DEVELOPMENT AND EFFICIENCY IMPROVEMENT OF A COMBINED SOLAR-WIND POWER PLANT

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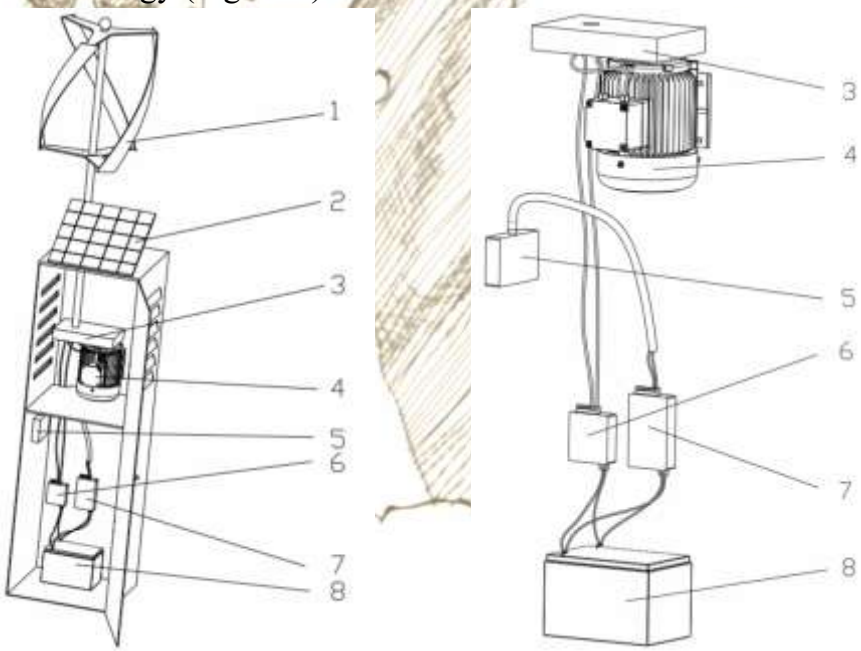
In recent years, in the context of the ongoing energy crisis in the world, the importance of increasing the reliability of energy supply systems and ensuring uninterrupted energy supply has been considered very high.

The improvement and development of solar and wind energy devices, which have higher utilization potential compared to other renewable energy sources, is of great importance in providing uninterrupted electricity to autonomous consumers [1].

Below is an analysis of research and development work on combined solar-wind energy devices produced and used in the world and in the regions of our Republic :

Liu Davei, Li Yinghan, Su Pu, and Liu Mingjie developed a hybrid solar-wind power system based on a helical Darye turbine and photovoltaic modules to generate electricity using solar and wind energy (Figure 1).



a) b)

Figure 1. Liu Davei and other's General view of the energy device developed by (a), the device electricity scheme (b).

This hybrid sun-wind energetic systems based on device 1- wind turbines, 2- solar photovoltaic module, 3- mechanical transmission, 4- electric generator, 5- inverter, 6- charge and discharge controller, 7- alternating current consumer and 8 - consists of an electric battery.

This combined device differs from the device proposed by Xie Fangwei et al. in the type and location of the wind blades in the turbine, and the electric generator present in the

device. In this case, the wind mechanical connection of the turbine to the shaft of the electric generator extension through. The disadvantages of this energy device are its low efficiency at low wind speeds and the low reliability of the generator producing electricity in variable and low-speed wind flows.

Chinese scientists Xie Fangwei, Ke Jun, Wang Cuntang, Zhang Kai, Xuan Rui, and Sheng Gang, " The Solar-Wind energetic "Invention received in 201 4 for the device " for in the patent [3] variable fast solar -wind power plants to efficiently generate electricity from wind and solar energy energetic proposed a device (Figure 2). The presented energy device consists of 1- solar photovoltaic module, 2- column, 3- extension shaft, 4- mechanical transmission, 5- wind turbine bushing, 6, 8- supports connecting wind blades, 7- wind blades, 8- water flow outlet pipe and 9-1, 9-2- flange connections. The wind flow is directed to the turbines one Despite the smooth transmission, the efficiency is very low. This increases the cost of electricity generated in the power device and limits its practical application.

