WIND ENERGY RESOURCES IN BOSNIA & HERZEGOVINA

by

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Bosnia & Herzegovina state has good potentials for generation of electric power. It applies, first of all, to its water and coal potentials. In addition to this, Bosnia & Herzegovina has good potentials of certain renewable energy sources, namely: wind, sun, water flows, and biomass. Observation and measurement of wind characteristics in Bosnia & Herzegovina have been performed for over 120 years now. However, the first measurements with adequate equipment and technology aimed at determining of the wind energy potential, started in 2002. Research is still incomplete and limited by complex terrain, the wind type „Bora", as well as by non-existence of necessary strategic documents and regulations on renewables. Based on this research, several wind farms have been already planned, with an installed power of about 200 MW, and with a high coefficient of energy efficiency. This paper provides a review of localities from the wind characteristics research performed in the area of Bosnia & Herzegovina in the period 2002-2008. Additionally, it gives a brief reference to the complexity of wind potential research under complex conditions of terrain and wind type in Bosnia & Herzegovina, giving in this way a contribution to a more realistic estimate of economically feasible potential of Bosnia and Herzegovina, which will consequently help creation of needed strategic documents.

Key words: *wind energy, research, potential, Bosnia & Herzegovina*

Introduction

EU has recognized in time a strong potential of renewable energy sources (RES). In fact, objectives, guidelines, and mechanisms for their implementation have been defined over 15 years ago. In the meantime, objectives have grown bigger, which resulted in new, adjusted mechanisms and guidelines. Today, situation is ready for the introduction of new political decisions that are more than appropriate for development of the wind energy strategy in Europe. It can be concluded that moves in the right direction will continue in the next period as well [1-3].

Since Bosnia & Herzegovina (B&H) is facing joining the EU, it is under obligation to meet certain EU standards, *i. e*. to adjust its regulations and legal system. This applies to the energy sector too. Until the year of 2020, B&H is to adopt its energy industry development strategy. The Study of Energy Sector in B&H [4] will serve as a starting point for an energy industry development strategy. The strategy should also trigger large investments, with around 3.5 bil-

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lions Euros planned to be invested just into basic energy facilities, in one part of B&H, and that is in fact the beginning of overall faster development of B&H. In ref. [4] these potentials have not been adequately analyzed. For that reason, this paper will present results from previous research on wind potentials for the electricity production in B&H.

Measurements of wind characteristics

In the previous period in B&H wind characteristics have been measured at 12 meteorological stations. Beside the fact that these stations have been installed mostly within big urban areas, they were also equipped inadequately for wind potential estimate (as part of FP6 project SEEWIND [5] this data is being digitized, see more at www.seewind.org). This situation, as well as the terrain complexity and complex wind conditions [6,7] resulted in the lack of appropriate data base for accurate B&H wind atlas production, *i. e.* determining wind potential for the electricity production.

The measurements at basic weather stations have been a basis for standards and technical regulations on wind power in ex-Yugoslavia [8]. Of course, this data could not have been relevant for determination of wind potential in B&H, but thanks to analyzing of this information and satellite snapshots (fig. 1), the area of south B&H has been recognized as an interesting region for wind power plants installation.

