Oct 27th, 3:00 PM - 4:30 PM

Wind turbine technology enables sustainable development of electricity in Kosovo

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Abstract: The requirements of the EU directives for the renewable energy market, in particular wind turbines, enable sustainable development to meet the requirements for electricity generation. Global changes and environmental disasters resulting from industrial pollution do not allow a sustainable development of alternative natural resource exploitation. Balkan states and Kosovo are obliged to increase energy efficiency, to increase the discipline related to flow of fossil fuel emissions, which means less CO_2 and greenhouse gases, and to advance the renewable energies by 20% up to 2020.Wind generation turbines are used to transform energy from a rotational mechanical action to generate electricity. Wind speed is the main parameter of which is shifting in the design of wind turbines that will be located in each geographic position in the country, the number of turbines to be placed, the location and spatial distribution in the territory of Kosovo. With a new energy strategy, with a near future orientation, Kosovo could be cautiously able to spend 100% of the RES, by following the rapid steps of economic development, including the development of the relevant education system in the new fields of innovative technologies, within the developmental competences. To reach a description of the new energy strategy of Kosovo's energy potential, it would bring economic stability with respect to the development of renewable energies related to the geographic factors that have been taken into account for the generation of wind energy.
Keywords: climatic conditions, turbine, geographic position, energy strategy.

Introduction

Due to the high dependence of wind speed power (wind energy dependence on cubic speed) requires accurate wind measurement in the country. Measurements should be made using anemometers that are attached to the poles, approximately at the peak of the axis to which the wind turbines will be housed (although in recent years there has been an increase in so-called, remote measurements using LIDAR). Usually, continuously, so many columns need to be erected in the country for a period of at least six months, and it is recommended that measurements take place for some years.

Due to the high wind energy dependence, the measurements should be performed using the anemometer that is attached to the poles, approximately at the apex of the axis to which the wind turbines will be housed.

Kosovo has launched a comprehensive strategy to meet its energy demand in an environmentally sustainable manner:

• Decommission Kosovo A by 2017 to comply with the Energy Community Treaty to which Kosovo is a signatory.

• Develop the country’s renewable resources.

• Rehabilitate Kosovo B to comply with EU environmental standards.
• Private Sector investment in new electricity generation capacity.
- 500 MW and a new lignite mine.
• Privatize Kosovo's electricity distribution.
• Increase Energy Efficiency
- Energy Efficiency Law approved.
• Meet Energy Community requirements – regional energy market
- Kosovo has ratified the Energy Community Treaty and transposed EU's energy acquis as required under the Treaty into its national legislation [1-2].

Generation of Electricity from TPP

Electricity generation in Kosovo is mainly dominated by lignite-fired power plants "Kosovo A and B". These two power plants have a nominal capacity of 1,478 MW. But, because of their age, in particular the TPP "Kosovo A", the available capacity of these units is much lower than the nominal values. Together, the overall available capacity of these plants blocks is around 900 MW.
Currently, the power generated from lignite-fired power plants covers about 97% of total consumption in Kosovo [2].
Apart from TPPs, the generation is also supported by hydropower plants, like that of "Ujmani", and some smaller plants, with a capacity totaling about 50 MW, 98% of electricity generation in Kosovo comes from two old, inefficient and highly polluting lignite-fired power plants: Kosovo A (445 MW, 40 year old) in poor condition and is the worst single-point source of pollution in Europe. Proposed to be shut down. Kosovo B (550 MW, 30 years old) needs rehabilitation to meet EU environmental standards. Outages in generation and power shortages hurt households and economy. Peak capacity gap (~ 950 MW by 2017 on closure of Kosovo A) [3-4].
could be less than 8%). High commercial losses (~ 24%, should be less than 5%).

