ENERGETIC STUDY FOR RENEWABLE SOURCES IN KARABURUN'S PENINSULA

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Abstract

Considering the importance of studies, the projects and research activities made in this area in this study a complementary energetic base method is performed. The potential contribution of renewable energy is analyzed, using short term data and long term data. Calculations for wind and solar are made using long term data, (1981 to 2014), for a typical meteorological year. For implementation of renewables energies one of the solution is a hybrid system hydro-solar-wind. The operation of this system is to be based in the complementarities between the two sources, solar and wind, and existing hydro power and wind. This method is a reference for application of more complex methods. Monthly average data allows the comparison of renewable resources with different characteristics of intermittency and variability. The results show a good complementarity between the two sources of solar and wind energy.

Key words: complementary, hybrid system, long term data, energetic method.

Introduction

The Karaburun Peninsula is a peninsula of the Mediterranean Sea located in Southern and Southeastern Europe, which is almost completely surrounded by the Adriatic Sea to the north and the Ionian Sea to the south. Karaburun's peninsula is located in southwestern part of Albania (40.39° N; 19.34° E; altitude 88 m; air density 1.211 kg/m^3. Due to the harsh terrain the peninsula has been completely uninhabited.

But today it has become a tourist attraction and in addition a renewable energy attraction for projects. The energy potential deriving from adaptable climatic conditions makes the peninsula a strategic starting point for significant wind power projects at 10MW, while solar power is only discussed for the potential [http://energjia.al/2018/04/12]. Such energy projects in the region are strongly applied, while Albania does not yet have significant renewable energy parks. About 97 percent of domestic production continues to be from hydropower. The development of the energy sector in other sources is also not favored by the state of the transmission system, which needs more investment to enable "with independent producers". Utilizing wind or solar energy would save Albania's rivers more than hundreds of hydropower projects. Wind and solar power provide options for electricity generation in windy and sunny regions. However, the variable nature of wind and solar power production limits their ability to be independent from conventional fossil fuels. Multiple generators or a storage system can reduce the uncertainty and variability of their output.

Reduced intermittency can be achieved by installing large wind farms or by complementary of the output of wind and solar systems. In this study we assumed the use of wind turbines with the maximum of hub heights determined from fabrication is 50m. In order to accurately evaluate the wind energy potential of the region and clarify its characteristics, it is required to carry out long-term meteorological observations for the location under consideration. To determine the potential for wind in the area, as no on-site observations with wind turbine were performed for this study, typical meteorological thirty-four years data was used to estimate various turbine outputs at the site of Karaburun. A long term data, consist in thirty-four years (1981 to 2014) of hourly mean wind data, which was adopted and analyzed. For solar radiation The SolarGIS database is used for solar calculation. The SolarGIS database is a high resolution database. The data is calculated using in-house developed algorithms that process satellite imagery and atmospheric and geographical inputs.

Methodology

Karaburun's peninsula is located in southwestern part of Albania (40.39° N; 19.34° E; altitude 88 m; air density 1.211 kg/m^3. The wind power plant will have a capacity of 13 MW. Albanian authorities aim at encouraging such investments that help to reduce dependence on hydropower and network losses and to delocalize energy production from the north to the south [Serdari E., *et.al,* (2015)]. In the study we assumed the use of wind turbines with the maximum of hub heights determined from fabrication, generally from 50m. In order to accurately evaluate the wind energy potential of the region and clarify its characteristics, it is required to carry out long-term meteorological observations for the location under consideration. To determine the potential for wind in the area, as no on-site observations with wind turbine were performed for this study, typical meteorological thirty-four years data was used to estimate various turbine outputs at the site of Karaburun. A long term data, consist in thirty-four years (1981 to 2014) of hourly mean wind data, which was adopted and analyzed in Figure 1.

