International Journal of Advanced Research in Management and Social Sciences
ISSN: 2278-6236
Impact Factor: 7.624

EVALUATION OF THE EFFECTIVENESS OF THE USE OF WIND TURBINES WITH A HORIZONTAL AND VERTICAL AXIS.

G.U. Bafoyeva , NematovSh.N.

ABSTRACT:

This article presents the possibilities of using wind energy in the consumption of electricity and the current situation in the use of this energy. In the effective use of wind energy, the correct selection of the type of wind energy devices, the advantages and disadvantages of horizontal axis and vertical axis wind energy devices are presented.

KEYWORDS: wind energy device, vertical axis, horizontal axis, electricity production capacity.

Nowadays, the high reliability of electricity is a very important factor for the improvement of human lifestyle. But today, the increase in the use of fuel energy resources and their limited reserves, along with reducing the amount of greenhouse gases in the atmosphere, the development of renewable energy sources requires the fulfillment of huge tasks for mankind. The potential of renewable energy sources around the earth is very large, the use of these energy sources can be very effective at the time when the demand for energy resources in the world is increasing and the environmental situation is changing in a negative direction [1].

Among the renewable energy sources, the use of wind energy is also widely popular nowadays. According to the information provided by the Organization for Economic Cooperation and Development, in 2017, 25.5% of the world's renewable electricity was produced through wind turbines. From 1990 to 2017, wind power increased from 3.8TWh to 696.9 TWh/h, with an average annual growth rate of 21.2%. This figure is the second fastest growing renewable energy source after solar photovoltaic modules. In 2017, the production of wind energy reached the highest level in Europe, that is, 53.3% of the total volume of production, and compared to the value in 1990, an average increase of 25.7% per year was observed.

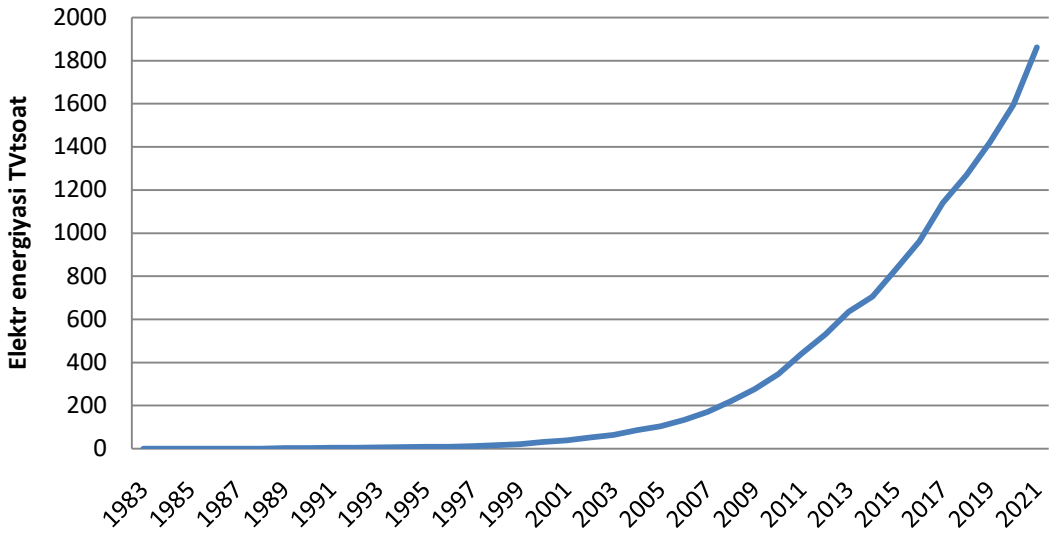
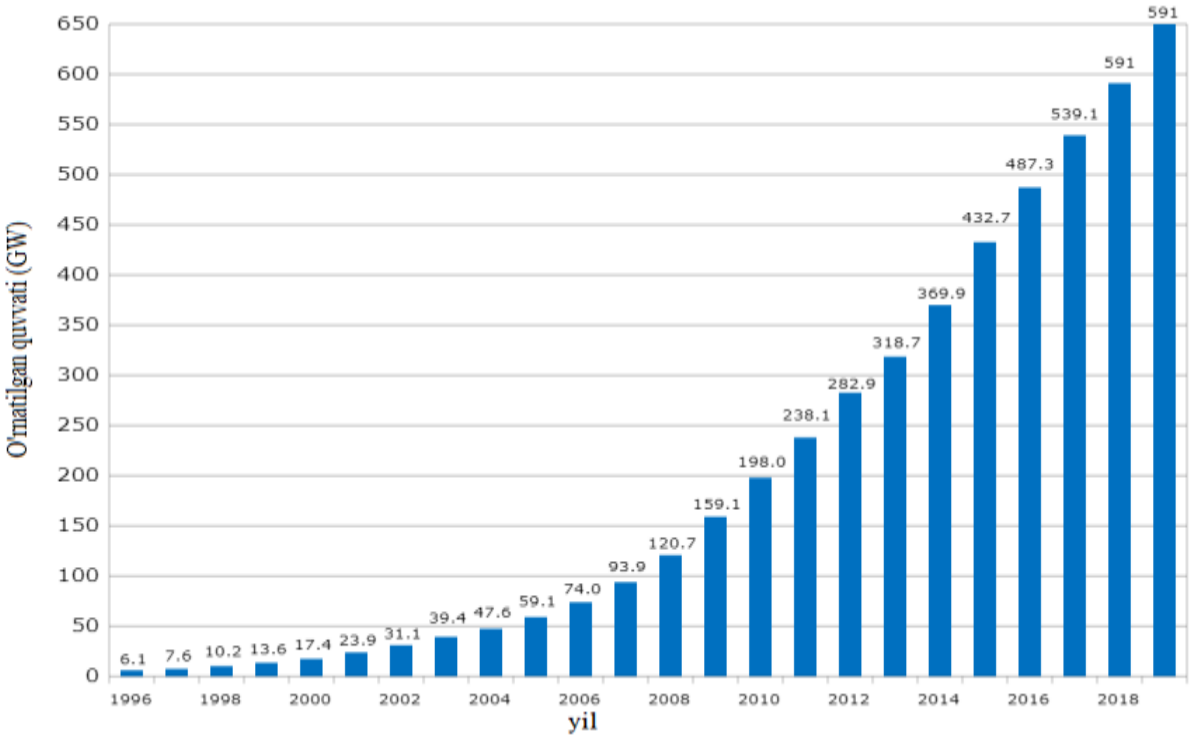