Table 1: Capacity of block of the thermal power plant in MWh

Blocks of the thermal power Plant	Capacity of block of the thermal power plant in MWh			Type of fuel	Starting year of the work (long-standing)
	Installe d	Threshold	Net available		
TC KOSOVO A					
Block A1	65	58	0	LIGNITE/FIRED OIL	1962
Block A2	125	113	0	LIGNITE/FIRED OIL	1964(44)
Block A3	200	182	110-120	LIGNITE/FIRED OIL	1970(38)
Block A4	200	182	110-120	LIGNITE/FIRED OIL	1971(38)
Block A5	200	187	125-130	LIGNITE/FIRED OIL	1975(33)
TC KOSOVO B					
Block B1	339	309	240-260	Lignite – Oil fuel	1983(25)
Block B2	339	309	200-280	Lignite – Oil fuel	1984(24)

Electricity sector in Kosovo is dominated by thermal production of KEC j.s.c., a vertically integrated system, with the exception of the transmission system that is not a part of KEC, with the overall effective capacity of 740 - 1000 MW (with an installed capacity of 1878 MW). Most of the generating capacity of KEC j.s.c. is in two thermal power plants of – Kosovo A and Kosovo B. Technically installed capacities of these two thermal power plants, despite their long-standing, approximately is between 24 - 46 years.

Two scenarios of the GDP’s rate of growth in [%] for the period 2009-2018 - Energy Sector Strategy and Legislation in Kosovo

The National Development Strategy 2016-2021 adopted by the Government in January 2016 provides four priority measures for the development of the energy sector:

1. Build new and sustainable power generation capacities;
2. Establish an open and competitive energy market;
3. Decrease energy consumption through energy efficiency measures; and
4. Rational use of renewable energy sources.

Each of these energy objectives has concrete actions behind them.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
TPP of Kosovo A	1300	1300	1300	1450	1450	950	500	0	0	0
TPP of Kosovo B	3300	3300	3300	3300	3300	3300	3300	2500	2500	3400
TPP of New Kosovo	0	0	0	0	0	0	1750	5500	7500	7500
HPP of Ujman	79	79	79	79	79	79	79	79	79	79
HPP of Zhur	0	0	0	0	0	0	398	398	398	398
Distributive HPP	42	100	125	150	175	200	210	225	240	250
Total	4721	4779	4804	4979	5004	4529	6237	8702	10717	11627

The National Development Strategy 2016-2021 was used as a basic reference for the drafting of this Energy Strategy.

Law No. 03/L-184 on Energy.

Law No. 03/L-185 on the Energy Regulator Law No. 03/L-201 on Electricity.

Administrative Instruction No. 01/2013 on Renewable Energy Targets.

Administrative Instruction No. 02/2013 on Use and Support of Energy Generation from Renewable Sources.

Law No. 2003/3 on Forests in Kosovo.

Law No. 2004/9 on an Amendment to Law No. 2003/3 on Forests in Kosovo.

Law No. 03/L-153 on Amending and Supplementing the Law No. 2003/3 on Forests in Kosovo.

The Government of Kosovo is committed to implement all obligations from the Energy Community Treaty (ECT) and the Stabilization and Association Agreement (SAA) related to the creation of a free and competitive energy market. Creation of a common energy trading zone between Kosovo and Albania, as a first step towards integration in a regional energy market, has been selected by the Government of Kosovo as one of the top priorities.

So far only three small wind turbines are connected to the grid. About 5 years ago these second-hand turbines were installed in “Golesh” with a capacity of 1.35 MW, but they are not supported by the feed-in tariffs because of old technology used.

• However, the potential of wind energy in Kosovo has been supported by the Government of Kosovo by encouraging private investment in energy from RES.

• Ministry of Economic Development (MED) has built the legal framework that sets the targets of renewable energy; the Energy Regulatory Office (ERO) has built the regulatory framework and has determined the feed-in tariffs for RES.

• The feed-in tariff with which the manufacturer sells power produced from wind farms is 85 EUR/MWh. The biggest wind energy park in Kosovo 35 MW – first phase of the plan.

It will help in achieving the targets of the Renewable Energy established by the Ministry of Economic Development - 25% by 2020.The project will be a great support, in particular for the development of the production and industrial sector[3-4].

• Reducing unemployment.

• Lowering import electricity.

• Increase security for electricity.

