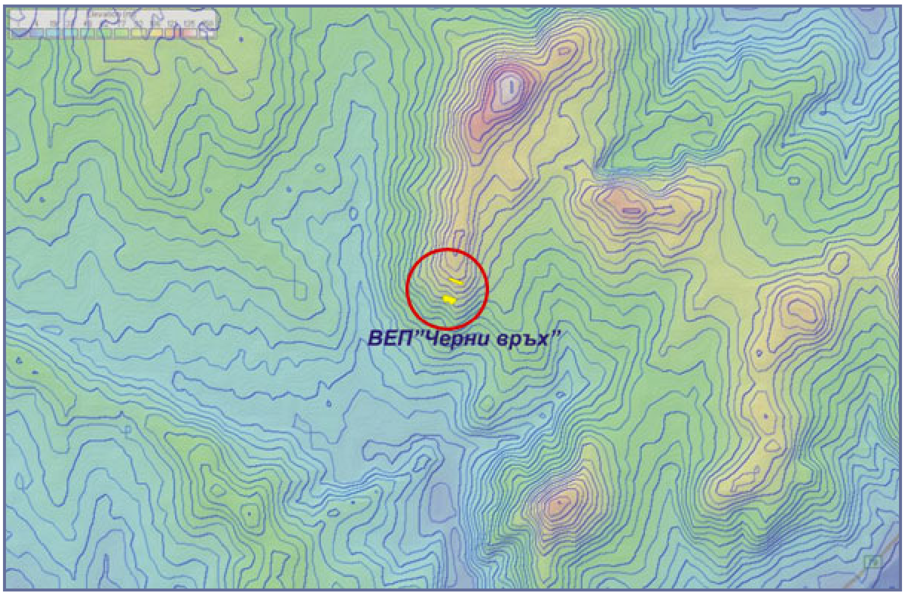

Figure 5: Location of the area

3. Assessment of the wind potential

The assessment of the wind potential is developed on the basis of numerical modeling. Statistical data from the Bourgas synoptic station and additional observation has been used as input data. The data is for a ten year period (365 days per year).

3.1. Climatic conditions

The climatic characteristics of the wind are modeled in the range of 80-100m above the ground level of the area. This condition is in conformity with the height of the axis of the generator.

3.2. Wind mode (climate)

3.2.1. Predominant wind direction

Wind direction of site, means the natural direction of the wind flow. Each wind speed direction is calculated in percentage (%) for each direction, whereas the sum of all the directions equals 100 %. The frequency is presented on the ordinate axis of the figures, whereas the directions are presented in degrees, as sectors of the horizon - (*Figure 6 and Figure 7*).

In the area of Wind Farm – ChV, the predominant wind speed for height 80m.a.g.l (the height of most of the wind generators) has been studied. As you can see on *Figure 6*, the predominant wind speed is north-northwest and southeast. The maximum frequency of these directions varies between 15-18 %, for the first direction and 14% for the second.

3.2.2. Directions of energy winds

The “Energy Winds” are winds with wind speed between 5 and 25 m/s i.e. wind with the necessary for the operation of the turbines speed. Important are the directions of the energy winds. They are reflected in percentage. These directions are presented with red color on *Figure 7* in red color. Usually these directions are close to the predominant wind direction, but in certain cases differ, depending on how the wind speed directions are distributed, due to the fact that wind energy apart from other factors, depends also on the wind speed distribution frequency. In this case the northern and the southern directions are predominant, with respectively around 22% and 11% frequency. ***In this case we have concurrence of the prevailing wind direction and energy wind***.

Figure 6 and Figure 7 present the predominant wind speed and the energy winds in the area of Wind Farm – ChV on height 80 m above ground level.

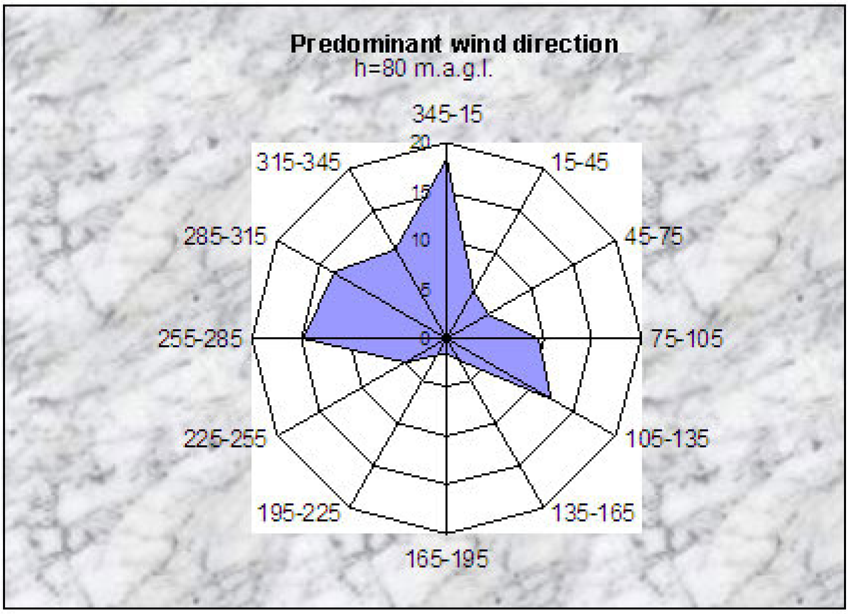

Figure 6: Predominant wind direction on height 80 m.a.g.l.

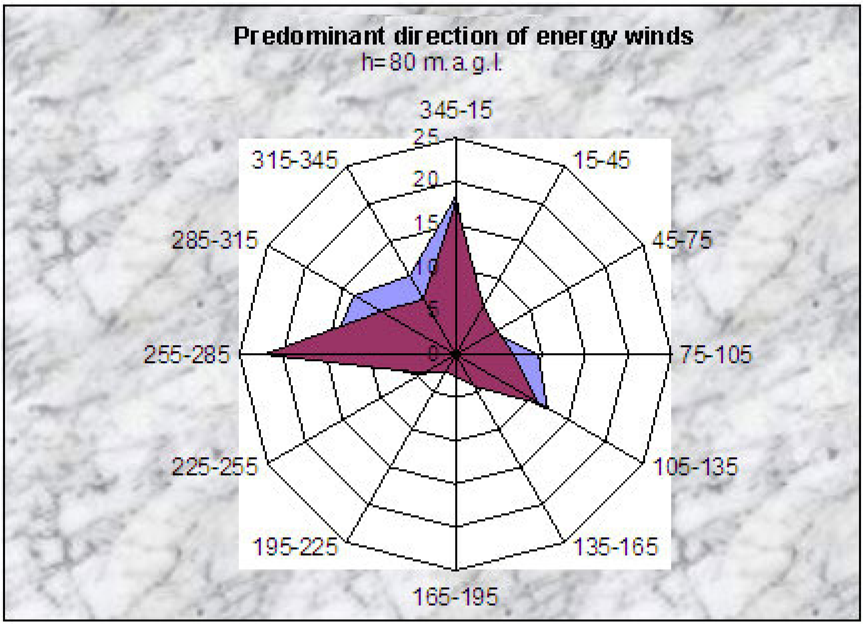

Figure 7: Predominant direction of energy winds on height 80 m.a.g.l.

3.2.3. Wind speed as height function

Figure 8 presents the subordination of the wind speed as height function (profile of the speed), whereas *Figure 9* presents the subordination of the capacity of the flow from the height.

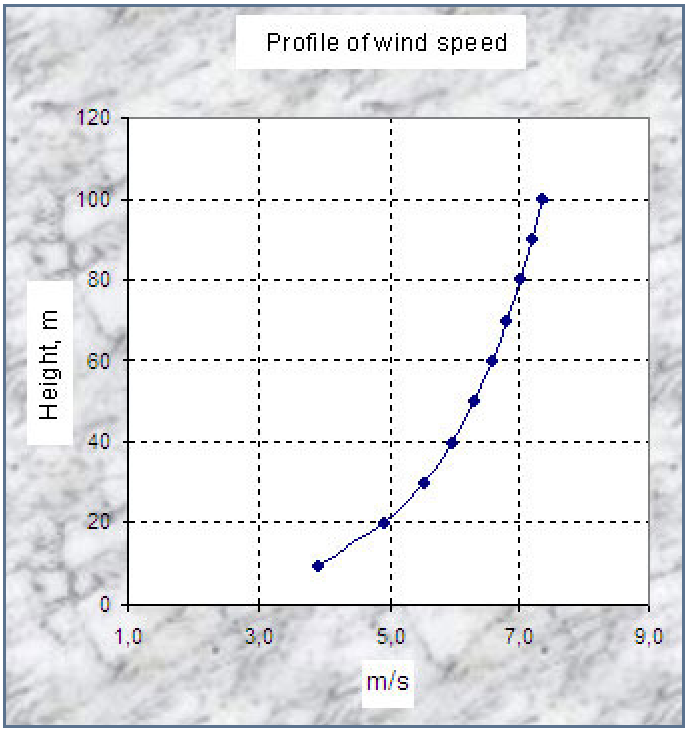

Figure 8: Subordination of wind speed from the height of the area

Figure 8 demonstrates that with the increase of the height over the area, the wind speed ranges from 10 – 100 m.a.g.l. increasing monotonously from 3.9 to 7.4 m/sec. The gradual alteration shows, that in the range of the reviewed height there is no wind “breaking”.

