EXPERIMENTAL DATA, MODELLING AND IMPLEMENTING A WIND POWER PILOT STATION

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The first principal objective was to monitor environmental data, to create a data base recognised by international forums and to select an appropriate area economically efficient to implement a wind power station. The numerical model was used to estimate efficiency for different types of wind turbines, in accordance with specific data, price and performance, in different conditions of work, different wind turbine dimensions, locations and numbers. An economic study of feasibility was made. Was adopted the optimum scheme taking into account produced energy-total costs. After that the Pilot station was realised and implemented. In present are made tests for further developments and during month of December this year the first wind power station with turbine of 2.5 Mw will be realised.

Keywords: wind turbine, environmental data-base, monitoring, numerical models

1. Introduction

The renewable resources represent an energetic important potential and offers unlimited possibilities of utilisation on local and national system. Utilisation of renewable resources is realised taking into account three hypotheses: accessibility, disposability and acceptability.

An important advantage of wind power stations is represented by the small surface affected; at local area may be maintained all agricultural, social and economic activities.

In last ten years utilisation of wind energy was confronted with a permanent development, annual rate being around 30% representing approximately twice that into nuclear domain.

The expert evaluation in USA shows that efficient utilisation of wind energy may extend the percent of 1% from present to more then 30% in 2030. The principal argument consists in fact, that even if the present percent is still small, the amount of produced energy from wind resources increased with more then 45% in 2008 then previous year. By maintaining of this rate it is estimated that in

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2030 will be produced 300000 MW compared with 16000 MW in present. All industrial involved partners recognise that the present development of wind power systems will assure that in next 20 years the produced energy from wind resources will represent more then 20% from all nuclear power plants from USA.

EWEA, European Wind Energy Association mentioned that in present "energy produced from wind resource is now an efficient and economic solution".

In Hungary Vestas Company implement 12 wind turbines V90 of 2 MW each in Region Bony, 80 km west from Budapest, starting with the forth trimester of 2009 and will ends in January 2010. The investment is realised by Euro Green Energy which already has installed another 11 functioning wind turbines.

Theoretically Romania may produce around 14000 MW only from wind resources, representing more then four times than Bulgaria. In fact, the produced energy from wind resources in Bulgaria exceeds 13 times the present production from our country.

During these days GE Energy has finalized acquisition of 101 wind turbines which will be installed in Cogealac, area Constanta, representing the second part of a bigger project developed by Czech part. The forth interested competitors were: General Electric, Vestas, Nordex and Siemens. The winning company was GE Electric. These turbines will have an installed power of 252.5 MW. The first project was represented by 139 turbines installed at Fantanele.

The CEZ project from Dobrogea intends to install a total power of 600 MW, an investment of 1.1 billion Euros and the Czech part already spend half of them. The working at the wind park of CEZ project started last year, since CEZ activates in Romania and has bought from the state company that manufactures and distributes electricity, Electrica Oltenia.

The European Union mentioned as one of the principal targets to assure an increase of produced energy from renewable resources, including wind energy at 20% till 2020, from the total produced energy. During this project some of the developed countries will subvention the investments from this domain to some less developed. The European authorities did not establish till now the contribution of each state to this project, but Andris Piebals, the European Commissar for Energy presented his opinion that it should be implemented a project which will allows to the governments of the UE new members to access a credit dedicated to this domain (Romania included)

2. Environmental data acquisition

In the present context regarding the extension of utilisation of renewable resources in Romania, was held a constant campaign for monitoring environmental data, in order to locate the economically favourable zones to implement some wind power plants. In Fig. 1 is presented the distribution of wind

intensity in Romania, with velocity more then 4 m/s; in legend are mentioned the number of hours registered.

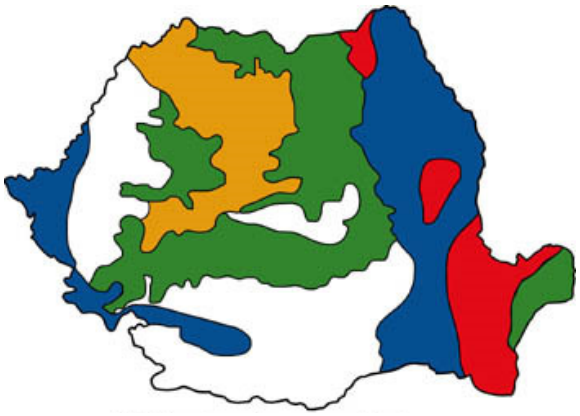


Fig. 1. The distribution of wind velocity:
green- 5000 h, red- 4000 h, blue- 3000 h, white- 2500 h, yellow- 1500 h

In present less of 1% from Romanian produced energy is from wind resources. At the end of 2008 in Romania was installed a capacity of 10 MW, from estimated approximately 65000 MW wing capacity totally installed in UE.

