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THE CONTRIBUTION OF THE WIND SOURCE IN THE PRODUCTION OF ELECTRICITY - CASE STUDY FUSHË-MILOT KURBIN AREA, ALBANIA

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1. THE CONTRIBUTION OF THE WIND RESOURCE TO EU AND NATIONAL ENERGY POLICIES

The continuous increase in energy demand and consumption of fossil fuels is accompanied by the emission of large and increasing amounts of CO_2 into the atmosphere. As a result, it is estimated that the temperature on earth will rise by **1.5 °C between 2030 and 2050**

In EU in **1997**, RE contributed with only **6%** of the total energy consumption. RES strategy was adopted that year and EU countries contribution of RE to the total energy consumption went up to **12% by 2010**. The target for the contribution of RE to electricity production was **21% by 2010.**

By 2030 EU should reduce emissions of GHGs by **40%** vs. 1990 emissions, and by building a competitive low-carbon economy, by **2050**, reduction of GHGs should go to **80%-95%**.

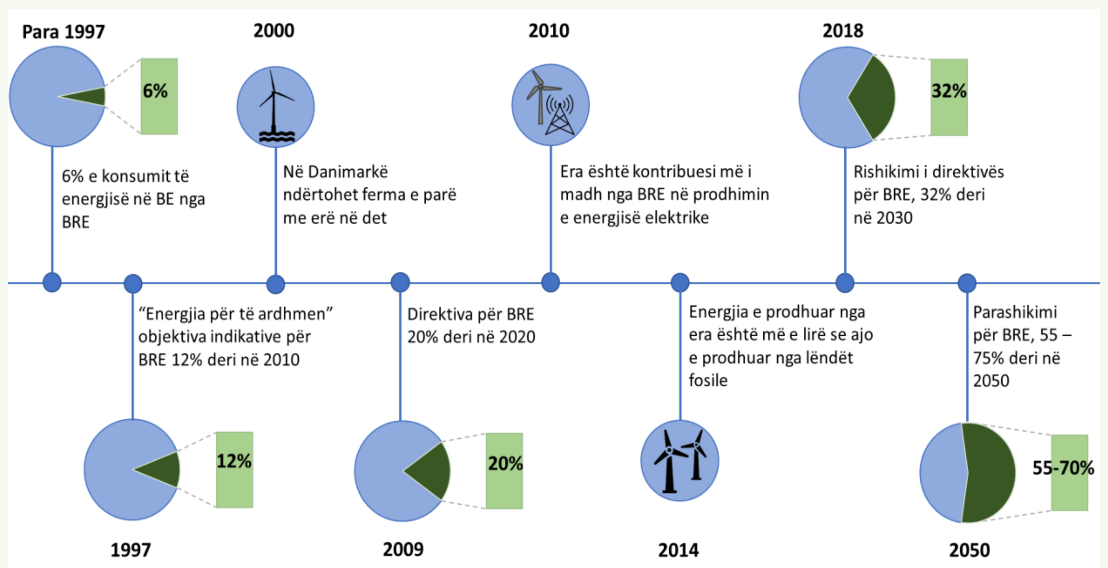


Figure 1. Development of EU RES targets and the role of wind energy [Source: EC 2020, adapted by author]

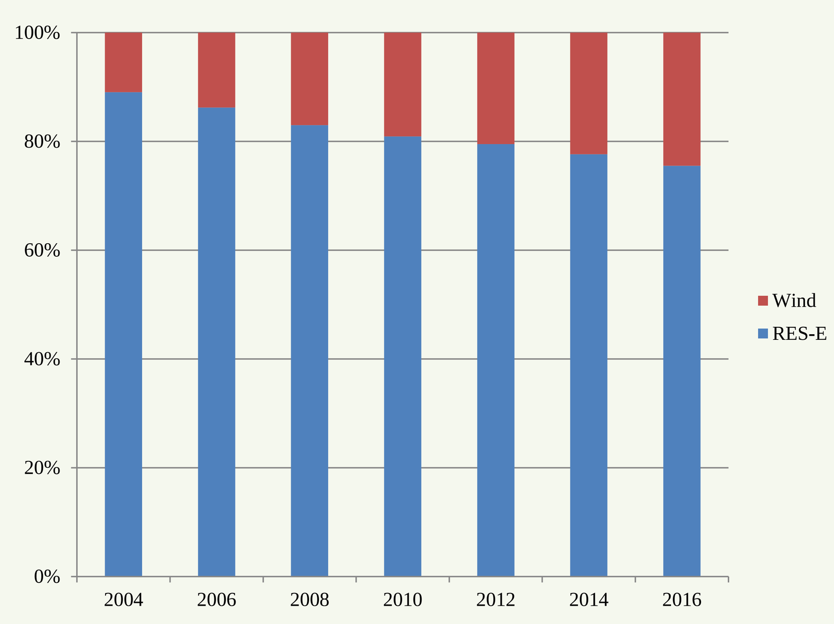


Figure 2. Wind's contribution to RES electricity production [Source: EC 2020, adapted by author]