Figure 1.The generation of electricity using wind energy devices in the world in a cross-section of years [2].



source:

https://commons.wikimedia.org/wiki/File:Global_Wind_Power_Cumulative_Capacity.svg

In Figure 2.A comparison of the use of wind energy devices around the world and their installed capacity is presented [2].

When using wind energy devices, it is necessary to thoroughly analyze the climatic conditions of the region. Because the types and structural structure of wind energy devices are different, they differ from each other in their technical and economic indicators. Wind turbines are mainly divided into two types: vertical and horizontal wind turbines. The horizontal axis wind turbine is the most common type of wind turbine in use around the world.

The vertical axis wind turbine is of great importance in the widespread use of renewable energy sources in energy consumption. Because it can be said that the vertical wind energy device was created in order to eliminate the shortcomings observed in the horizontal wind energy device. Although vertical wind energy devices are not used as often as horizontal axis wind turbines, they are very convenient for residential installation.

In 200 BC, the first vertical axis wind turbines were used on the Persian-Afghan border. These turbines served as mills for the population to turn grain into flour. By AD 1300-1875 it was found that horizontal axis windmills were used in the Netherlands [3]

Figure 3. Horizontal axis wind energy devices.

A) two-layer B) three-layer C) Multi-layer devices.

Vertical-axis wind energy devices are distinguished by the fact that there is no need for a mechanism that adjusts the turbine to the wind direction. Because the rotation speed of the wind energy device does not depend on the direction of the wind flow affecting the turbine.

Figure 4. Vertical axis wind energy devices

. A) helicoid type B) Darrius type C) Savonius type.

But nowadays, vertical axis wind energy devices are rarely used compared to horizontal axis devices. The main reasons for this are that such devices are used mainly for small-power energy devices and have relatively low efficiency due to their relatively new constructions. In a vertical axis wind turbine, the rotor is placed on a vertical axis and can generate electricity regardless of the wind direction[4]. The advantage of this type of vertical wind turbine is that it can generate electricity even in areas where the wind speed is low. That is, through horizontal wind energy devices, it is possible to generate electricity even in areas that are not suitable for electricity generation. Vertical wind turbines, unlike horizontal ones, are always installed in a direction perpendicular to the wind flow[5].