Considering a PHARE study, the wind potential of Romania is around 14000 MW installed power, respectively 23000 GWh, electric energy produced/ year. This is the total potential. Considering only technically and economically potential to be used, around 2500 MW, the total produced electric energy will be approximately 6000 GWh/year, representing 11% from the total produced energy from our country.

It must be mentioned that by realizing wind power systems new working places will be realized, will be reduced the consumption of conventional resources and also will be reduced the emission of CO_2. The emission of CO_2 in nature from the energetic domain represents the principal factor of climate changes.

Before implementing the Pilot Station were monitored the environmental data during an entire year, into the selected area, south Moldavia, one of the red area presented into Fig.1. In this area the principal argument of developing wind power system is not only the intensity of wind (representing hours of working system) but also the relatively constant direction of wind. To encourage the production of wind energy not only the price of sold energy is important but also the obtained Green Certificates, possible to be negotiate into international market. Each MW produced by wind energy will be reworded with 2 Green Certificates.

Due tot the fact that was in plan to develop a power system of 2.5 MW, the monitoring system is realized at 60 m level from ground.

It was implemented a whether station WeatherHawk**,** series 500 Signature. This type allows radio transmission with special antennas of registered data till 5 km distance.

Fig. 2. Images during assembling and installation of monitoring weather station

This weather station may store 8000 data measurements. It has a LCD monitoring system and personal buttons that means that it can be set without PC, 3 anemometers for estimating wind intensity between 0-60 m/s, precision ±0.3 m/s, girouette made from inox steel, sensitivity 0-360º, precision ±3º, having functioning temperature between -40^{o} and + 50^{o}. The time interval of measurements may be set between 1 and 60 min. The angles of wind directions may be set as compass points or as geographic points (north, south, etc.). By settings the station it may be obtained the medium velocity during a day, the maximum values (in m/s, mph or lm/h). It may be set an alert for medium values or wind blast and earthquakes.

It may be measured wind intensity, wind direction, air temperature, solar radiation, rain fall, barometric pressure (in mBar/ hPa, mmHg or inHg), dew point and relative humidity. It also establishes the altitude, pressure tendencies, temperature tendencies, etc. The measurements were made during a whole year.

3. Experimental data

Further will be presented some experimental data collected as an example of the environmental data base, monitored starting March 2008.

Table 1

Monitored environmental data – Date 03.04.2008

Parameter	Max	Max Time	Min	Min Time	Average
Wind Direction	304	5:27am	267	1:00pm	292
Wind Speed	11	9:16am	0	8:00am	6
Wind Gust	11	10:00am	0	8:00am	8
In Humidity	0	5:24am	0	5:24am	0
Humidity	86	8:00pm	44	8:00am	71
In Temp	-17.8	5:24am	-17.8	5:24am	-14.2
Out Temp	20.5	8:00am	7.7	6:48pm	20.2
Raw Barometer	748.26	10:00am	732.46	8:00am	602.87
Total Rain	0.00	5:24am	0.00	5:24am	0.00
Ch 1 Temp	0.0	5:24am	0.0	5:24am	0.0
Ch 1 Humidity	0	5:24am	0	5:24am	0
Evapotranspiration	0.99	11:00pm	0.00	5:24am	0.53
Battery Volt	14	11:00pm	12	5:00pm	13
Solar Radiation	94	10:00pm	0	2:00pm	21
Wind Chill	20.5	5:24am	-17.8	8:00am	10.9

Table 2

Monitored environmental data – till July 2008

Parameter	Max	Max Time	Max Date	Min	Min Time	Min Date	Average
Wind Direction	351	10:45am	7/15/08	0	10:46am	7/15/08	248
Wind Speed	3	10:34am	7/15/08	0	10:26am	7/15/08	0
Wind Gust	3	10:34am	7/15/08	0	10:26am	7/15/08	0
In Humidity	0	10:26am	7/15/08	0	10:26am	7/15/08	0
Humidity	53	10:26am	7/15/08	47	5:37am	4/3/08	49
In Temp	-17.8	10:26am	7/15/08	-18.7	10:26am	7/15/08	-17.8
Out Temp	28.5	10:45am	7/15/08	27.3	10:27am	7/15/08	28.1
Raw Barometer	744.0	10:45am	7/15/08	495.2	10:26am	7/15/08	739.41
Total Rain	0.00	10:26am	7/15/08	0.00	10:26am	7/15/08	0.00
Ch 1 Temp	0.0	10:26am	7/15/08	0.0	10:26am	7/15/08	0.0
Ch 1 Humidity	0	10:26am	7/15/08	0	10:26am	7/15/08	0
Evapotranspir.	0.00	5:40am	4/3/08	0.00	10:26am	7/15/08	0.00
Battery Volt	12	10:26am	7/15/08	12	5:34am	4/3/08	12
Solar Radiation	2	10:44am	7/15/08	0	10:28am	7/15/08	0
Wind Chill	28.5	10:45am	7/15/08	-17.8	4:48am	4/3/08	27.4
In Heat Ix	-19.0	10:26am	7/15/08	-19.0	10:26am	7/15/08	-19.0
Out Heat Ix	29.3	10:45am	7/15/08	-19.0	4:48am	4/3/08	27.8
Dew Point	17.8	10:45am	7/15/08	-17.8	4:48am	4/3/08	15.7
SL Barometer	744.0	10:45am	7/15/08	495.1	10:26am	7/15/08	739.41