Table 1. Forecast for the expansion of installed capacities for the generation of electricity from RES [Source: Energy Community 2020, adapted by author]

Estimated capacity (MW) for energy production from RES	2015-2020	2018 - 2020	2019 - 2020
Hydro	750	600	57
PV	50	120	490
Wind	30	70	150
Biomass	0	8	41
TOTAL	830	798	738

Table 2. Price for electricity production from RES plants. [Source: ERE 2020, NREP 2018-2020]

The RES technologies that are applied	Tariffs (feed in) €/MWh
PV modules with installed capacity of electricity up to 2 MW	100
Wind turbines with installed capacity of electricity up to 3 MW	76
Small HPPs with installed capacity up to 15 MV	69

3. THE AREA UNDER STUDY

- ***The Fushë - Milot Kurbin area***, it is planned to be used to build a wind park with a capacity of 24 MW. 8 Siemens SWT 113 turbines, each with a power of 3 MW will be installed at a height of 92.5 m.
- **Figure 3** shows the map of the area with the distribution of the average wind speed at a height of 100 m, and **Table 4** provides the main technical data of the project.
- Table 5 summarizes the technical information for the area. It presents an average speed of about 4.9 m/s. The wind speed is distributed in the area in different values, which vary from 4.9 - 5.4 m/s. In the graph if we look at 10% of the best windy areas in this region we will identify the average speed 5.28 m/s.
- The power density in the 10% of the best areas, in the region we are studying, at a height of 100 m is 450 W/m². The dominant wind direction is North-East and South-East. The wind speed index is highest during the months of January, February and December. These are the best months for using wind energy in this region.

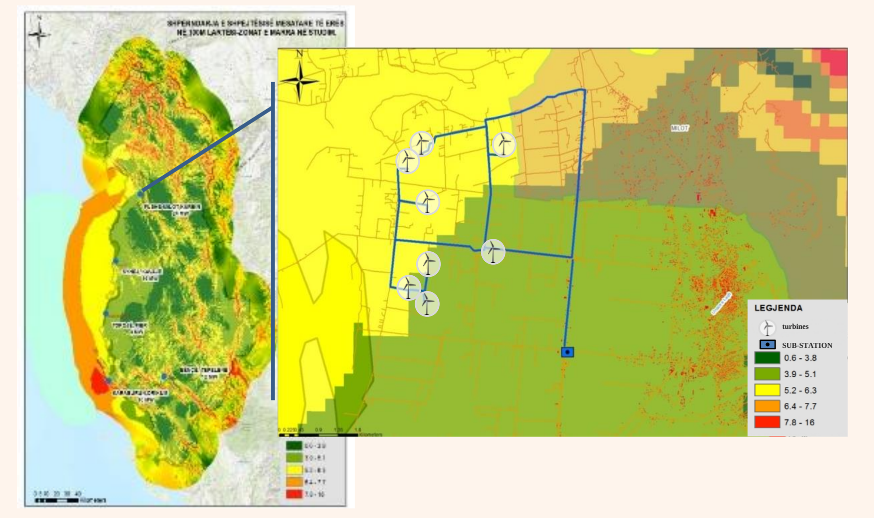
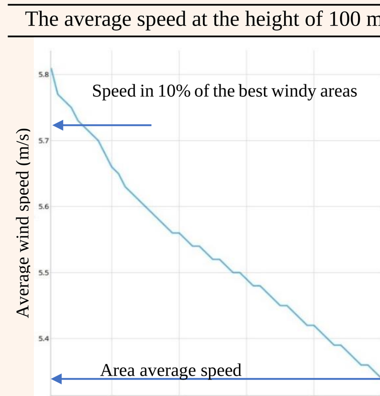
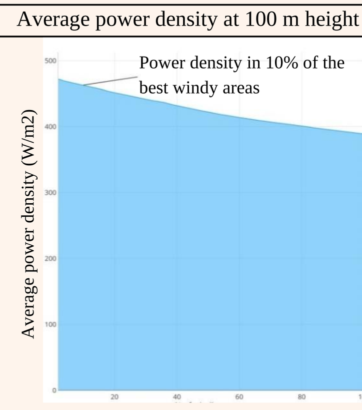
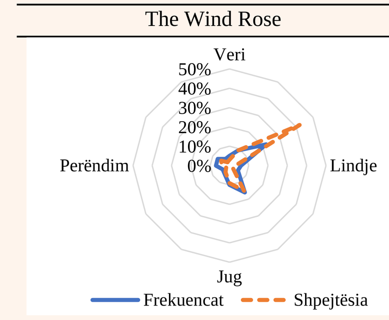
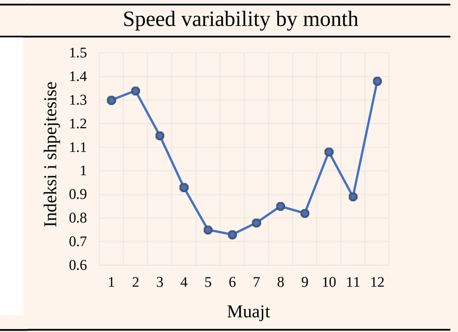