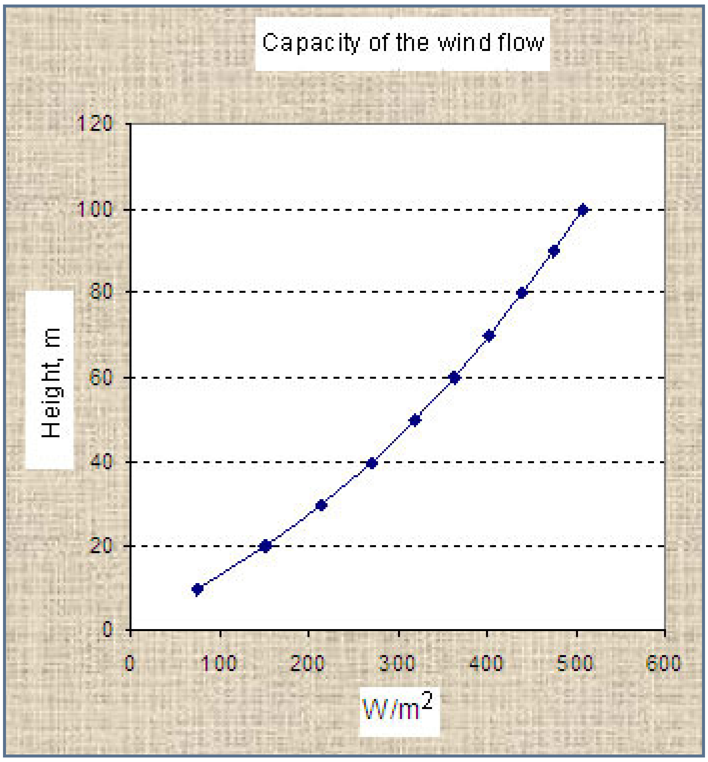

Figure 9: Subordination of the capacity of the wind flow from the height of the area

The alteration of the density of the air flow (*Figure 9*), which is favorable for the selection of the height of the generators is gradual too.

The numerical values from the graphs (*Figures 8 and 9*) are presented on *Table 2*.

Table 2

Height	**Wind speed**	**Density of the flow**
m.a.g.l.	*m/sec*	*W/m²*
10	3,9	73
20	4,9	151
30	5,5	214
40	6,0	271
50	6,3	319
60	6,6	363
70	6,8	403
80	7,0	440
90	7,2	475
100	7,4	507

Figure 10 and Table 3 present the annual wind speed in the area of Wind Farm – ChV on height *80, 90* and *100 m.a.g.l* (height of the most generators). It shows that the highest wind speed is during the winter (November – April), respectively 7.0, 7.2, 7.2, 7.5, 7.5 m/s, and lower during the summer (May- September), respectively 6.7, 6.5, 6.7, 6.7, 6.8 m/s., for 80 m.a.g.l.

Table 3

Height	**Month**											
m.a.g.l.	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*
80 m	7.2	7.5	7.5	7.2	6.7	6.5	6.7	6.7	6.8	6.8	7.0	7.2
90 m	7.4	7.7	7.7	7.4	6.9	6.7	6.9	6.9	7.0	7.0	7.2	7.4
100 m	7.6	7.9	7.9	7.6	7.1	6.9	7.1	7.1	7.2	7.2	7.4	7.6

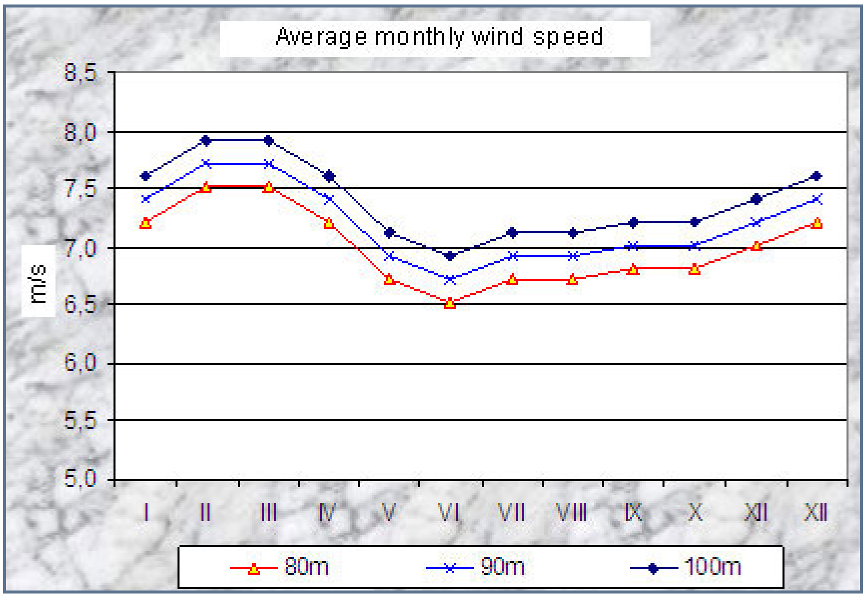

Figure 10: Average monthly wind speed in the area of Wind Farm – ChV on height of 80, 90 and 100 m.a.g.l.

3.2.4. Hourly distribution of wind speed

The hourly distribution of wind speed is an important indicator for the identification of the produced energy, as well as for the identification of the total effective operating hours of the turbines. These are presented on *Table 4* for the respective heights, as well as in graphical representation, *Figure 11*.

Figure 11 and *Table 4* present the subordination of the annual number hours in the Wind Farm "Cherni Vruh" from the wind speed for heights of 80, 90 and 100 meter above the ground level. It is observed that with the increase of wind speed, the number of operation hours decreases. Simultaneously with the increase of the height above the ground level, reduction in the number of low speed hours and increase in the high speed hours is observed.

Table 4:
Number of operating hours per year for heights 80, 90 and 100 m above the ground level

h = 80m											
Velocity m/sec	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***
Duration - hours	926	896	824	724	610	495	387	292	213	151	103
Velocity m/sec	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	***24***	***25***	
Duration - hours	68	44	27	17	10	6	3	2	1	0	
h = 90m											
Velocity m/sec	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***
Duration - hours	905	885	823	732	625	514	408	312	232	167	116
Velocity m/sec	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	***24***	***25***	
Duration - hours	78	51	33	20	12	7	4	2	1	1	
h = 100m											
Velocity m/sec	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***
Duration - hours	890	879	825	742	640	531	426	330	247	179	126
Velocity m/sec	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	***24***	***25***	
Duration - hours	86	57	37	23	14	8	5	3	1	1	

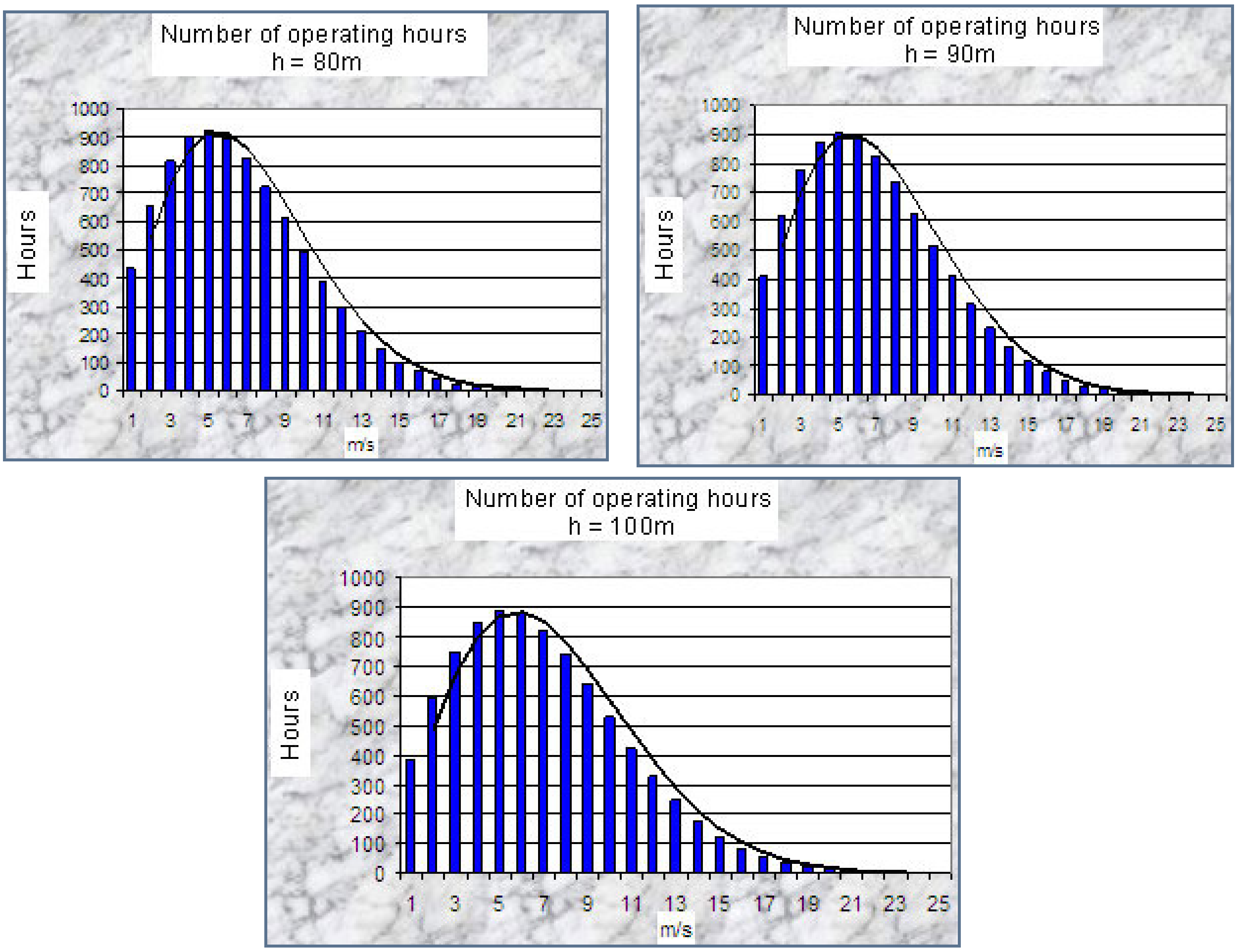

Figure 11: Number of operating hours with different wind speed for the area of Wind Farm "Cherni Vruh"

4. Forecast annual electricity production

The forecast annual electricity production is based on the following initial conditions:

- Type of the turbines: ***Enercon-2.0MW, Enercon-2.3MW, Nordex-2.5MW and Vestas-3.0MW.*** The selection of unit capacities has been considered in accordance with the requirements of the Contract, item 4.5.
- Assessment of the wind speed and density of the wind flow;
- The location of the area;
- Limitations, if any.