The environmental data base till now is systematically presented into EWEA Association. In Table 1 are presented the stored data measured during a day. In Table 2 are presented the environmental values monitored till start to present report. As example are mentioned measured values till July 2008.

Table 3

Measured value during month August 2008

D	Te	high	time	low	time	heat deg	rain	wind avg	wind hi	dom dir	mean barm	mean hum
4	26.2	32.6	3:32pm	19.6	8:31am	25	0.00	2	6	WSW	743.09	47
5	0.0	22.3	11:25a	22.3	11:25a	0	0.00	0	0	NW	745.04	42
7	23.4	27.8	2:41pm	19.5	11:29p	22	0.00	3	5	NW	745.95	40
8	19.2	21.8	9:43am	15.7	3:53pm	507	9.00	6	12	NW	747.18	77
..												
19	18.2	25.4	5:28pm	16.6	5:01am	315	0.00	5	9	NW	748.44	72
20	21.9	30.7	10:52a	15.3	6:49am	43	0.00	3	8	SE	746.96	55
21	22.0	28.6	6:29pm	15.4	6:06am	43	0.00	4	12	NNW	747.27	59
22	23.3	30.9	5:05pm	17.7	6:22am	42	0.00	3	7	NNW	747.86	61
23	24.7	33.2	3:48pm	16.3	6:50am	40	0.00	3	13	SE	743.66	52
24	23.6	32.7	4:45pm	16.2	10:28p	41	4.00	6	19	SE	739.47	53
25	19.5	26.6	4:29pm	15.3	4:17am	34	0.00	4	13	NW	746.27	57
26	20.6	27.3	2:52pm	15.1	7:02am	22	0.00	2	7	NW	750.30	55
27	20.6	27.1	4:34pm	14.7	6:01am	22	0.00	3	8	NNW	751.51	56
28	22.0	29.9	4:31pm	15.5	6:50am	22	10.0	3	10	NNW	747.82	57
29	20.9	30.4	1:57pm	16.5	3:58pm	22	17.0	2	16	NNW	743.81	75
30	17.9	23.2	12:21a	11.7	9:28am	24	2.00	6	16	NNW	744.54	60
31	15.8	22.1	3:04pm	9.5	7:04am	25	0.00	4	12	NNW	750.99	49
T	33.2	22.2	8/23/08	9.5	8/31/08	1248	42.00	3	19	NW	745.39	57

Table 4

Yearly climatologically summary for 2008, including September

m	T avg	high	date	low	date	rain avg	wi sp	date	wind dir	Bar avg	hum
4	22.2	25.9	4/15	17.3	4/05	0.23	7	4/05	WSW	739.73	48
6	25.9	27.1	6/18	25.5	6/22	0.12	5	6/22	SSW	727.14	46
7	28.1	28.5	7/15	27.3	7/19	0.02	3	7/15	WSW	739.73	48
8	22.2	33.2	8/23	9.5	8/31	42.0	19	8/24	NW	745.39	57
9	18.8	27.0	9/3	9.5	9/1	92	13	9/2	SE	748.81	50
t	22.9	33.2	8/23	9.5	9/1	75.0	19	8/24	WSW	744.73	53

In Table 3 are mentioned the values as they are presented, for an entire month, as an example. In Table 4 are mentioned the annual values, included august 2008 and finally in Table 5 the entire average values, as they are reported into statistic international data base. Into some tables are presented only a part of the experimental measurements, just to explain the data base realised. Even today the weather station is functioning and reports on-line.

After ending an entire year of measurements into mentioned location was selected another place not far away, for possible further developments of a second wind power station.