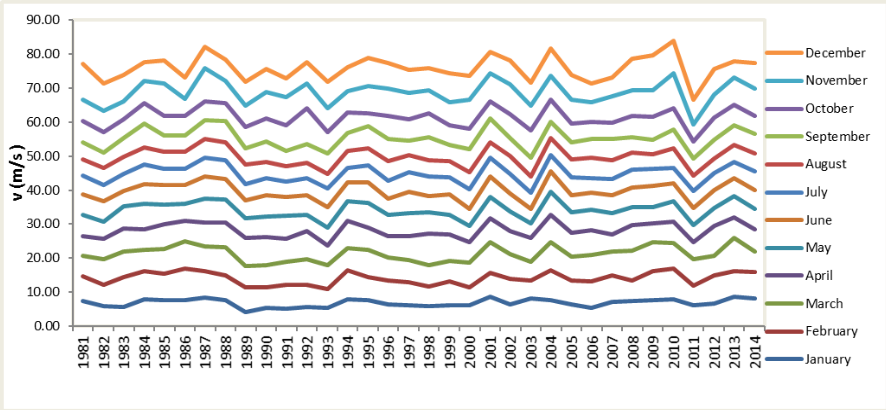

Figure 1. Monthly average velocities in m/s from 1981 to 2014

In the figure 2, Weibull probability density function from calculations is given. Weibull parameters k and c are between 1.56 ≤ k ≤ 1.77 and 6.26 ≤ c ≤ 7.84 m/s. The annual mean wind speed is between 5.58 and 7.02m/s at 50 m height [Serdari E., *et.al* (2017)]. The monthly mean wind speed has a variation 4.99 to 7.38 m/s at 50 m height.

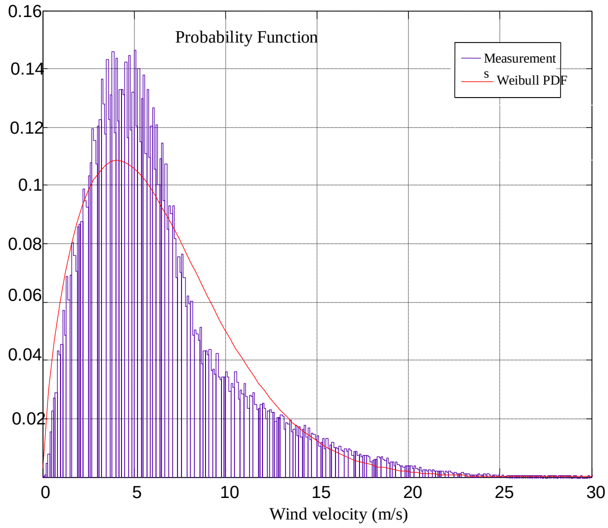

Figure 2. Weibull probability function and measurements

For the solar data is calculated using in-house developed algorithms that process satellite imagery and atmospheric and geographical inputs. Uncertainty of SolarGIS Global Horizontal Irradiance GHI and Direct Normal Irradiance DNI yearly summaries for 80% of observations is within the range of ±4% and ±8% (±5% and ±10% for 90% of observations), respectively. In complex geographies and extreme cases, uncertainty of GHI and DNI yearly summaries can be as high as ±8% and ±15%, respectively. PvPlanner is a tool for calculate PV electricity potential with accuracy. It is the best choice for site prospection. It is also the ideal tool for comparing energy yield from various PV technology options (e.g. crystalline versus amorphous silicon modules) and benefits from different mounting systems.

Simulations methods used in PvPlanner are scientifically validated. In PvPlanner, photovoltaic power production is simulated using numerical models developed or implemented by GeoModel using aggregated data based on 15-minute time series of solar radiation and air temperature data as inputs. Data and model quality is checked according to recommendation of IEA SHC Task 36 and EU FP6 project MESoRstandards [http://solargis.info/].

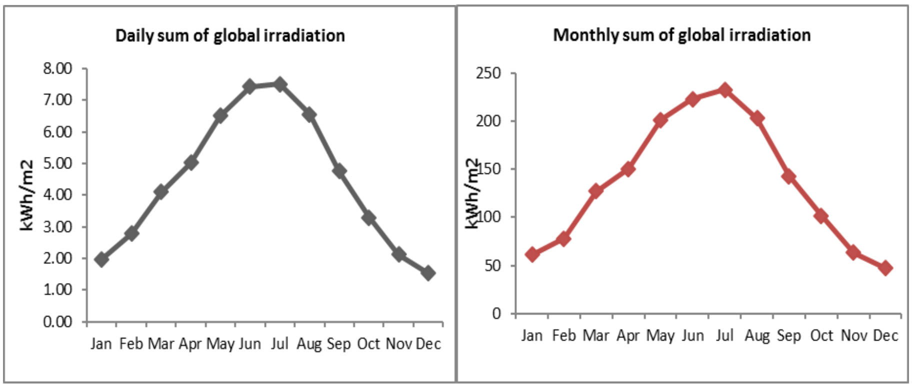

Figure 3. Variation of daily sum and monthly sum of Solar Irradiation

Results and discussion

For the annual energy output, the chosen wind turbine will have the highest capacity factor, defined by the ratio of the actual power generated to the rated power output. Estimation of the wind speed distribution with a Weibull distribution and with a modified Weibull was compared to actual wind speed measurements from the site. This is done at a 50-m measurement height [Mitrushi D., *et. al* (2019)].