4.1. Technical characteristics of the wind generators

The current study includes examination of four different types of turbines: ***Enercon-2.0MW, Enercon-2.3MW, Nordex-2.5MW and Vestas-3.0MW*** – *(see Table 5).* All the generators are European production. Characteristics are presented on *Table 5* and *Figure 12*.

Table 5

№	***Type of turbine***	***Capacity of the generators***	***Height***
		kW	*m.a.g.l*
1	Enercon	2000	80
2	Enercon	2300	80
3	Nordex	2500	80
4	Vestas,V90	3000	95

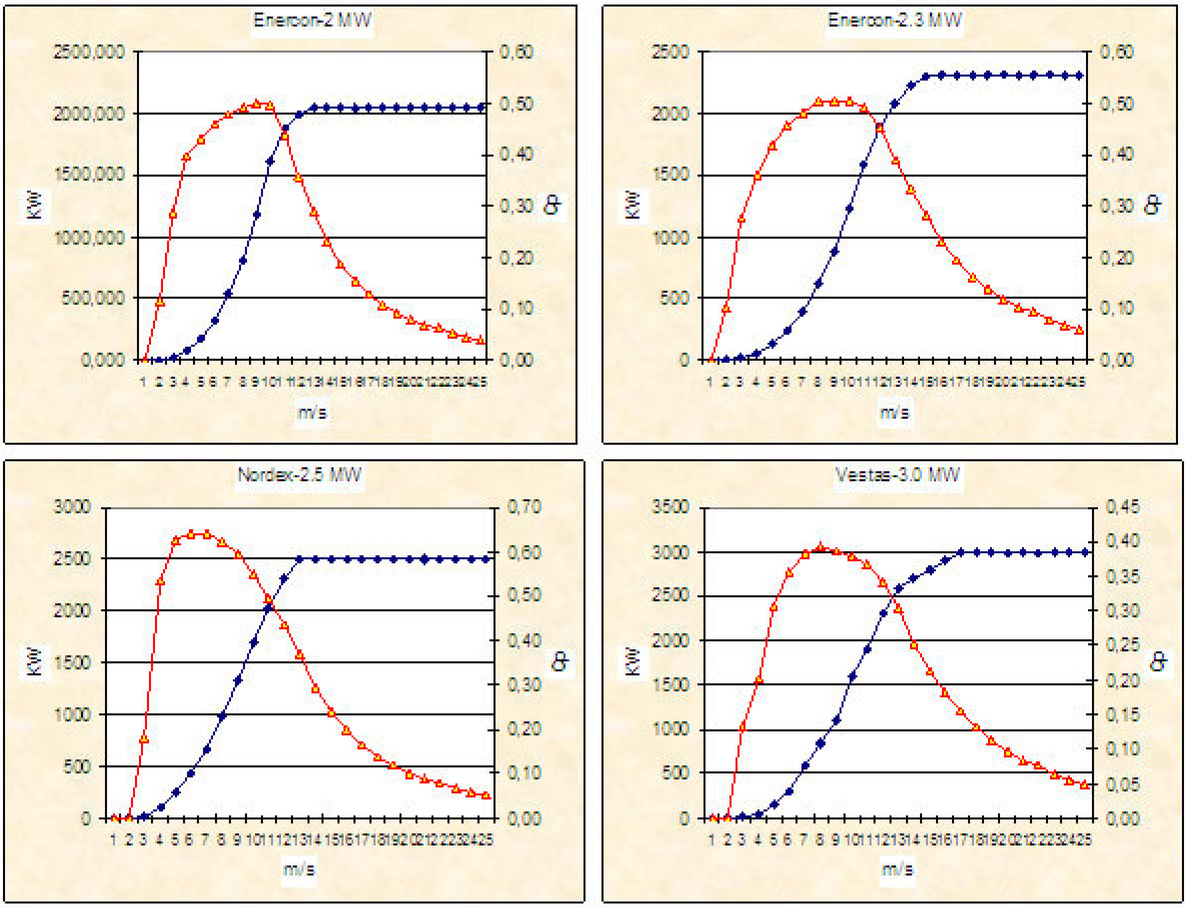

Figure 12: Working characteristics of the used in the analysis wind turbines

Figure 12 presents the working characteristics of the used in the analysis wind turbines. They demonstrate the subordination of the capacity of the turbine from wind speed.

Most of the wind generators start operating with wind speed of 3-4 m/s and reach nominal capacity at 13-15 m/s, preserving capacity up to 25 m/s, while the systems ceases operation, due to danger from damage. Therefore, it is extremely important the wind speed in the area of the wind farm on the respective height over the area to range between 3/5 – 25 m/s, as well as to maintain the nominal velocity (13-25 m/s) as much as possible, to make the generators operate in full capacity. Wind speeds ranging beyond 4-5 m/s and over 25 m/s are the so-called “energy attenuation” i.e. when most of the generators are not operating.

The height of the generators Enercon-2.0MW, Enercon-2.3MW, Nordex-2.5MW and Vestas-3.0MW vary from 80 to 95 m above the ground level.

Table 6 presents the diameter of the rotor, namely: Enercon-2.0MW – 82m; Enercon-2.3MW – 71m; Nordex-2.5MW – 80m and Vestas-3.0MW – 90m.

Typical for these types of generators is the performance of the capacity curve (*Figure 12*), which increases fast with the increase of wind speed, but under different angle until it reaches its nominal capacity. *Figure 12* presents the subordination of the capacity (Cp) of the generator from the wind speed, demonstrating that they are highly efficient at wind speed of 5-10 m/s.

The main characteristics of the generators, including the heights of the axes are presented on *Table 6* and *Figure 12*. *Table 6* presents the annual electricity production generated by the turbines on the project site.

Table 6

Type of turbine	Capacity	High	Diameter of the rotor	Average wind velocity	Average density	Annual production of electricity
	kW	m.a.g.l.	m	m/s	W/m^2	MWh/y
Enercon	2000	80	82	7.0	440	5442
Enercon	2300	80	71	7.0	440	4681
Nordex	2500	80	80	7.0	440	6388
Vestas,V90	3000	95	90	7.3	491	8016

Table 6 presents the average values of the wind speed, the density of the flow and the annual generation of electricity in the area of the Wind Farm – ChV for different heights. Used are different in capacity and origin turbines: ***Enercon-2.0MW, Enercon-2.3MW, Nordex-2.5MW u Vestas-3.0MW***.

Thus the average wind speed for the past few years for these heights varies from 7.00 m/s (80 m.a.g.l.) to 7.38 m/s (90 m.a.g.l.) – see *Table 2, p.12 and Figure 8, p.11*.

The density of the flow (*Table 2, p.12 and Figure 9, p.11)* varies between 440 W/m^2 to 491 W/ m^2 for the same heights.

The defined annual production of electricity in the area of Wind Farm – ChV (*Tables 7 and Figure 13*) for the main heights is as follows:

Table 7

№	Type of the generators	Electricity production MWh/y
1	Enercon 2.0	5 442
2	Enercon 2.3	4 681
3	Nordex 2.5	6 388
4	Vestas,V90 - 3.0	8 016

The increase of the quantity of electricity from main height to 100 m gradually grows from 5-16% to over 50% at 120 m. It should be noted, that each generator is offered on the market with few (usually five heights at 5 m) heights, which differ from the main one with no more than 20m. When the generator is higher, the values of the generated electricity are higher, but as we going to see in the economic analysis section, it is not always economically feasible, due to increase of investment.

Figure 13 presents the annual electricity production from the reviewed turbines in the area of Wind Farm “Cherni Vruh”. *Figure 13* and *Table 7* demonstrate that the highest electricity production is generated from wind turbine Vestas-3.0 MW – 8 016 MWh/y.

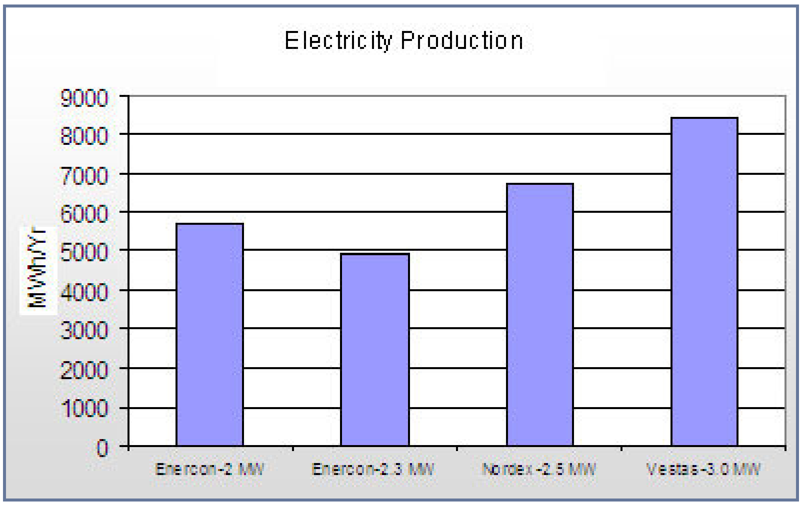

Figure 13: Production of electricity from different turbines as function from the height of the area

4.2. Subordination of the energy from wind speed

Figure 14 presents the subordinations of the expected quantity of electricity from wind speed from each of the reviewed turbines at the respective location – the area of the Wind Farm – ChV.