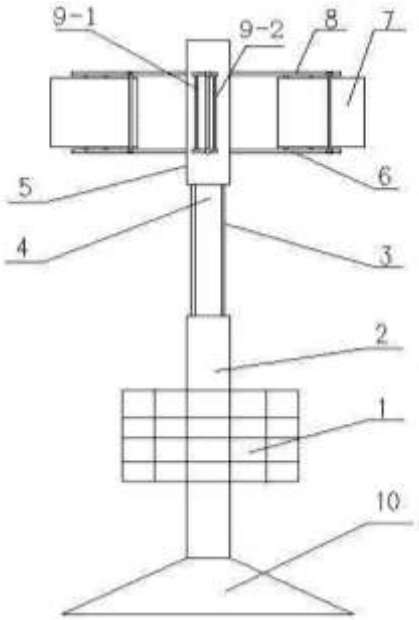
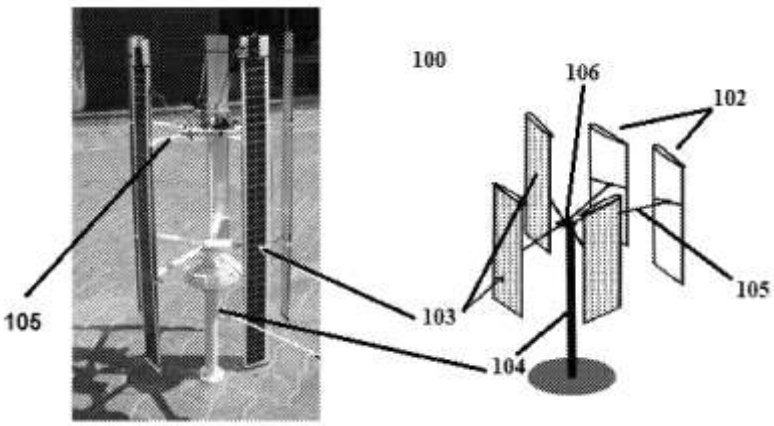


Figure 2. Proposal made solar-wind energetic device.

In a 2020 United States patent for a “solar-wind hybrid energy device,” scientists Anas IQ Al Tarabsheh, Muhammad Abdul Majeed Hareb, and Mahmoud Raouf Kahla, all based in the United Arab Emirates, proposed a hybrid energy device consisting of a vertical axis wind turbine and an FEM mounted on the front of the turbine blades (Figure 3).



100- solar-wind hybrid energy device, 102-wind blades, 103-solar photovoltaic modules, 104-rotating vertical axis, 105,106- supports connecting the blades.

Figure 3. Proposed solar - wind hybrid energy device.

In Uzbekistan G '.N. Uzoqov, AB Safarov and RA Mamedov (" Combined sun-wind energetic (who received a patent for the “ device ” [5]) developed a combined solar-wind energy device that operates efficiently in weak wind currents and high temperature regimes. The combined solar-wind energy device consists of solar photovoltaic cells (4)

and 6 identical sized NACA 63-415 wind blades (9,10) consists of a vertical axis wind turbine (6). (Figure 4).

Based on the analysis of combined solar-wind power plants, the combined solar-wind power plant adapted to changing climate conditions consists of a three-blade Savonius wind turbine with wavy zigzags and guide surfaces, an H-type wind turbine with trapezoidal pipes on the blades, metal profiles connecting the Savonius and H-type wind turbines with flanges, bearings mounted in an aluminum housing, inductors consisting of permanent magnets mounted on a silicon alloy steel disk, a metal tube mounted on the bearings, an armature consisting of copper coils attached to the metal tube, flanges attached to the flange connecting the Savonius and H-type wind turbines with the magnetoelectric generator, flanges attached to the flanges of the magnetoelectric generator attached to the metal tube and attached to the metal tower, an electric grid consisting of a hybrid controller, batteries and an inverter attached to the metal tower, and solar photovoltaic panels attached through metal profiles. Figure 5 shows the general layout of this device. and The front view is shown.