Figure 3. Distribution of average wind speed at 100 m height in the area of Fushë – Milot Kurbin

Table 4. Technical data for the proposed project in the area of Fushë- Milot Kurbin

Zone	Fushë – Milot Kurbin
Installed capacity	24 MW
Number of turbines and their capacity	8 x 3MW
Type of turbines	Siemens SWT 113
The height of the turbines	92.5 m
Rotor diameter	113 m
Average speed in 100 m	5.34 m/s
Average speed in the best areas	5.73 m/s
No. of wind hours	3000
Dominant direction	N-E-S-E
Connection point and distance from the network	110 kV Laç – Fushë Kuqe

Table 5. Average speed, frequencies, wind density at 100 m height and their variability in the Fushë-Milot Kurbin area

The average speed at the height of 100 m	Average power density at 100 m height
	
The Wind Rose	**Speed variability by month**
	

2. METHODOLOGY

The calculations of all technical, economic and environmental parameters were carried out with the RETScreen Expert program in the absence of field measurements.

1. **Energy Analysis:**

Net energy (MWh) produced by the wind:

$$E_{neto} = E_{gross} \times C_{losses} \quad (1)$$

Gross energy (MWh) that a turbine produces:

$$E_{gross} = (24 \times 365) \sum_{v=0}^{25} P_v f(v) \quad (2)$$

Loss coefficient (a result of mutual influence (1.5%), air losses (1%), technical losses (3%) and losses (0.03%).

$$C_{losses} = (1 - 0.15) \times (1 - 0.01) \times (1 - 0.03)(1 - 0.0003) = 0.9 \quad (3)$$

Capacity factor of the plant :

$$CF = \frac{E_{neto}}{(24 \times 365) \times Cap.Plant} \quad (4)$$

Specific output of the plant (kWh/m²):

$$Y = \frac{E_{neto}}{(No._{turbines} \times Area_{rotor})} \quad (5)$$

2. **Economic analysis:** The program analyzes in detail initial costs, annual costs, annual savings and periodic costs. The program suggests the percentages that each of these costs occupies in the total cost of a project for a large or small capacity wind farm.

Table 3. Analysis of initial costs for small and large wind farms. [Source: RETScreen]

Type of cost	Small plants	Large plants
Feasibility study	1 - 7%	< 2%
Development	4 - 10%	< 1 – 8 %
Engineering	1-5%	1 - 8%
The electrical system	47 - 71%	67 - 80%
System balancing	13 - 22%	17-26%
Others	2 - 15%	1 - 4%

3. **Environmental analysis:** This analysis is based on two scenarios.

The baseline scenario calculates the net emission of greenhouse gases (GHGs) that would be emitted into the atmosphere if the same amount of energy were produced in an alternative way from a conventional plant. In this scenario, it is assumed that the entire amount of energy produced in the area comes from an imaginary plant that works with fuel in the ratio of 30% natural gas and 70% diesel.

4. **Financial analysis:**

This analysis provides information on the viability of a project. It uses as input data: *inflation, discount rate, project life, grants or incentives, loan level, loan, capital, loan interest rate, loan duration and its payment*. The results of the financial analysis are *internal rate of return (IRR), return on capital, net present value, life cycle savings, cost benefit ratio, debt coverage and energy production cost*.

4. ANALYSING THE RESULTS

The areas have a considerable technical potential for the use of wind energy. It has a positive ***net present value*** and a ***benefit-cost ratio greater than 1***. Investment payback time 4.7 years. The total amount of electricity produced by this plant is calculated at 50 GWh/year, with a cost of €0.047/kWh. The total emission reduction for all proposed projects is 965,000 tCO_2 per year.