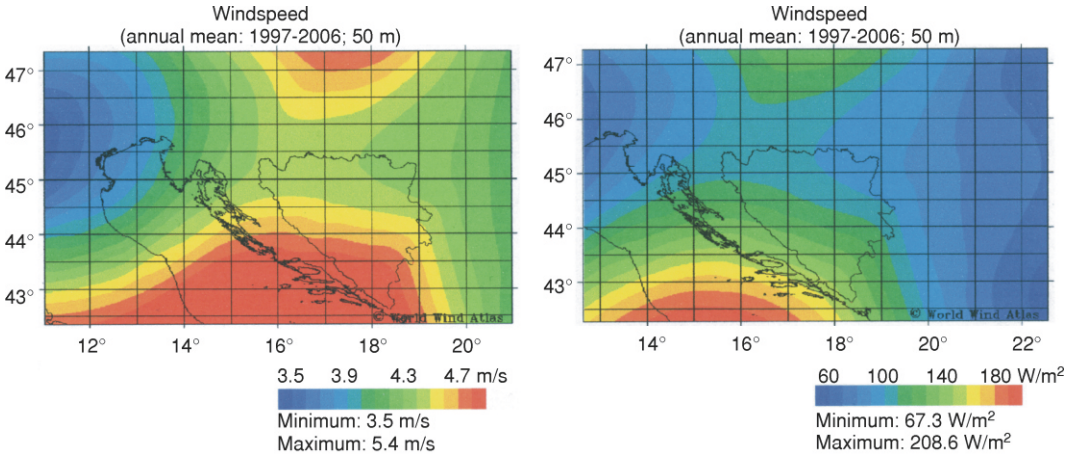

Figure 1. Average annual wind speed and wind power at height 50 m above ground, period 1997-2006 [9] (color image see on our web site)

Consequently, the first analyses, research, and investigations of wind power potential were related to the area of south B&H. In April 2002, the very first measuring station was installed at the location of Sveta Gora – Podveležje, Mostar, with all needed equipment. Other stations followed. Prior to 31st December of 2008, a total of 39 locations with measuring equipment has been installed at 18 different areas. A map of locations is shown in fig. 2 and tab. 1.

At these locations the wind speed and direction have been measured at different heights (6, 10, 25, 30, 40, and 50 m) by using anemometers and wind vanes with a 10-minute measuring