• Contribute to lowering the carbon footprint on atmosphere and reduce air pollution.

Determination of Wind Location for Power Plants

Due to the high dependence of wind speed power table 1 (wind energy dependence on cubic speed) requires accurate wind measurement in the country.

Table 1: Sensitivity to the production of electricity at wind speeds

Wind speed m/s	**Wind speed in normal operation of 6 m/s**	**Energy production of 10MW Wind Farm (Mwh/year)[2]**
5	83	11.150
6	100	17.714
7	117	24.534
8	133	30.972
9	150	36.656
10	167	41.386
	Electricity production in normal operation pre 6 m/s (%)	Consumption capacity Of 6 m/s part (%)
	63	100
	100	100
	138	102
	175	105
	207	110
	234	120

The wind farm is planned to be implemented in cadastral boundaries of Zborc figure 2, Lower Godanc and Upper Godanc, in a space of about 300 Ha.Usually, continuously, so many columns need to be erected in the country for a period of at least six months table 2, and it is recommended that measurements take place for some years.

Figure 2: Map of location of Wind Park in Shtimje

Table 2: The results of the wind measurement in monthly increments

Measurement of wind speeds for each month in Shtimje													
Month	January	February	March	April	May	June	July	August	Septemb.	October	November	December	Mes.vjet%
m/s	7.5	7.5	7.6	7.2	6.5	6.0	5.5	5.5	6.0	6.0	6.5	6.9	**6.5**

Meteorology of wind

Measurement of wind speeds for each month in Shtimje

The basic driving for ceofai rmovementis a difference in air pressure between two regions. This air pressure is described by several physical laws. One of these is Boyle'slaw, which states that the product of pressure and volume of a gas at a constant temperature must be a constant, or $p_1V_1 = p_2V_2$. Another law is Charles'law, which states that, for constant pressure, the volume of a gas varies directly with absolute temperature.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad (2)$$

If a graph of volumeversus temperature I smade from measurements, it will be noticed that a zero volume state is predicted at -273.15^{o}Cor0K.Thelaws of Charlesand Boylecanbe combined into the *ideal gas law.*

In this equation, R is the universal gas constant, T is the temperature in Kelvins, $V$is the volume of gasin m^3,n is the number of kilomoles of gas, and p is the pressure in Pascals(N/m^2).

At standard conditions, 0^{o}Cand one atmosphere, one kilomole of gas occupies 22.414$m^3$and the universal gas constant is 8314.5J/(kmol·K)where J represents a joule or a newton meter of energy. The pressure of one atmosphere at 0^{o}C is the n

$$\frac{(8314.5J/(kmol \cdot K))(273.15K)}{22.414\, m^3}=101.34 \text{ Pa} \tag{4}$$

Thes eregionsare formed by complex mechanisms, which are still not fully understood. Solar adiation, surface cooling, humidity, and the rotation of the earth all play important roles [3-4].

$$pV= nRT \tag{3}$$

Technology of wind turbine

Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor figure 3. The rotor is connected to the main shaft, which spins a generator to create electricity [5-6].