Table 1: Energy output and characteristics for different wind turbines

Turbine Types	**Rotor diameter (m)**	**Hub Height (m)**	***v* in (m/s)**	**Pmax**	**Power Input (W/m^2)**	**Power output (W/m^2)**	**Energy output ($kWh/m^2/year$)**	**Energy output (kWh/year)**
Bonus 33.4Mk 300kW	33.4	40	12.2		448	113	990.558	867886
Bonus 44 Mk 600 kW	44	55	12.8		516	123	1078.218	1639464
Bonus 1000/54 1000kW	54	70	13.2		572	138	1209.708	2770499

Bonus 1300/62 1300kW	54	68	13.2	565	183	1604.178	3673922
Vestas V47 660kW	47	55	12.8	516	126	1104.516	1916274
Vestas V29 225kW	29	31.5	11.7	398	105	920.36	607962
Wind World 170/27	27	41.5	12.3	453	89	780.174	446693
Wind World 600/42	42	62.5	13.0	543	126	1104.516	1530243

For monthly wind energy production values varies between 367kWh/m^2 in January the lowest value is 199,13kWh/m^2 in July, and the maximum value in march 572kWh/m^2. The calculations were performed for Vestas 47 V Model. The energy output of photovoltaic systems is calculated by considering the amount of solar radiation that arrives at the surface of the photovoltaic modules. Performance ratio is calculated as: [Mitrushi D., *et. al* (2016)]

$$PR = \frac{Energy\ Production}{Exepted\ Energy} = \frac{E_{AC}}{G_h + S + \eta_{St}} \quad (1)$$

From the calculations using optimum inclination angle, the results for daily sum of GHI was 4.48 kWh/m^2, global in-plane irradiation was 5.11kWh/m^2. Daily sum of electricity production varies between 4.01kWh/kWp for c-Si modules, for a-Si modules 4.01kWh/kWp. Annual average for electricity production is 1462kWh for c-Si modules and 1518kWh for a-Si modules. In the figure 4 average monthly sum of global irradiation is given. As it is expected the peak is in July that correspond to the minimum of wind production. Wind energy production has a variation slowly complementary for April and May and the complementarity is good for the months of November December and January.

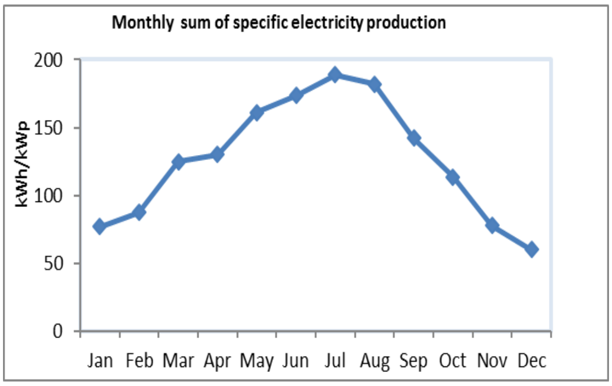

Figure 4. Average monthly sum of global irradiation for different types of surfaces

We can conclude:

For different modules of solar cells annual average electricity production has been calculated.

For different types of wind turbines Energy output (kWh/m^2/year) and (kWh/year).

For the site selected wind potential is highly observed, solar potential energy is calculated to be good, but the terrain for solar plant is inappropriate.

Wind and solar energy were observed to be highly complementary on an annual basis, and monthly this is more a specific for winter season.

References

A new solar radiation database for estimating PV performance in Europe and Africa Avalaible on: http://solargis.info/doc/about-pvplanner

http://energjia.al/2018/04/12/vjen-aplikimi-i-pare-per-central-me-ere-ne-shqiperi

Mitrushi D., Serdari E., Berberi P., Bërdufi I., Muda V., Topçiu D. (2019): Feasibility study of impact of wind energy potential in Karaburun's area in Albania. AIP Conference Proceedings, DOI: 10.1063/1.5099034

Mitrushi D., Berberi P., Bërdufi I., Muda V., Topçiu D., Buzra U. (2016): Use of satellite solar data for assessment of performance of photovoltaic systems installed in different regions of Albania. AIP Conference Proceedings DOI: 10.1063/1.4944284

Serdari E., Berberi P., Puci I., and Halili M. (2015): Potential estimation and GHG estimation of a wind power system in Albanian South Coast. International Journal of Ecosystems and Ecology Science, Vol. 3: 453-458

Serdari S., Berberi P., Muda V., Buzra U., Mitrushi D., Halili D. (2017): Wind Profile Characteristics and Energy Potential Assessment for Electricity Generation at the Karaburun Peninsula, Albania. Journal of Clean Energy Technologies. No. 4, Vol. 5: 310-313