Table 6. Results of the energy analysis for the Fushë Milot project, Kurbin

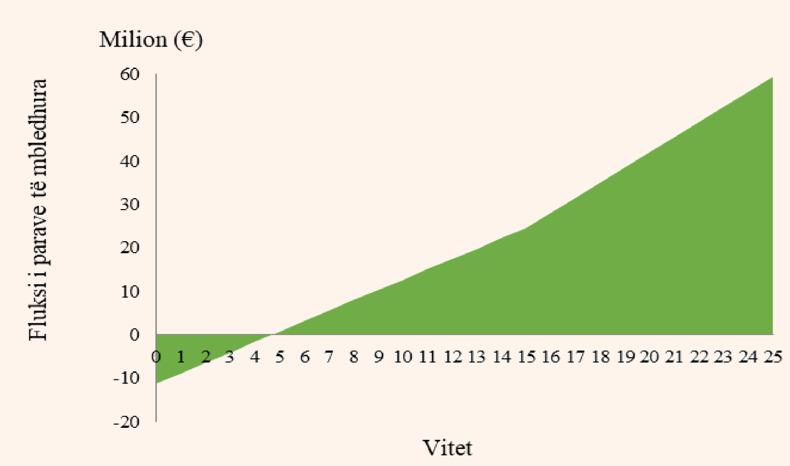
Energy production results for the proposed plant in Fushë Milot - Kurbin	
Net energy per turbine (MWh)	6,823
Loss ratio	0.9
Capacity factor (%)	23.5
Turbine efficiency kWh/m²	617
Electricity produced annually by the plant (MWh/year)	49,326

Table 7. Results of the environmental analysis for the Fushë Milot project, Kurbin

GHG reduction results for the proposed plant in Fushë Milot - Kurbin	
Amount of emissions for the base case	41,945.9
Amount of emissions for the proposed case (tCO_2)	3,357.7
Reduction of annual emissions (tCO_2)	38,588.2
Reduction of emissions throughout the life cycle (tCO_2)	964,705

Table 8. Results of the financial analysis for the Fushë Milot project, Kurbin

Financial results for the proposed plant in Fushë-Milot Kurbin	
Total investment cost (€)	22,565,547
Internal rate of return on capital IRR (%)	21.6
Internal rate of return on assets IRR (%)	10.4
Payback period of initial investment (years)	6.3
Years of capital return (year of positive flows in years)	4.7
Net present value (€)	14,152,588
Annual Lifetime Savings (€)	1,440,822
Benefit-cost ratio	2.3
Debt coverage (years)	3.1
Electricity production cost (€/kWh)	0.047



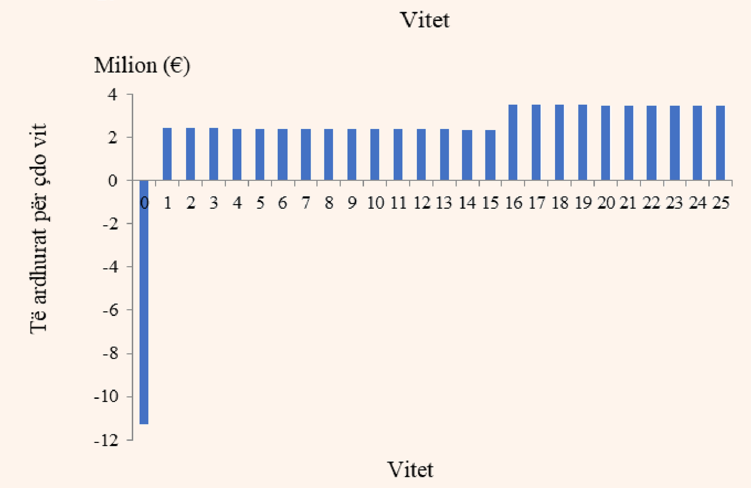


Figure 4. Income flows for the project in Fushë – Milot Kurbin

5. CONCLUSIONS AND RECOMMENDATIONS

Wind energy, among all renewable energy sources, occupies a significant place in the energy market. The main benefits of wind-generated energy are the environmental advantages, compared to energy generated from traditional fuels. Moreover, the cost of producing electricity from wind is the cheapest compared to other energy sources, as from fossil fuels.

The main barriers faced by investors toward investing in wind energy farms construction are summarised to be:

(i) lack of long-term data and measurements in the areas of interest for the use of this energy,
(ii) high investment costs and uncertainty about the income and expenses of these projects
(iii)lack of effective support schemes if the cost of wind power production is higher than the market price of electricity.

Based on the results of this case study for further research it is recommended:

(i) The design and implementation of concrete projects aimed at a detailed assessment of the wind source in the area studied as the most interesting for the use of this energy.
(ii) More detailed assessment of the wind source, based on monitoring with field measurements of wind speed. This is the main element to determine the financial viability of a wind energy project.
(iii) Drafting favorable policies for the use of RS in general and the wind source, to create more security for investors.
(iv) The construction of effective financial support schemes and the creation of successful business models per exploitsesource source teeres