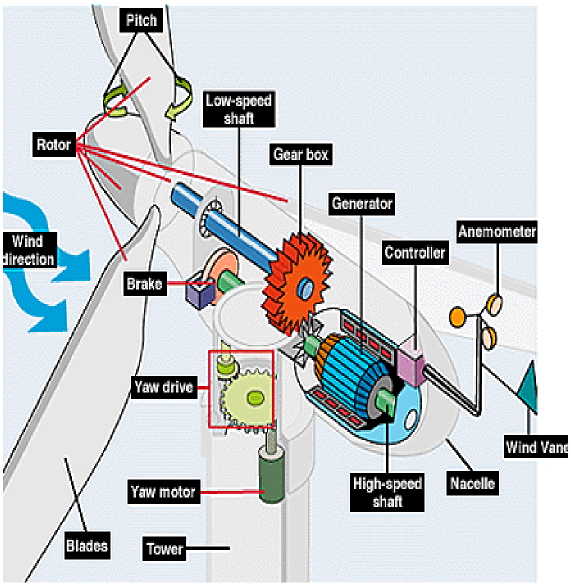

Figure 3: The peripheral parts of the generator

The future of wind turbines technologies

Modern wind turbines are increasingly cost-effective and more reliable, and have scaled up in size to multi-megawatt power ratings. Since 1999, the average turbine generating capacity has increased, with turbines installed in 2014 averaging 1.9 MW of capacity. WETO research has helped facilitate this transition, through the development of longer, lighter rotor blades, taller towers, more reliable drive trains, and performance-optimizing control systems. Over the last two decades, the program has worked with the industry to develop a number of prototype technologies, many of which have become durable commercial products [7].

The future of wind turbines – no blades

It’s no longer surprising to encounter 100-foot pinwheels spinning in the breeze as you drive down the highway. But don’t get too comfortable with that view. A Spanish company called Vortex Bladeless is proposing a radical new way to generate wind energy that will once again upend what you see outside your car window. Their idea is the Vortex, a bladeless wind turbine that looks like a giant rolled joint shooting into the sky. The Vortex has the same goals as conventional wind turbines: To turn breezes into kinetic energy that can be used as electricity. But it goes about it in an entirely different way. Instead of capturing energy via the circular motion of a propeller, the Vortex takes advantage of what’s known as vorticity, an aerodynamic effect that produces a pattern of spinning vortices. Vorticity has long been considered the enemy of architects and engineers, who actively try to design their way around these whirlpools of wind. And for good reason: With enough wind, vorticity can lead to an oscillating motion in structures, which, in some cases, like the Tacoma Narrows Bridge, can cause their eventual collapse [8-9].

Figure 4: The Vortex of wind turbine being developed without any blades.

The standard Wind spire figure 5 is 30-feet tall and 4-feet wide, designed to come in under the typical 35-foot height restrictions of local municipalities. Due to the vertical axis design, sound levels were tested at 6 decibels above ambient, rendering it virtually inaudible and the 1.2kW Wind spire installed at the farm will produce approximately 2000 kilowatt hours per year in 11 mph average wind [10-13].

Figure 5: Wind spire vertical Axis Turbines

Quiet Wind Turbines

The Eco Whisper wind turbine. This sharp-looking little contraption may only have a 20 kW generating capacity figure 6, but the company claims that the turbine is "virtually silent". It's also, allegedly, more efficient [9-10].

Figure 6: Quiet Wind Turbines

The company that has design this technology, said the turbine is "virtually silent," thanks to its unique design, in which the 30 blades are angled outward from the hub, and surrounded at their ends by a ring. This ring, the company says, "prevents air 'spilling' off the tip of the blades," the source of much of the noise that traditional turbines produce. The company also lists greater efficiency and lower start-up speeds as advantages compared to competitors [13-15].

Conclusions

Wind speed is the main parameter of which moves in the design of the wind turbines to be located in the country, the number of turbines to be installed and the spatial distribution. Wind speed also serves as a starting point for all calculations on the feasibility and potential of energy during economic output. The sensitivity of the power contribution depends on the wind speed and subordinates over the wind speed presented with the appropriate data as in the table.

This makes it particularly important in order to accurately measure wind speed in countries where this rate is lower.
It should also be emphasized that it is important to take notes of wind speeds for longevity and air density in locations where the intensity of wind turbulence for certain locations is constant, which in itself impacts wind energy production, but it will also affect the pre-determination of the energy load on rotor blades in a way that the wind generator to be with a fixed life expectancy.
Two methods are used for long term forecasting of wind potential at locations:
1. Location data are collected from the collection of long-term data with reference points of metrological station data.
2. Use of data, in particular, from measurement of location.
Wind turbine technology brings sustainable development,
Kosovo has a suitable geographic position for the exploitation of this resource RES,
The new innovation technology increases the generation capacity
Kosova has the necessary legislation feed in tariff for wind energy
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For certain locations the importance is the direction of the wind from which the wind blows (windmill) in order to determine the optimum value of the wind generators, so that maximum wind can be used in all directions.

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