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Complex alternative source of electrical energy

A new complex alternative source of electric energy was proposed; it combines two renewable forms of energy: solar and wind in the form of helicoidal wind generator. The use of solar panels in combination with a wind installation will be effective in terms of reducing the threshold wind speed required to exit the installation to the nominal rotation speed using energy produced by solar panels.

Analyzing the atlas of the wind potential of Ukraine, it is determined that a complex alternative source of electrical energy (CASEE) will run out at nominal turns at a wind speed of 3-4 m/s. The territory of the Kyiv region and in general the northwestern Ukraine is characterized by the average wind speed of 3-4 m/s. That is why the implementation of the complex solar-wind energy installation will be relevant and effective [1]. If you take into account the area where the wind speed is 4-5,6,7 m/s respectively, then the implementation of the complex solar-wind energy installation will be more efficient and will give more power over the same period of time.

The constant growth of the cost of natural gas, electric and heat energy, petroleum products and related raw materials leads to the development of ways to obtain renewable (alternative) energy, which is an important step for gaining Ukraine's energy independence and saving traditional types of fuel. The issue of own energy resources production is very important for Ukraine because it is ensured by its own recourses only for 60%. The main advantages of energy generation from renewable sources are absolute environmental friendliness, ease of use, long term of systems operation, and minimal service and technical maintenance. The use of renewable (alternative) energy sources is one of the ways of solving the problem of Ukraine energy supply.

A complex alternative source of electrical energy is based on a helicoidal wind generator with four convex blades without a definite air dynamic orientation. The blades are mounted in the lower and upper points of the rotor axis and are installed on a separate pillar with a corresponding prepared foundation, which is located on an flat surface of the earth or the roof of the building (Fig. 1).

Solar modules are proposed to place on the top of each blade, which, when rotating, will form a holistic semicircle.

The use of solar panels in combination with a wind installation is effective in terms of reducing the threshold wind speed of a helicoidal rotor, which is required to exit the installation at the nominal rotation speed and increase of the total volume of the produced alternative electrical energy.

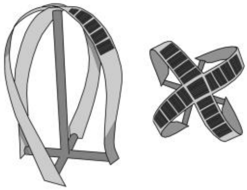

Fig. 1. Construction of the wind wheel CASEE

It has been determined from Fig. 2 that at a certain angle of incidence of sun rays the level of insolation in different zones of the installation would change, but an average value as a result would be obtained in the result.

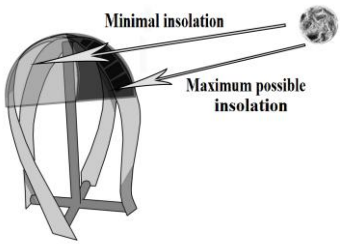

Fig. 2. Insolation level depending on sun rays angle of incidence

Precisely the helicoidal rotor is offered for CASEE, because its efficiency characteristics of the wind energy use are almost the same as those of high-speed horizontal wind whales. The great advantage of this form of a wind energy installation (WEI) is the absence of a need for wind pointing, in contrast to horizontal wind installations.

The forms of implementation of most wind WEI have a rather low potential for improvement and further development, as well as low wind energy usage rates [2-4].

It is proposed to use solar cell nC-Si (HIT) type solar modules, which begin to generate electrical energy efficiently at 800 W/m^2 and 25 °C. Therefore, solar modules will generate electricity even during the winter season. It is known that solar modules react negatively to temperatures above 30-35 °C, as their performance deteriorates during operation [5]. This minor flaw will be eliminated in CASEE by installing solar modules on the rotating blade, so solar modules will be provided with cooling due to wind flow, especially it is important at high temperatures in the summer season.

The solar panel is a prefabricated panel that transforms the energy of sunlight into electrical energy. Output power of each module under the standard conditions of use is within the range from 100 to 365 W.

