International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 12, December - 2013

Power Supply of Consumers by the Group of Low Power VAWT

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Abstract

It was compared the work of wind farms, consisting of a vertical-axis and horizontal-axis wind turbines of equal power, with approximately equal swept area. It was estimated the efficiency of use land areas to be allocated for the construction of vertical-axis wind turbines, as well as of horizontal-axis wind turbines. It was counted the value of potential output possible horizontal axis and vertical axis wind turbines, depending on the speed of the wind flow. It was made a comparison of the total usable capacity for the considered types of wind turbines installed in an area of 1 km^2, depending on the speed of the wind flow. It was described a successful implementation of the project in the "Baikal harbor"

1. Introduction

The main load for sports complex "Neprjahino" South-Ural State University (SUSU) are: lighting, heating, household appliances and heating.Permissible load is - 360 kW [1].

2. Calculation of wind speed

It was analyzed wind data considered locality (village Neprjahino, Chelyabinsk region) to determine the feasibility of the project supply consumers with a group of wind turbines (WT).

The data for analyze was taken from the web-site www.wunderground.com for weather station at the airport "Balandino" (Chelyabinsk). Because this weather station is located in an area with a wind "Neprjahino".Obtained values of wind speed can be used for further calculations. [2]

It was evaluated parameters of the random variable using Pearson on the basis of annual values of wind speed. As a result, it was found that the distribution of wind speeds within one calendar year featured satisfies the normal distribution.

The calculated results indicate that the 95% probability it can be argued that the value of the random wind speeds in Neprjahino will be in the range of 3.522 m/s– 3.888 m/s.

These speeds are considered to be minimal for the horizontal-axis wind turbines (HAWT) and their application in this case is inappropriate. Currently, however, there vertical-axis wind turbines (VAWT) produced by LLC "SRC-Vertical", Russia [3], which at this rate may already generate electricity.

3. Calculation of wind farm capacity

It should be noted that it is very important to determine optimal configuration and density of placement wind turbines in a wind farm. It is necessary to exclude wind shielding of wind turbines from each other, consumers consider location, distance from electrical networks and access roads, terrain and other conditions.

It was made comparative evaluation of the effectiveness of the use of wind resources on limited land areas at approximately equal swept area for VAWT (12.92 m$^{2)}$, and HAWT (12.8 m$^{2)}$ equal to 3 kW. [3]

Diameter VAWT is D = 3.4 m, diameter HAWT is D = 4 m, the minimum distance between adjacent wind turbine is assumed equal to n = 10 of rotor diameter. Thus, it was found that 1 km ^{2} of land area can accommodate 865 VAWT and 625 HAWT in the case of their location in the nodes of a square grid with a side of a square $n \cdot D$, or 999 of VAWT and 721 of HAWT in the case of their location in the nodes of a regular triangular grid with sides of the triangle $n \cdot D$.

Thus, we can conclude that the use of VAWT allows efficient use of the land area allocated for the construction of wind turbines group than in the case of HAWT.

However, the main criterion for the efficiency of the group of wind turbines is a power that they can produce for consumers.

In respect that the known potentially possible power multiplier and the maximum permissible density of wind turbines as part of a wind power plant, is: for HAWT - 20384 kW for VAWT - 26390 kW for the total maximum net power developed by the wind turbine installed on an area of 1 km^{2,} with a wind speed of 10 m/s.

The maximum total power developed established on an area of 1 km^2 of modern wind turbines at wind speeds of the order of their speed control and maximum density of their placement as part of wind farm is: for HAWT - 2.7 MW/km ^{2} for VAWT - 1.9 MW/km ^{2} based on actual wind conditions

However, considering the fact that for VAWT can shorten the distance between adjacent wind turbines as part of wind farm through the placement of the wind wheel on the masts of different heights, the maximum total power developed by the VAWT are increases at area of 1 km^2.

Thus, the total output of VAWT on 1 km ^{2} and is 7.9 MW/km^2 (for n = 5 rotor diameters).

After analyzing the data andconsidering possible solutions to optimize the placement of VAWT when placing wind turbines on towers of different heights, we can say that a wind farms consisting of VAWT in a limited area at a lower wind speed can producemuch more electricity than wind farms consisting ofHAWT. It is very important criterion in the South Ural.

4. Choice of generator

It was decided to use synchronous generators for VAWT because it’s required small wind turbines (up to 30 kW) for power supply in the sports complex "Neprjahino" and possible modes of operation with no connection to the system.

5. Smart Grid technology for the project

Moreover,for the project it’s should be the implementation of Smart Grid technology to optimize and improve the effectiveness of the system because the electric network is always constructed as a one-way data transfer system [4]

6. Project in "Baikal harbor"

It wasmade a group VAWT in the special economic zone "Baikal harbor" in the Baikal region (Republic of Buryatia, Russia) on the basis of theoretical research.

For implement of the project it was carried out analysis of annual wind areas, on the basis of which it was decided to use VAWT in the construction of wind farm.

The VAWT works in parallel with the grid. The wind farm is used as a backup power source and for continuous power supply for low power devices. Object is successfully commissioned and accepted by the customer.

7. Conclusion

Successful implementation of the project "Baikal harbor" lead to the conclusion of the possibility to create a wind farm in "Nepryahino".

8. References

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