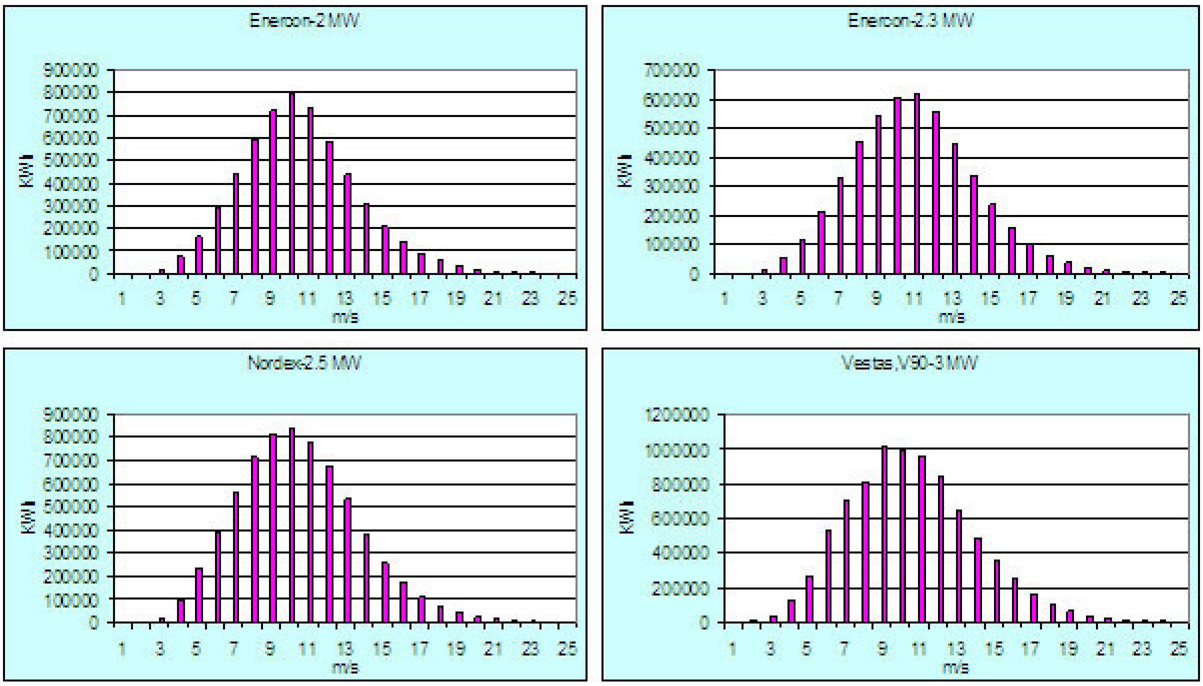

Figure 14: Production of electricity from different types and capacity wind generators, installed in the area of Wind Farm – ChV for the main heights over the area

The electricity generation dependants on the parameters of the respective turbines, as well as from the density distribution of wind speed in the area. Thus the annual electricity generated from Enercon-2.0MW is over 700 MWh at wind speed of 9-11 m/s; for Enercon-2.3MW the annual electricity generated is over 600 MWh at wind speed of 10-11 m/s; for Nordex-2.5MW annual electricity generated is over 700 MWh at wind speed of 9-11 m/s and for Vestas-3.0MW annual electricity generated is over 800 MWh at wind speed of 9-11 m/s.

Regardless of the fact that some of the turbines demonstrate consistent preservation of the capacities, after reaching the nominal value (*Figure 12*) the quantity of the produced electricity is reduced (*Figure 13*), due to reduction of hours with higher speed (*Figure 14*).

4.3. Assessment of the annual electricity generation

Table 8 and *Figure 15* present the distribution of the produced electricity by months throughout the year. The data is calculated for the main heights of the turbines. It is obvious that 27.5% from the energy is produced during the winter period (December, January and February), 26.2 % during spring time (March, April and May), 22.3 % during the summer season (June, July and August) and 24.1% during the autumn period (September, October and November). Thus 53.7 % from the electricity is produced during the cold season, when the consumption is high, whereas the remaining 46.3% during the summer and autumn.

Table 8

Turbine	I	II	III	IV	V	VI	VII	VIII	IX	X	XII	XII
	MWh											
Enercon-2.0 MW	510	555	555	510	435	405	435	435	450	450	480	510
Enercon-2.3MW	439	477	477	439	374	348	374	374	387	387	413	439
Nordex-2.5MW	598	651	651	598	510	475	510	510	528	528	563	598
Vestas-3.0MW	751	817	817	751	641	596	641	641	663	663	707	751

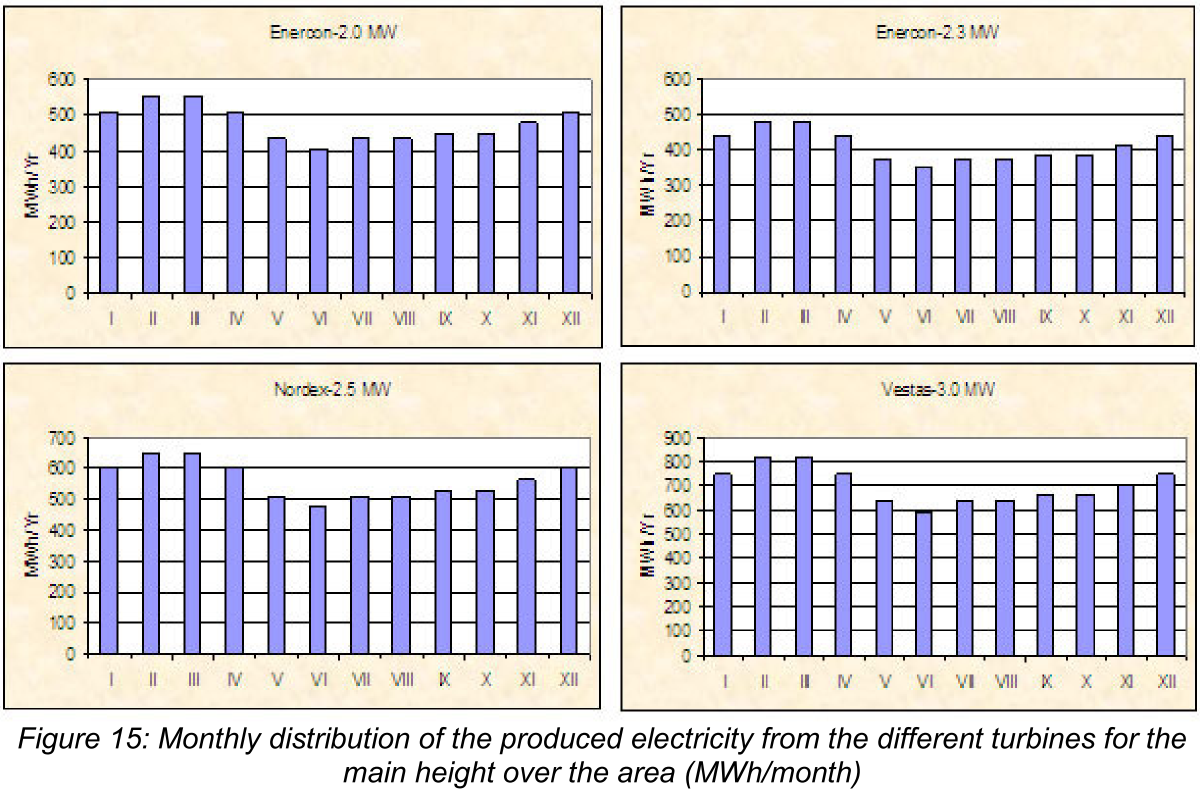

Figure 15: Monthly distribution of the produced electricity from the different turbines for the main height over the area (MWh/month)

In the area of Wind Farm "Cherni Vruh", the total capacity factor (CF) for Enercon-2.0MW is 31.1 %, for Enercon-2.3MW it is 23.2 %, for Nordex-2.5MW the efficiency factor is 29.2 % and for Vestas-3.0MW it is 30.5 %. Thus it can be concluded that Enerrcon-2.0MW has the highest total capacity factor (CF) of 31.1%.

The full effective annual operation hours for all the presented generators are higher than 2250 hours, except for Enercon-2.3 MW. Accordance to the last decision of the State Water and Energy Regulation Committee (SWERC) the purchase electricity price for generators with lower than 2250 annual operation hours is 186 BGN/MWh, whereas for the generators with higher than 2250 effective operation hours the electricity purchase price is 168 BGN/MWh.

The "Energy attenuation", where the generators cease operation varies between 13.2 to 14.3 %.

The nominal capacity load of the generators is between 2.6-10.7 % from the annual number of hours.

On *Table 9* is presented Capacity factor, full effective operation hours of the generators, energy attenuation (%) and loading of the nominal capacity (in % from 8760 hours) for the area of Wind Farm "Cverni Vruh".

Table 9

Type of turbine	***Capacity***	***Capacity Factor (CF)***	***Total effective operation hours – Wind generators***	***Energy attenuation***	***Nominal capacity load***
	kW	*(%)*	*Hours*	*(%)*	*(%)*
Enercon	2000	31.1	2721	14.3	10.7
Enercon	2300	23.2	2035	14.3	4.9
Nordex	2500	29.2	2555	14.3	7.4
Vestas,V90	3000	30.5	2672	13.2	2.6

The comparison on *Table 9* is made in accordance with the following parameters:

- ***Capacity factor***. Represents the correlation of the quantity generated electricity to the total number of operating hours during the year multiplied to the capacity of the generator.
- ***Total effective operation hours of the wind generator.*** Represents the correlation of the generated quantity of electricity to the installed capacity of the generators.
- ***Energy attenuation*** represents the number of hours, outside the range of the operation of the generator to the total number of annual operation hours.
- ***The nominal capacity load*** represents the number of operating hours of the generator at nominal capacity to the total number of operating hours per year.