Below are the advantages of vertical axis wind energy installations.

- Vertical readable energy devices can be installed at relatively low heights from the ground level.
- Since the vertical axis wind turbine is placed closer to the ground, it reduces construction costs and the device is easy to maintain.
- Since the vertical feed is placed closer to the turbine, the damage to the birds is relatively lower.
- Additional devices (wind deflector, speed booster and other mechanisms) are not needed to operate the wind turbine.
- The value of the wind speed driving the turbine is relatively low.
- Since the vertical axis wind turbine is independent of the direction of the wind flow, it can also be used in areas where the direction of the wind flow is variable.

- Vertical axis wind turbines are relatively low noise and therefore do not cause inconvenience to the population and telecommunication systems.
- Turbines can be made more resistant to different weather conditions. This reduces the use of expensive protection systems and devices that provide additional durability.

There are also disadvantages to using a vertical wind turbine. They are as follows:

- Compared to a horizontal wind turbine, the efficiency level is lower.
- Using large-scale wind power can be economically costly.
- Vertical axis wind turbines are very difficult to mount on tower type supports, which can be mounted on the ground or on buildings.

The power produced by a wind energy device can vary depending on the pressure and density of the air flow in the selected area. This power difference can change significantly when using especially large wind power plants. The following equations are used to estimate the power of a wind power plant in real conditions[6]:

$$P_{WGT} = \left(\frac{\rho}{\rho_o}\right) \cdot P_{WTG,STP}$$

where:

P_{WGT} = output power of the wind turbine [kW]

$P_{WTG,STP}$ = wind turbine power under normal conditions [kW]

r = density in real conditions [kg/m3]

r_0 = air density under normal conditions (1.225 kg/m3)

The gross potential of the wind on the unit surface is determined by the following formula, that is, the power of the wind flow passing through the unit surface is directly proportional to the cube of the speed of the wind flow passing through this surface and the density of the air flow.

The power of the wind current flowing through the unit surface[7]

$$N_{ветро} = \frac{\rho V_0^3}{2} A$$

A – selected surface ()m^2

v0 is wind speed

r iswindcurrentdensity

a wind turbine can absorb a maximum of 0.593 of this power according to Betts' law. Depending on the shape of the turbine, the coefficient of wind energy absorption (Cp) of the turbine varies, and this indicator is the power coefficient of the turbine.

The mechanical power that a turbine can produce.

$$N_{ВД} = c_p \frac{\rho V_0^3}{2} A$$

Power factor of the turbine.

$$C = \frac{N_{ВД}}{N_{ветро}}$$

Advantages and disadvantages of horizontal axis wind energy devices. The advantages of horizontal wind energy devices include the following[8]:

• A vertical axis wind can provide relatively large power to an energy device.

• high efficiency at high wind speeds

• Low price.

• High reliability.

• high profitability.

• Can work even in high wind speeds.

• High wind power can effectively angle blades in wind turbines.

The following disadvantages are observed in the use of horizontal wind energy devices.

• Has large dimensions.

• Has a lot of weight.

• Orientation of the turbine in the direction of the wind flow is required.

•Emits high noise during operation

• High installation costs Ustanovkazatrudnena.

• Difficulty of maintenance.

REFERENCES :

1. Omar Ellabban, Haitham Abu-Rub, Frede Blaabjerg. Renewable energy resources: Current status, future prospects and their enabling technology. Renewable and Sustainable Energy Reviews 39 (2014) 748–764
2. https://ourworldindata.org/grapher/renewable-energy-gen
3. Kaldellis JK, Zafirakis D. The wind energy (r) evolution: A short review of a long history //Renewable energy. - 2011. - T. 36. – no. 7. - S. 1887-1901.
4. Nasulloyevich NS, Bekmurodovich SA Increase of efficiency of the alternative source of the electric power with use of the mechanical energy storage //European science. – 2017. – no. 4 (26). - S. 26-27.
5. Nasulloyevich NS, Bekmurodovich SA Increase of efficiency of the alternative source of the electric power with use of the mechanical energy storage //European science. – 2017. – no. 4 (26). - S. 26-27.
6. https://www.homerenergy.com/products/pro/docs/latest/how_homer_calculates_wind_turbine_power_output.html
7. R. A. Janson. Vetroustanovki. Uchebnoeposobie. Moscow State University Baumana. Moscow-2007
8. https://www.elprocus.com/horizontal-axis-wind-turbine.