Technical parameters (at illumination of 800 W/m^2, t = 25 °C):

- class of module - nanocrystalline nC-Si (HIT) - 23%;
- power - 267 ± 20% W;
- voltage - 18.9 V;
- voltage at maximum power - 16.8 V;

• current at maximum power - 15,9 A.

The most unfavorable month for the Kyiv region is December due to analysis the insolation indices, depending on the angle of incidence of sunlight. The daily averaged insolation on the horizontal surface of the earth is 0.5 kW·h/ m^2/day, to the vertical - 1.22 kW·h/ m^2/day.

Insolation will be 1.26 kW·h/m^2/day at an angle of inclination of the plane to the ground of 70 degrees; the optimal angle for December is 74 degrees.

June is the most favorable month, and the insolation on the horizontal surface will be 5.27 kW·h/m^2/day, with an optimum angle of inclination of 11 degrees for this month.

If solar modules will be used in the summer months, the insolation level will be in an order higher. It is also necessary to take into consideration the angle of sun rays inclination, which will change the insolation level and, accordingly, the power. Since the solar cells are located on the surface of the blades of the wind generator and they have a different angle of inclination, the average value of this angle would be the optimal power indicator. The average optimum angle of sun rays inclination is 44.6 degrees, which is a close indicator to the position of panels on CASEE in the territory of Kyiv region [2, 3].

The average insolation index of modern solar modules is 1000-1200 kW/m^2 per year. The territory of Kyiv region is characterized by this indicator in ranges 1100-1200 kW/m^2, so their use will be effective in terms of solar energy optimal use and its transformation into electrical energy.

It has been determined the minimal insolation indicator for the Kyiv region, which is 0.86 kW·h/m^2 per day even in the winter season.

The battery capacity is one of its most important technical characteristics. This term refers to the amount of time during which it is possible to supply consumers by the electric energy, that is, the maximum amount of electricity accumulated by the battery for a full charge cycle and the unit of the capacity measurement is A·h.

It is suggested to use a type of batteries that would be discharged by 30% of their total capacity during operation, after which they would be charged immediately. In this case, they can withstand about 10,000 charge-discharge cycles. If the size of the discharge decreases to 70% the number of cycles will decrease by about 2000. In the case of CASEE reliability, the source of the battery should have about 20% of reserve for its not complete discharge. This will save the term of work and reliability for the maximum possible period of the CASEE operation.

In the case when several batteries are used for reserving the load, the amount of the accumulated energy absolutely does not depend on the type of their connection - parallel, serial or mixed.

Ultracapacitors play an important role in improving the quality of electricity for consumers, stabilizing voltage and equaling load schedules (especially in the presence of sharply variable, pulse-like loads). Extremely relevant is the use of storage devices to equal power delivery schedules in the energy system based on CASEE.

Efficient use of ultracapacitors in CASEE on wind installations provides a high-quality electric energy at moments of the wind direction or force change, giving the necessary amount of energy to compensate the voltage dips, providing the necessary parameters of electrical energy.

Conclusions

In a result of work on the creation of a complex alternative source of electrical energy it has been determined its main advantages: it operates stably under snow and icing conditions; the blades begin to rotate by themselves at a wind speed of 0.2-0.5 m/s; the nominal power value is achieved at a speed of 3-4 m/s; the noiselessness of the motion of the rotating parts, at any wind speed; CASEE easily catches the versatile wind without a weathervane system; relatively small working rotation speed, up to 200 rpm; the vertical CASEE allows to use any downwind, turbulence, wind along the street or between high-rise buildings.

The power of solar modules and wind installation has been determined, which will give 15 kW of power to consumers depending on CASEE sizes: diameter 5 m and height 9 m. The change of these parameters gives a possibility to get another level of electrical power.

Efficient use of ultracapacitors in CASEE on wind installations provides a high-quality electrical energy at the moments of the wind direction or power change by giving the necessary amount of energy to compensate the voltage dips. The use of elements of relay protection and automation will positively affect the efficiency and reliability of electricity supply for consumers of the 2nd and 3rd categories.

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