The assessment of these parameters is an important prerequisite for the proper selection of the turbines, as well as for the financial and economic assessment of the project.

5. Location and number of wind generators

Wind Farm "Cherni Vruh" has irregular geometrical shape (indented polygon oriented to the north-west to its shortest side and to north-east at its longer side) consisting of four plots with total area of about 60 decars.

The location and number of the generators to be installed is a function of the following parameters:

- Area of the plot;
- Proportion of the sizes (long, short side);
- Orientation of the plot in respect to the predominant winds from north and south.
- The diameter of the blades of the turbine (*Table 4, p.13*);
- The existence of technical and non-technical limitations;
- Limitations (if any).

On the basis of the above criteria, the possible numbers of wind generators, which can be installed on the respective plots, are presented on *Table 10* and *Figure 16*.

Table 10

№	Type of turbine	Number of units	Total install capacity	Remarks
1	Vestats,V90 3000	3	13.6 MW	Max. capacity
	Enercon 2300	2		
2	Vestats,V90 3000	3	9.0 MW	Optimal capacity
3	Nordex-2.5	3	7.5 MW	Optimal capacity
4	Enercon-2.3	3	6.9 MW	Optimal capacity
5	Enercon-2.0	3	6.0 MW	Optimal capacity

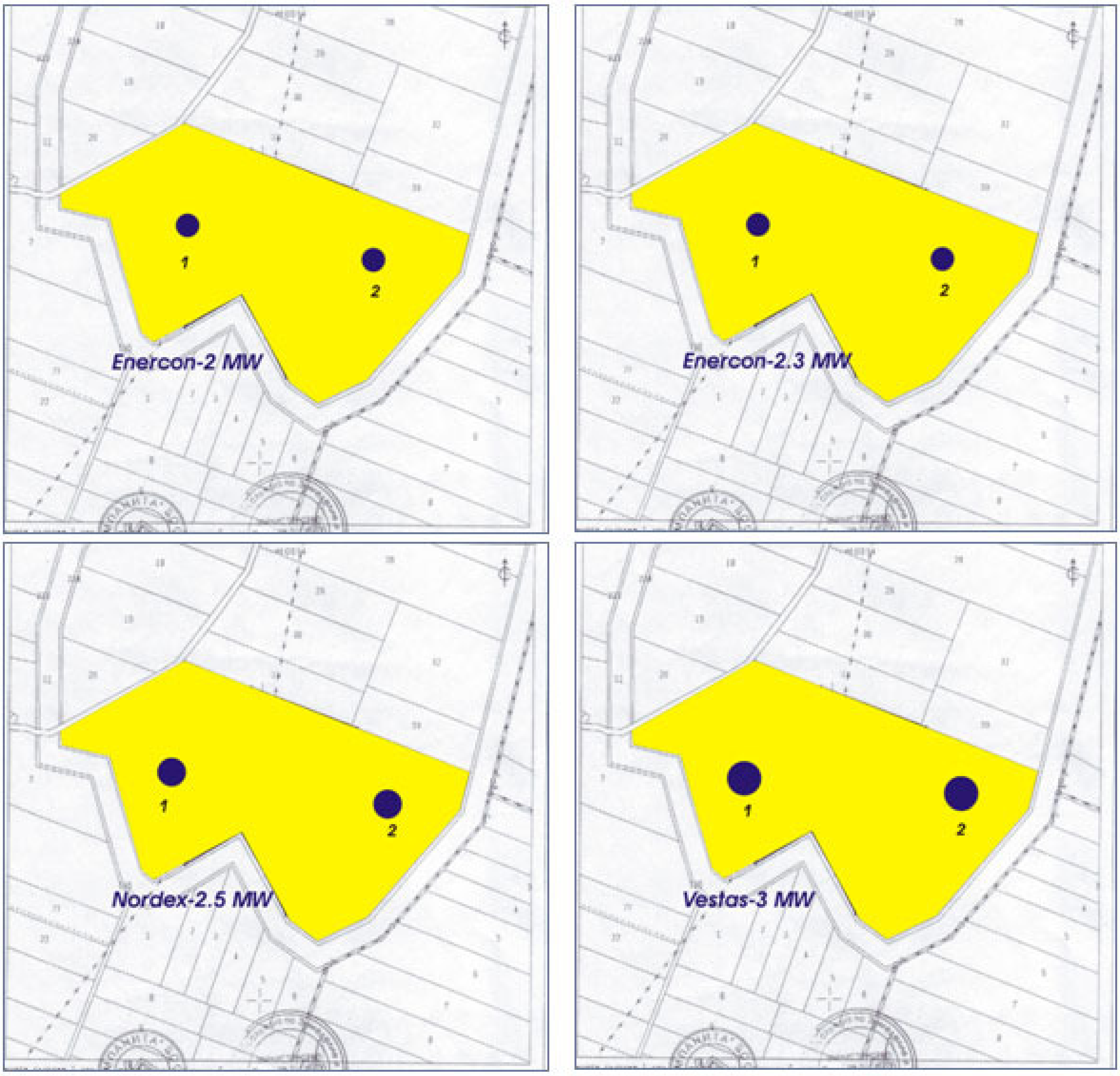

Figure 16: Examples for configuration of Wind Farm – ChV for different types of generators

Detailed situation of the wind generators are presented in the Appendix 2.

6. Economic feasibility of the project

The economic feasibility of the project will be performed for the three types of turbines, showing best results: Vestats,V90 – 3.0MW; Enecrom – 2.3MW and Nordex – 2.5MW.

6.1. Objective and subject of analysis

Key element in the investment policy is defining the financial efficiency of the provisioned investment solutions. The financial analysis of the proposed investment projects is based on the well known principles, whose observation is a prerequisite for effective assessment and successful selection of investment options.

The spectrum of the economic information, necessary for the financial assessment of the implementation of the investment solutions is considerably wide. Among the more prominent financial parameters are:

1. Volume of the planned investment costs;
2. Incomes;
3. Running costs;
4. Depreciation of the tangible assets.

An important element while assessing the investment projects is the identification of the cash inflows and outflows.

The current financial and economic analysis aims at providing information on the possibilities for construction of Wind Farm “Cherni Vruh”, whereas three options are reviewed:

- Construction and exploitation of wind farm consisting of 3 wind generators „Vestas 3.0 MW” and two wind generators “Enercon 2.3 MW” with total installed capacity of 13.6 MW;
- Construction and exploitation of wind farm consisting of 3 wind generators „Vestas 3.0 MW” with total installed capacity of 9.0 MW;
- Construction and exploitation of wind farm consisting of 3 wind generators „Nordex 2.5 MW” with total installed capacity of 7.5 MW;

The analysis is based also on the results and recommendations from the technical analysis of the report.

Recommendations are formed on the best possible option for the investor.

6.2. Methods and criteria for assessment the alternative for the implementation of the project. Selection of investment. Efficiency parameters.

There are two main groups of methods for selection of project:

- Methods, related with the measurement of the economic effect;
- Methods, related with the application of optimization algorithms.

The method for assessment of the alternatives is divided into dynamic and static.
The static methods for assessment of the financial efficiency of the investment projects are popular and easy to apply, but they cannot ensure long-term optimization of the investment solutions, because they do not evaluate the value on money in time. Usually based on comparison of the elapsed in the different periods cash flow.

The dynamic methods are more precise and therefore they are applied for assessment of investment projects with considerably longer life cycle. Unlike the static methods, the dynamic methods for assessment render the time distribution of the cash flow. They are based on the idea, that the financial project cash flows must be corrected, in order to be comparable. The investment selection is based on criteria, which correspond to the objective for reaching maximum long-term financial impact:

- Maximum increase of the investors capital;
- Maximum return on investment;
- Maximum incomes for the investor.

Each of these specific formulations of the objective, provides the long-term optimization of the investment solutions. These formulations are based on the applied dynamic methods for assessment of the financial efficiency of the investment projects.

The dynamic methods for assessment of the financial efficiency of the investment projects are as follows:

1. Method of the Net Present value (NPV) - (objective – maximum increase of the capital of the investor).
2. Method of Internal Rate of Return (IRR) - (objective – maximum return on investment).
3. Method of the modified IRR (objective – maximum return on investment).
4. Method of the factor “incomes: costs” (objective – maximum return on investment).
5. Method on the index of the profitability (objective – maximum return on investment).
6. Annuity method (objectives - maximum incomes from investment).
7. Method of period of discount payback (objective – minimum period of return on investment).
8. Method of net future value (objective – maximum increase of the capital).

The main method of the investment analysis, which has to be applied, is the NPV method. Below, in the report, we will review the selected by us methods for assessment of the investment options for the Wind Farm “Cherni Vruh”.

6.2.1. Method of NPV

The leading index for assessing the financial efficiency of the investment projects is the net present value. The net present value of a certain investment project is the difference between the present value of the future incomes from the project and the present values of the future project costs.

The content of this index is identified with the increase of the total amount of all the discounted net cash flows from the exploitation of the investment site over the amount of the current value of the investment costs. In pragmatic aspect, the calculation is the difference between the total current value of the expected net annual flows and the value of the investment. If the NPV is a positive value, an assessment will prove that the investment is financially viable. Every positive NPV proves an effective spending of resources. The NPV shows the absolute amount of growth of the owner’s wealth, who invested their capital in the project, over the return of the alternative investment options of the same capitals.

When the NPV is zero, then it can be concluded that the investment is on the boundary of the efficiency. The investment project can be implemented with the preliminary consideration, that it will not bring higher return on the similar investment solutions. At the same time the zero net current value is a good argument for a different option – rejection of the project.