Table 5

Average value during a year 2008, including September

Parameter	Max	Max Time	Max Date	Min	Min Time	Min Date	Average
Wind Direction	360	11:42pm	8/18/08	0	7:08pm	8/7/08	248
Wind Speed	19	7:47pm	8/24/08	0	4:41am	3/9/09	3
Wind Gust	19	8:00pm	8/24/08	0	4:41am	3/9/09	3
In Humidity	0	4:41am	3/9/09	0	4:41am	3/9/09	0
Humidity	95	3:10pm	8/18/08	16	4:00pm	8/23/08	53
Out Temp	33.2	3:48pm	8/23/08	15.3	4:17am	8/25/08	23.1
Raw Barometer	749.91	8:00am	8/22/08	372.68	11:49am	7/16/08	744.55
Total Rain	46.00	9:00pm	8/24/08	0.00	4:41am	3/9/09	26.62
Evapotranspiratio	18.16	11:00pm	8/24/08	0.00	12:00am	7/16/08	1.37
Battery Volt	14	4:20pm	8/18/08	12	7:30am	7/16/08	13
Solar Radiation	1012	12:03pm	7/16/08	0	1:26pm	7/15/08	165
Wind Chill	32.4	5:00pm	8/23/08	-17.8	4:41am	3/9/09	22.8
Dew Point	18.3	3:08am	8/5/08	-17.8	4:41am	3/9/09	11.9
SL Barometer	749.91	8:00am	8/22/08	372.68	11:49am	7/16/08	744.55

4. Numerical modelling of wind Power system of 2.5 MW

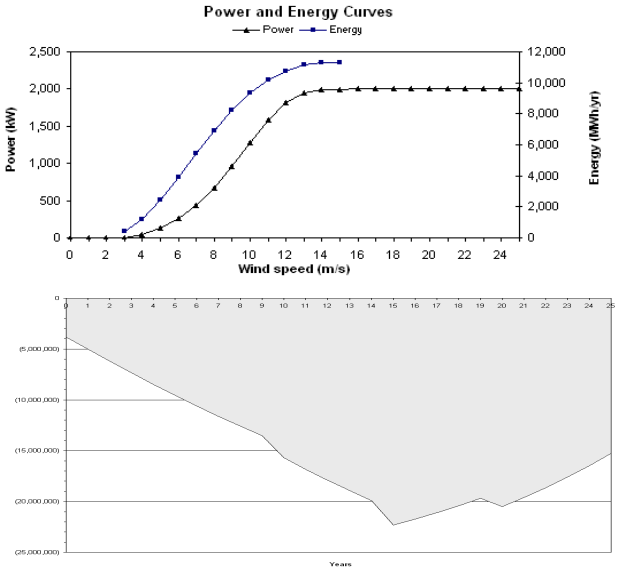
A numerical model for selecting the optimum type of turbine was realised. It were tested many models: Siemens 1 MW, De Wind 1 MW, De Wind 1.25 MW, Nordex 1.3 MW, Enercon 2 MW, Gamesa 2 MW, De Wind 2 MW, Vestas 2 MW, Gamesa 2.4 MW, Vestas 2.5 MW. The last mentioned was selected for implementation. In present at the mentioned location is tested an experimental prototype of wind rotor, new patent pending. Till the end of the 2009, beginning 2010 the wind turbine will arrive in Romania and installed; the team hope in short time the first results will be promoted. Further are mentioned only a part from the numerical modelling of wind turbine, efficiency calculus, etc.

Table 6

Numerical modelling, efficiency, financial aspects

System Characteristics	VESTAS			
Grid type	-	Wind plant capacity	kW	2,000
Wind turb rated power	kW	Unadjusted energy production	MWh	4,515
Number of turbines	-	Pressure adj coefficient	-	1.00
Wind plant capacity	kW	Temperature adj. coefficient	-	1.01
Hub height	m	Gross energy production	MWh	4,560
Wind sp at hub height	m/s	Losses coefficient	-	0.90
Power density hub height	W/m²	Specific yield	kWh/m²	820
Array losses	%	Wind plant capacity factor	%	24%
Airfoil soil/icing losses	%	Renewable energy delivered	MWh	4,121
Other downtime losses	%		GJ	14,83

Wind speed	Power curve data	Energy curve
(m/s)	(kW)	(MWh/yr)
4	44.1	1,200.8
5	135.0	2,420.0
6	261.0	3,905.8
7	437.0	5,458.2
8	669.0	6,929.2
9	957.0	8,231.8
10	1,279.0	9,317.3
11	1,590.0	10,163.
12	1,823.0	10,763
13	1,945.0	11,138.
14	1,988.0	11,313.
15	1,998.0	11,323.
16	2,000.0	-
17	2,000.0	-



Cash balance

6. Conclusions

The paper presents the principal steps into realisation of a wind Pilot station. First is mentioned and argue the selection of this area, advantages compared with other areas. After that is presented the implementation of a weather station and a part of the elaborated environmental date base. It must be mentioned that from the moment of first registration till present, the date base is monthly sent to international forum. A numerical modelling of project of a wind power station were tested for more then ten variants; was selected variant Vestas 2.5 MW. In present paper only a part of calculus are mentioned; also a study of feasibility was realised. In present at the mentioned location is working a prototype wind rotor turbine. Till the end of this year the turbine will be installed into selected area, and first results will be reported.

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