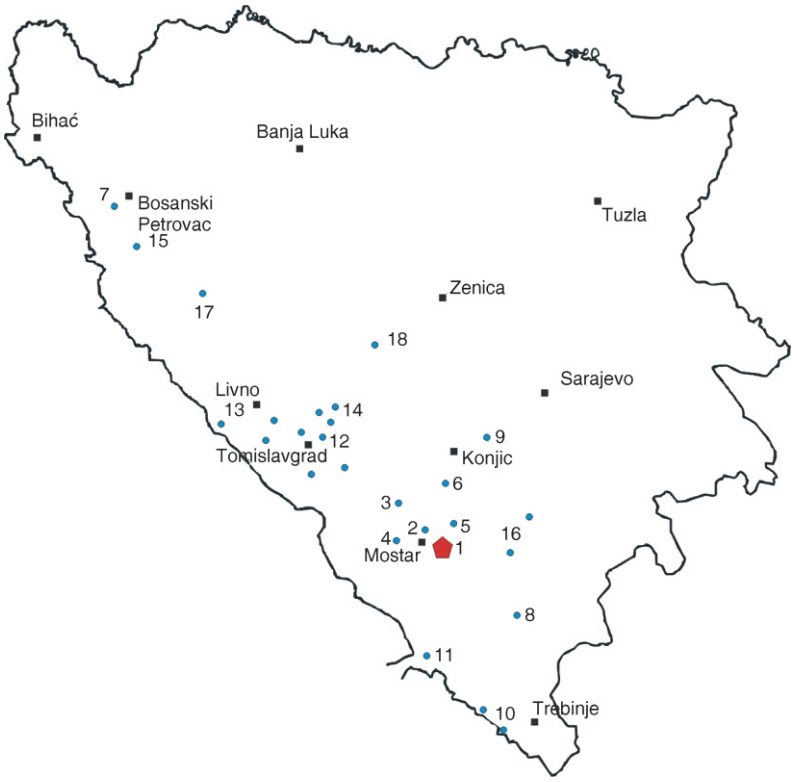

Figure 2. Locations of measuring stations

average. The measurement period is 6 months and more. The information acquired from these measuring stations may be considered as representative and useful for further analysis. Analyses have proved that some locations have good potentials, but the other not. First measuring and research have resulted in new perceptions. In other words, due to distinctive features of area and wind conditions it was necessary to develop and implement a special research model, [10, 11, 12]. Terrain complexity as well as complexity of the wind "Bora" in an interesting area required a greater number of measuring locations. The measurements were performed in a relatively small area of Podvelezje (about 60 km^2) at 12 locations. Within FP6 project [5] at the location Mali Grad – Podvelezje the measurements were performed by using special equipment: SODAR (Sonic Detection and Ranging) and LIDAR (Light Detection and Ranging) aiming to define the vertical wind profile and analyse the mentioned equipment at sites in complex terrain and under harsh conditions of the wind Bora [13]. The LIDAR and the SODAR system showed both a good performance under the extreme climatic conditions at site, while obtained information on vertical wind profile deviate from standards [13]. Namely, analyses were performed for the two prevailing wind directions at Mali Grad, ones tipical of the wind Bora (sectors: 15-45°, 165-195°). At the measuring site, the increase of wind speed with height (vertical wind profile) is very small. The turbulence intensities for both prevailing wind directions are below class I and II of the IEC [14], which is not increased at a higher wind speed [13, 15].

Table 1. Locations of measuring stations

	Area	Micro location	Measuring height
1	Podveležje Mostar	Sveta Gora	10
		Poljica 1	20, 30
		Lokvice	20, 30
		Mali Grad	12.5, 30.5
		Relej – Velež	6
		Smajkići	10
		Kamena	20, 40
		Velina Gomila	20, 40
		Ravnice	20, 40
		Dražnjača	20, 40
		Merdžan Glava	20,40
		Poljica 2	20,40
2	Planinica, Mostar	Planinica	50
3	Jastrebinka, Mostar	Velika Vlajna - Jastrebinka	10, 50
4	Miljkovići, Mostar	Miljkovići	10
5	Pločno, Mostar	Pločno	10, 30
6	Prenj, Mostar	Bahtijevica	10, 30
7	Bosanski Petrovac	Medeno polje	25
8	Berkovići	Berkovići	10
9	Ivan Sedlo	Ivan Sedlo	10
10	Ravno	Ivanjica	10
		Velja medja	10
11	Neum	Crkvina	10
12	Tomislavgrad	Mesihovina	10, 50
		Mokronoge	50
		Srdjani	50
		Vitrenik –Stipanići	10
13	Livno	Kamešnica	10
		Borova Glava	10, 50
		Pločno (Vran)	10
14	Kupreško polje	Ravanjska vrata - Crljenac	25, 50
		Paklina – Vrh Klis	25, 50
		Debelo brdo 1	10, 30
		Debelo brdo 2	50
15	Bitovnja	Bitovnja	10
16	Drvar		30
17	Grahovo		30
18	Nevesinje	Grebak	60
		Morine	28.5

Estimation of potential for construction of wind power plants

With regard to the potential for construction of wind power plants, it is necessary to differentiate theoretically possible and economically feasible potential. Both demand a certain number of representative input data. Considering terrain complexity and wind characteristics, it is necessary to perform more measurements within a longer measurement period. Only after that and after completion of the analysis it is possible to talk precisely about the potential for the wind farm construction. Any other information would be too general and imprecise.

According to feasibility studies on the basis of measurements and analysis, the wind farms in B&H by the end of 2008 had an installed power capacity of about 200 MW. The beginning of construction of the wind farms is expected in 2009/10.

According to the evaluation of power supply companies in B&H, the electricity transfer network can undertake up to 500 MW. There are number of factors that influence the precise estimation of the potential construction of wind power plants in B&H, deficiency of the local spatial plans, among other things. According to the existing analyses the economically feasible potential should be around 1000-1200 MW.

Conclusions

The B&H has the potential for construction of wind farms. At this moment it is impossible to talk precisely about the real potential for the wind farm construction. The additional investigation is necessary to be carried out before economically justified wind power plants are build. According to our rough estimation, economically feasible potential should be around 1000-1200 MW. In any case, it would be a success to install 200 MW before the year 2015.

Apart from many interactive factors influencing the project's implementation, the beginning of construction will probably be possible in 2009/10. For a successful implementation of these potential projects, it is necessary to have unambiguous political support for defining objectives, legislative, for introducing scientific institutions in the process, making favourable economic climate, preparation of national production capacities for equipment production *etc.*

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