When the NPV has a negative value, the project should be considered as unprofitable and the implementation of the investment project as financially unfeasible. In this case the capital investments have lower return than others, parallel investment solutions. The analyzed project should be either ignored or improve its financial parameters.

There are two approaches when calculating the NPV of the investment projects.

In the *first approach,* during the first phase of the decision, we modernize the expected future cash flows. During the second phase we deduct the value of the investment from the obtained sum of the discounted cash flows. The investment cost is not discounted, because it is performed in the basic period. The obtained result represents the net present value of the project. The procedure on calculating the NPV can be also performed in another manner – through the method of discounted cash flow.

The method of the NPV is suitable for comparing the investment alternatives and for optimization of the investment options.

6.2.2. Method of IRR

The second main index for assessment of the financial efficiency of the investment projects is the internal rate of return. The IRR is defined by that (conditionally taken) norm of discounting, which levels the amount of the discounted positive and negative cash flows caused by the investment project. Very often, the interpretation of the IRR is reduced to discounting norm, which reduces the IRR to zero.

The IRR measures the financial efficiency of the investment projects in relative dimension. The exceeding parameter over the adopted norm of discount (minimal norm of return of capital) demonstrates financial attractiveness of the investment solution.

This method is suitable for assessment of investment projects, where the financial costs are at the beginning of the project, whereas later on a positive effect on the investment is expected.

6.2.3. Method of period of discounting payback

The objective of this method is to calculate the payback period of the investment, while rendering the difference in the value of the money in the different years. The time is required, necessary to return the investment on the basis of the net annual incomes from sales. After the expiring of the period, the investor profits until the period of exploitation ends.

This method demonstrates successful investment turnover, which makes it suitable for measuring the efficiency during short-term investments, as well as for following the liquidity.

6.3. Method for calculating the economic effect from the implementation of investment project Wind farm ”Cherni Vruh”

The selection of the most suitable option for the implementation of the investment project is performed after the assessment of the available wind potential transformation in to electricity, carried out after a detailed analysis of the wind energy characteristics of the wind generators, whose electricity generation is the highest at the respective wind and other energy indexes of the selected areas.

The methodology, which is used for calculating the economic effect from the implementation of the proposed investment options, including

1. Defining the value of the first investment
2. Calculation of the costs, related wit the implementation of the investment project.
3. Calculation of the incomes, related with implementation of the investment project.
4. Discounting the calculating cash flow at present value – identification of the NPV of the investment;
5. Identification of the investment payback period (discounting payback);
6. IRR;
7. Comparison of the options.

The following conditions were considered while defining the value of the initial investment:

- The biggest investment costs are related with purchase of wind generators, supply, installation and adjustment of the equipment;
- Unit price of new generators;
- Costs for connecting to the respective transmission or distribution grid, as well as land, construction of foundation, infrastructure, setting system into operation – 72 hour tests, system for monitoring and control, consulting costs.

The annual operation costs are related with the operation and the maintenance of the equipment, according to the respective technical standards. They are formed mainly from the repairs and maintenance costs, insurances, administrative costs and without the depreciation costs they reach 20% of the annual costs for production of wind energy.

The accepted optimum period for exploitation of the wind parks with new generations is 20 years.

When defining the incomes from electricity generation from wind energy, the discount factor of 9.8% is accepted for the minimum required price of capital.

The IRR of the own capital for electricity production from wind generators in Bulgaria is defined to be 12%, whereas the drawn capital amount to 8.3% or weighted average cost of capital of 9.80 % (with capital structure in proportion to the drawn to the own as follows 70:30). This type of capital structure is realistic, considering the fact, that the production of wind energy is characterized with the high level of engagement of capitals, while at the same time 75% of the investment must be invested during the start of the production process.

6.4. Calculations of the main economic indexes for each option

Capital investment and electricity production

The capital investments related with supply and installation of the necessary equipment, construction of foundation, temporary roads, connections with grid, engineering activities are based on detailed study of the price lists and offers and the existing practices abroad and in Bulgaria.

When defining the total amount of the investment, the costs of land are not included in the capital costs of the investor as such.

Summary of investments and electricity generation of Wind Farm “Cherni Vruh” for the three options are presented on *Table 11*.

Wind Park - Option 1

- Wind generators “Vestas” with unit capacity of 3.0 MW – 3 units;
- Wind generators “Enercon” with unit capacity of 2.3 MW – 2 units;

Wind Park - Option 2

- Wind generators “Vestas” with unit capacity of 3.0 MW – 3 units;

Wind Park - Option 3

- Wind generators “Nordex” with unit capacity of 2.5 MW – 3 units;

Table11:
Investments and electricity generation

№	Index	Unit	Wind Farm Vestas 3MW – 3 units and Enercon 2.3MW – 2 units	Wind Farm Vestas 3MW – 3 units	Wind Farm Nordex 2,5MW – 3 units
1	**Total installed capacity**	***MW***	**13.6**	**9.0**	**7.5**
2	**Annual electricity generation**	***MWh***	**33 410**	**24 048**	**19 164**
3	**Total investment, incl.**	***BGN***	**42 375 400**	**28 055 000**	**23 394 500**
3.1.	Grid connection		45 000	40 000	40 000
3.2.	Transport (200 BGN/kW)		2 720 000	1 800 000	1 500 000
3.3.	Temporary roads (lump sum)		10 000	10 000	10 000
3.4.	Wind generators (2640 BGN/kW)		35 904 000	23 760 000	19 800 000
3.5.	Installation (10% from 3.4)		3 590 400	2 376 000	1 980 000
3.6.	Foundations (lump sum)		56 000	39 000	34 500
3.7.	Other unforeseen costs (Lump sum)		50 000	30 000	30 000
4.	**Investment for 1 MW**	***BGN/MW***	**3 115 838**	**3 117 222**	**3 119 266**

The necessary investments per unit installed capacity ranges from 3.115 to 3.119 million BGN per MW.

Exploitation costs

The exploitation costs are formed mainly from the costs for maintenance and the planned repairs of the equipment. According to data, provided by wind energy electricity producers and on the basis of the world practices, these costs vary with about 1,2 Euro cents of generated kWh. Considering the 2008 level of inflation, which according to the NSI is 12.3%, the amount of 1,347 Eurocents per generated kWh has been defined. The calculations provision for 2009 exploitation/operastion costs amounting to 0.0269 BGN per generated kWh. For completeness of analysis, options with 1,5% annual growth of exploitation/operation costs are observed.

6.5. Price of sale of electricity and assessment of the expected incomes from electricity generation of the wind park

According to Article 9, paragraph 5 from the *Renewable and Alternative Energy Sources and Biofuels Act (RAESBA)*, the electricity generation from renewable and alternative energy sources is stimulated through defining preferential price for purchase of electricity, generated from such type of sources.

According to Article 21, paragraph 1 from the *Renewable and Alternative Energy Sources and Biofuels Act* and Article 4, paragraph 3 from the *Ordinance for Regulating the Electricity Price,* the State Energy and Water Regulation Committee (SWERC) every year by the 31st of

March each year no later than 31 March, determine the preferential prices for sale of electricity generated from renewable or alternative energy sources, except for electricity generated by hydroelectric power plants with installed capacity exceeding 10 MW.

Article 21, paragraph 2 of the *Renewable and Alternative Energy Sources and Biofuels Act* states that the preferential price of electricity generated from renewable energy sources shall be determined at 80 percent of the average sale price for public utilities or end suppliers for the preceding calendar year plus an addition determined by the SWERC depending to the type of primary energy source as indicated in the *Ordinance for Regulating the Electricity Price.*

The main factors, defining the level of electricity prices, produced from wind generators are as follows:

- Inflation;
- Investment costs;
- Exploitation costs;
- IRR;
- Capital structure.

The IRR of the own capital for electricity production from wind generators in Bulgaria is defined to be 6.62 % (after tax), whereas the drawn capital amount to 7.6 % or weighted average cost of capital of 7.53 % (with capital structure in proportion to the drawn to the own as follows 70:30). This type of capital structure is realistic, considering the fact, that the production of wind energy is characterized with the high level of engagement of capitals, while at the same time 75% of the investment must be invested during the start of the production process.

The electricity, generated from RES is subject of compulsory purchase.
According to Decision № Ц-015/31.03.2008, as of **01.04.2008**, the preferential price for sale of electricity, generated from wind energy using new equipment, enforced on the 01.04.2008, as follows:

- For new wind generators with total effective operation hours up to 2250 hours – 185,95 BGN/MWh;
- For new wind generators with total effective operation hours over 2250 hours – 167,90 BGN/MWh;

The duration of the preferential prices scheme agreements is 12 years, but only if the project is implemented up to the year 2010, in accordance with the Energy Act. After 2010, there is no clear indication on the part of the Government if this mechanism will be preserved, or transferred to non-market mechanism (TGC with quotas or free market). Thus, when there is a lack of energy strategy and policy, the forecast and the scenarios become pointless.

The preferential price of electricity are determined at 80 percent of the average sale price for end suppliers for the preceding calendar year plus an addition determined by the SWERC depending to the type of primary energy source, which cannot be less than 95% from the allowance of the previous calendar year.

The minimum threshold of the generated electricity price is defined by the costs for production, presented above.

The expected revenues from the two options are presented on *Table 12*.

Table 12:
Incomes from electricity generation

№	Indicators	Measure	Wind Farm Vestas 3MW – 3 units and Enercon 2.3MW – 2 units	Wind Farm Vestas 3MW – 3 units	Wind Farm Nordex 2,5MW – 3 units
1	Electricity generation	*MWh*	Total – 33410 Vestas – 24 048 Enercon – 9 362	24 048	19 164
2	Electricity price	*BGN/MWh*	167.90 (Vestas) 185.95 (Enercon)	167.90	167.90
3	Incomes from electricity generation	*BGN*	5 778 523.10	4 037 659.2	3 217 635.6

The expected annual incomes ranges from 3 217 thousand BGN to 5 778 thousand BGN, which is proportional to the annual electricity generation.

6.6. Assessment of the economic efficiency of the activity

On the basis of assessment of the annual costs and revenues, financial model on the construction, funding and exploitation of the site has been developed for the options. The main conditions and presumptions of the financial model are:

- Investment activities:
  - ~ The costs for the initial capital investments are divided by types of Long-term Tangible Assets (LTA) – buildings, machinery and equipment, other Long-term Assets (LA), costs for land are not provisioned;
  - ~ Period of construction and setting system into operation – 1 year;
  - ~ The depreciations correspond to the depreciations norms, according to the Law on Corporate Income Taxation;
- Financial activities:
  - ~ Funding the construction of wind park with own funds and loans in proportion 30:70;
  - ~ Period of investment credit – 10 years with 3 year gratis period;
  - ~ Price of the loan capital – 8.3 % (interest rates and bank charges);
- Operational activities:
- Annual exploitation costs: 0.0269 BGN per productive kWh, and respectively indexing the approved price of 0.0269 BGN per kWh with acceleration rate of 1,5% per year;
  - ~ Incomes from activities – according to the assessment of the annual electricity generation and price of sale of electricity;
  - ~ Taxes – corporate tax value, according to the active legislation – 10% from the excisable positive financial result;

The summarized financial results from the activities for the two options are provided on *Table 13*.

Table 13:
Average annual financial results

№	Indicators	Unit	Wind Farm Vestas 3MW – 3 units and Enercon 2.3MW – 2 units	Wind Farm Vestas 3MW – 3 units	Wind Farm Nordex 2,5MW – 3 units
1	Exploitation costs	*BGN*	898 729	646 891	515 512
		BGN/MWh	26.90	26.90	26.90
2	Depreciation	*BGN*	2 118 548	1 402 836	1 169 874
3	Financial costs	*BGN*	369 302	244 499	203 883
4	Total costs	*BGN*	3 341 642	2 261 882	1 863 493
		BGN/MWh	103.30	92.36	100.05
5	Incomes from electricity generation	*BGN*	5 778 523.10	4 037 659.20	3 217 635.60
6	Profit before taxation	*BGN*	2 436 881	1 775 777	1 354 143
		BGN/MWh	69.61	70.68	67.71

Table 13 shows that Option 2 – wind farm with “Vestas - 3.0 MW” generators has the best parameters, followed by wind farm consisting of 3 wind generators "Vestas - 3.0 MW" and 2 generators "Enercon - 2.3 MW ".

Option 2 is characterized also with lowest exploitation/operation costs and highest profit value before tax per generated MWh, which makes it the most attractive for implementation.

The electricity generation profitableness for the three compared options is high, after the pay back period – 84%.

6.7. Assessment of the economically feasible efficiency and the expected incomes for the investor

Net Present Value (NPV)

The NPV is defined on the basis of the net cash flows discount method. The essence of the method is in defining the future revenues and costs for the activities and setting the net cash flow to the date of the preparation of the analysis, through the respective discount norm. Discount norm of 9.80 % is accepted. The NPV represents the amount of the discounted cash flows through the years. In respect to the projects, the NPV should be positive, which demonstrates the economic and financial validity of the investment project, considering the conditions proposed to the investor.

Internal Rate of Return (IRR)

The IRR is the second important index for assessment of the financial efficiency of the investment projects. The IRR is defined with the conditionally taken discount rate, which levels the values of the discounted net revenue and expenditure cash flows, as a result of the implementation of the project, or IRR is the percentage of discount, which deduces the NPV of the project to zero. This norm demonstrates the return of the made investment within the entire period of exploitation.

The pay-back period (PBP)

The period of return of investment or the pay-back period, defines the period of time, necessary for the recovering of the investments on the account of the financial results of the investments.

The summarized results for each option are presented on *Table 14a and 14b*.

In *Table 14a* presents the options, with set annual exploitation/operation costs growth of 1.5%.

Table 14a

№	Indicators	Unit	Wind Farm Vestas 3MW – 3 units and Enercon 2.3MW – 2 units	Wind Farm Vestas 3MW – 3 units	Wind Farm Nordex 2,5MW – 3 units
1	NPV @0.0980	*BGN*	4 805 333	4 393 559	2 696 970
2	IRR	*%*	13.929	15.511	13.991
3	PBP	*Years*	11.5	11	11.5

Table 14b

№	Indicators	Unit	Wind Farm Vestas 3MW – 3 units and Enercon 2.3MW – 2 units	Wind Farm Vestas 3MW – 3 units	Wind Farm Nordex 2,5MW – 3 units
1	NPV @0.0980	*BGN*	4 085 340	3 875 319	2 283 982
2	IRR	*%*	13.38	14.944	13.42
3	PBP	*Years*	11.9	11.3	11.7

The growth of exploitation/operation costs does not influence considerably the final results. The payback period increases with 3-4 months, whereas the changes in IRR is insufficient.

The annual cash flows (see details in the Appendix 3) are formed from operational activity, consisting of incoming cash flows from sale of electricity and outgoing cash flows, formed on the basis of costs from activities, consisting of costs for interest rates and taxes. The depreciation costs increase the cash flow, due to the fact that they are non-cash cost. The cash flows from operational activities have negative value as of the first exploitation tear.

The annual cash flows are formed from investment activities, which include only outgoing cash flows for performing initial investments.

The annual cash flows from financial activities, consist of incoming cash flows from credits and outgoing cash flows from paying off capital. The annual cash flows are negative after the third year, i.e. after the completion of the loan’s gratis period.

The net cash flow, unifying the cash flows from the operational, investment and financial activities, presents the cash flow of the investor.

The investment payback period ranges from 11 to 12 years, which can be perceived as acceptable.

Recommendations

On the basis of the performed assessment of the options for the implementation of the investment project for Wind Farm "Cherni Vruh" the following conclusions and recommendations can be made:

1. The NPV for the three options is with positive value and the three cases can be reviewed as feasible and economically viable.

2. The IRR is ≥ «r» (minimal norm of return of capital) for the three options, but the IRR value for wind park utilizing wind generators Vestas 3000 kW considerably exceed the minimum norm of capital return.

3. The pay-back period varies from 11 to 11.9 years, whereas Vestas 3000 kW has the shortest period.

4. The calculations do not include the direct and indirect benefits from the reduced CO_2 emissions as a result from the substitution of power energy, generated from conventional energy sources with renewable energy sources.

As a conclusion we can state that the construction of wind park Wind Farm "Cherni Vruh" is economically efficient. The option for construction of wind park with wind generators Vestas 3000 kW is with better financial indicators.

The difference between the payback period of Option 1 and Option 2 is extremely small. The difference in the IRR is small too. The advantage of Option 1, compared to Option 2 is that after the repayment of investment the project will generate larger cash flow (with about 30%), respectively larger profit.

7. Risk analysis

7.1. Risk analysis

The risk is assessed in accordance with the Up and Down method, on 10 level scale consisting of total 6 indices and 20 indicators. Each index has average indicator value. The assessment is performed only for the most efficient generators – Vestas V90 and Nordex – 2.5MW.

The results are presented on *Tables 15a and 15b* and *Figure 17*.

Table 15a

Nordex - 2.5 MW						
Index	**Limitation of natural resources Availability**	**Marks**	**Technical**	**Marks**	**Investment**	**Marks**
Features	Favourable wind conditions in the considered area	3	Technical capability for grid connection	7	Cost of the technology	8
			Negative influence on the local grid	9	Funds supporting RES	9
			Skill for mounting of wind generators	8	Receipt of design permission	4
			Permission for grid connection	8	Receipt of construction permission	4
					Receipt of License permission	7
Average		***3***		***8***		***6,4***
Index	**Operational**	**Marks**	**Environmental - Public Acceptance**	**Marks**	**Political**	**Marks**
Features	Servicing costs	9	Location on the protected areas	0	Change of legislation	8
	Reliability of the technology	5	Change of the land	4	Negative change of the feed in tariffs	6
	Servicing Frequency	5	Influence of objects on the landscape	2		
	Technology guarantee period	5	Influence on local economy	2		
			Bird migration path	2		
Average		***6***		***2.2***		***7***

Table 15b

Vestas V90, 3.0 MW						
Index	**Limitation of natural resources Availability**	**Marks**	**Technical**	**Marks**	**Investment**	**Marks**
Features	Favourable wind conditions in the consider area	3	Technical capability for grid connection	7	Cost of the technology	7
			Negative influence on the local grid	8	Funds supporting RES	9
			Skill for mounting wind generators	8,5	Receipt of design permission	4
			Permission for grid connection	8	Receipt of construction permission	4
					Receipt of License permission	7
Average		***3***		***7.88***		***6***
Index	**Operational**	**Marks**	**Environmental - Public Acceptance**	**Marks**	**Political**	**Marks**
Features	Servicing costs	8	Location on the protected areas	0	Change of the legislation	8
	Reliability of the technology	5	Change of the land	4	Negative change of the feed in tariffs	6
	Servicing Frequency	4	Influence of objects on the landscape	2		
	Technology guarantee period	4	Influence on local economy	2		
			Bird migration path	2		
Average		***5.25***		***2***		***7***

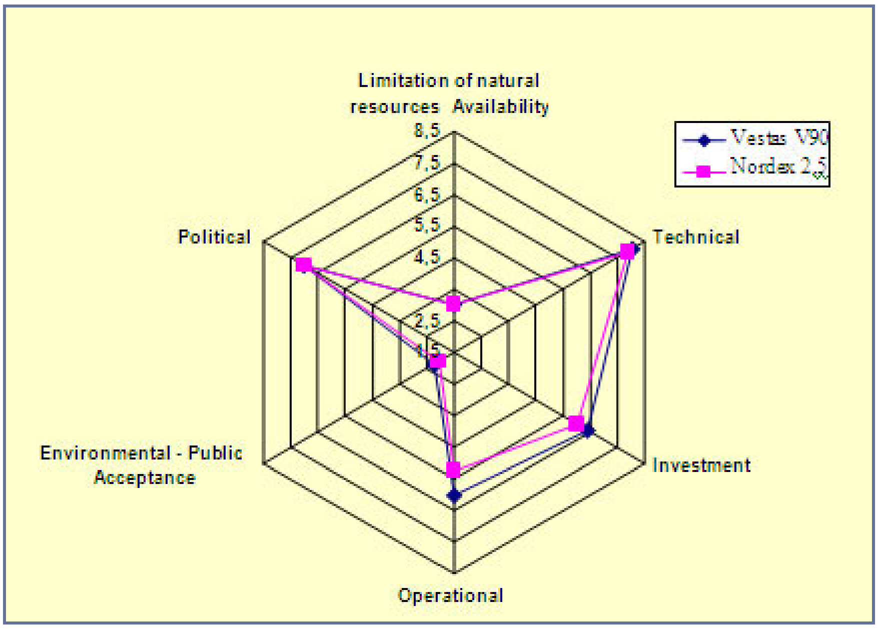

Figure 17: Risk Analysis – Cerni Vrah Wind Park

The performed analysis shows that this type of project is risky. When we exclude the risk for all renewable energy technologies, the political, investment, exploitation and technical risks, indicate considerably high values *(the assessment is based on 10 level scale)*.

7.2. Management of risk

Table 16 presents the risk and recommendations for its management.

Table 16

№	Risks	Management - recommendations
1.	**Limitation of natural resources. Availability**	***Extremely low*** Not a subject of management.
2.	**Technical**	***Relatively high*** Can be partially managed through signing of contracts for services – subscription.
3.	**Investment**	***Relatively high*** Can be partially reduced, if the activities for issuance of the respective permits are granted to specialized companies.
4.	**Operational**	***Relatively high*** Can be partially reduced if experts with the necessary experience and qualifications are appointed for the operational activities. Existence of monitoring system is important.
5.	**Environmental-Public Acceptance**	***Relatively low*** Can be minimized. Good organization and performance of public awareness campaigns.
6.	**Political**	***Relatively high*** Not a subject of management.

8. Assessment of the GHG emissions reductions

The assessment of the CO_2 GHG emissions reduction (*Table 17*) has been performed, considering the following:

- Approved for Bulgaria emission factor of **0.790** ton CO_2/MWh (2012);
- Annual electricity production from the wind farm – MWh/year;
- For a period of **3** years (2010 - 2012).

Table 17

№	Type of turbine	Units	Total install capacity	3 Years energy production	CO_2 emission reduction
		Number	MW	MWh	Tons
1	Vestats,V90 3000	3	13,6	10 0227	**75 170,25**
	Enercon 2300	2			
2	Vestats,V90 3000	3	9	72 144	**54 108**
3	Nordex-2.5	3	7,5	57 487,5	**43 115,63**
4	Enercon-2.3	3	6,9	28 083	**21 062,25**
5	Enercon-2	3	6	48 978	**36 733,5**

9. Preliminary evaluation of the environmental limitations

9.1. NATURA 2000 – Initial Assessment

The initial assessment for the area of the wind farm is based on officially published map for areas included in Nature 2000. *Figure 18* presents part of the map, covering the studied area. The arrow shows the approximate location of the wind park.

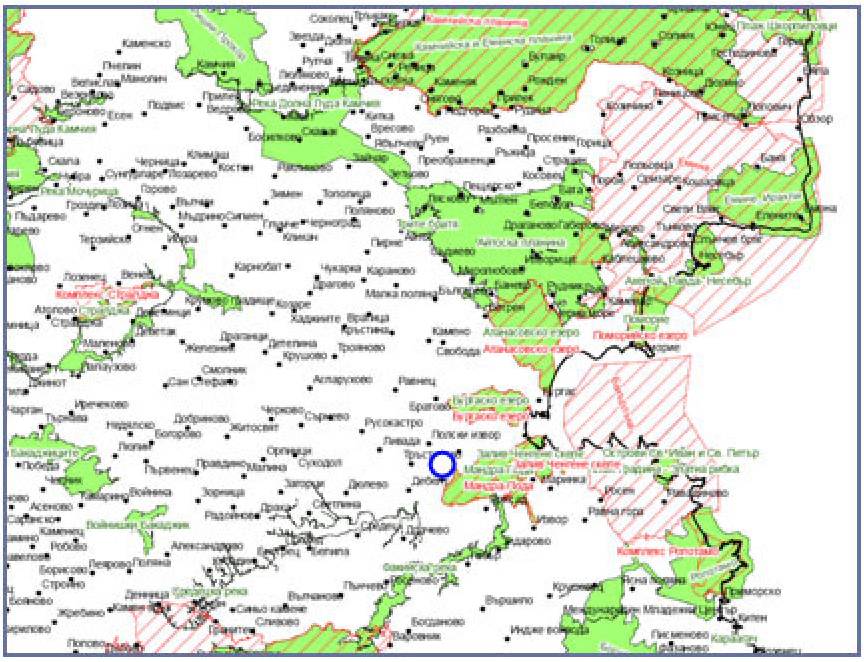

Figure 18: Territories falling under Natura 2000 (green colour)

Figure 19 presents the protected areas by Natura 2000, inhabited by birds.

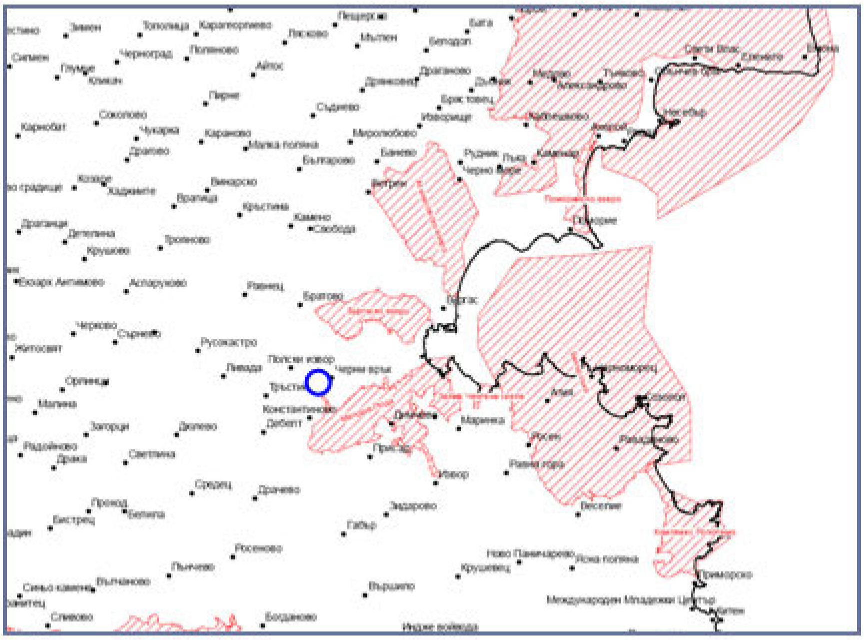

Figure 19: Protected areas falling in to Nature 2000 (white colour) inhabited by birds

The areas of Wind Farm “Cherni Vruh” is not included in the list of Nature 2000, which means that the future park does not falls in the Nature 2000 zones.

9.2. Meteorological characteristics of the area of “Cherni vrah” Wind Farm

Table 18 presents the main environmental characteristics in the area of the Wind Farm “Cherni Vruh” for height over the area 80 m, necessary for the design and purchase of suitable generator. These are: average turbulence intensity for 15 m/sec, standard quadratic deviation at 15 m/s; average air density; maximum air density; minimum air density; average annual air temperature; minimum air temperature at 1% security; maximum air temperature at 99% security; maximum air temperature at 99% security; number of days with air temperature - 20°C; number of freezing days; relative air humidity; maximum wind speed with frequency once every 50 years and 10 minutes interval of average speed; wind load with frequency once every 50 years; speed pulse at every 50 year frequency and 10 minutes average interval; load at 3 seconds speed pulse once every 50 years within 10 minutes interval.

Table 18:
Main environmental characteristics in the area of “Wind Farm – ChV”, h=80 m.a.g.l.

Parameters	***Dimension***	***80м***
Average turbulence intensity 15 m/s	*%*	*5,3*
Standard quadratic deviation at 15 m/s	*m/s*	*8,7*
Average annual air pressure	*mbar*	*981,3*
Maximum air pressure	*mbar*	*998,0*
Minimum air pressure	*mbar*	*956,1*
Average air pressure density	*kg/m^3*	*1,184*
Maximum air density	*kg/m^3*	*1,200*
Minimum air density	*kg/m^3*	*1,158*
Average annual air temperature	*°C*	*12,7*
Minimum air density at 5% security	*°C*	*-17,3*
Maximum air density at 95% security	*°C*	*29,8*
Number of days with air temperature of over 40°C	*days*	*0,0*
Number of days with air temperature below - 20°C	*days*	*0,1*
Number of freezing days	*days*	*0,0*
Relative humidity	*%*	*70*
Maximum wind speed with repetition 1 time every 50 years at 10 minutes average interval	*m/s*	*22*
Pulsation of the wind speed with repetition every 50 years and 3 minutes interval	*m/s*	*30*
Loading with repetition once in 50 years, with 10 minutes average interval	*kN/m^2*	*0,310*
Load at 3 seconds speed pulse once every 50 years	*kN/m^2*	*0,565*

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Appendixes

Appendix 1
Agricultural Land Committee

Appendix 2
Detailed Situation of the Wind Generators

Appendix 3
Annual Cash Flows Analysis

Appendix 4
Wind energy potential methodology