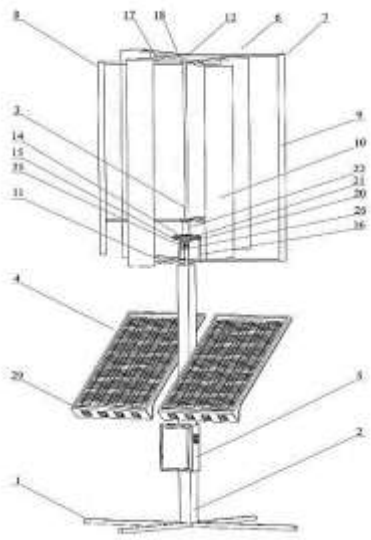
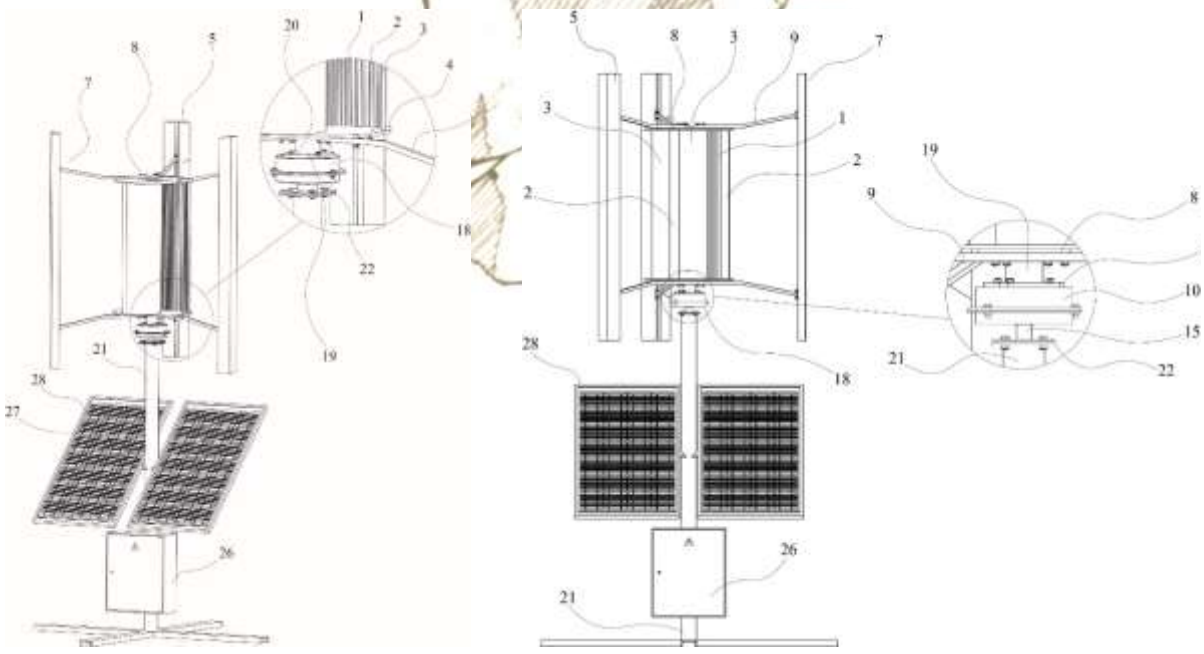


Figure 4. Combined solar-wind power plant.



a) b)

a) General view of the device, b) Front view of the device.

5. Combined solar-wind power plant.

Vertical arrow wind torque coefficient of the turbine and wind from the stream use coefficients of mathematician expression :

$$C_{Q2} = \frac{\overline{T_{dw}}}{1/2\rho_\infty V_\infty^2 S R_D} \quad (1)$$

$$C_{Q2} = \frac{NcH}{2\pi S}\int_{\pi/2}^{3\pi/2}\int_{-1}^{1} C_T^{`}\left(\frac{\eta}{cos\delta}\right)\left(\frac{W}{W_\infty}\right)^2 d\theta d\zeta \quad (2)$$

$$C_{P2} = \left(\frac{\omega R}{V_\infty}\right)\overline{C_{Q2}} \quad (3)$$

$$C_{P-D} = C_{P1} + C_{P2} \quad (4)$$

The electricity generated by wind power plants is defined by the mathematical expression below:

$$E = \frac{\rho \cdot S \cdot V_\infty^3}{2} \cdot C_{P-D} \cdot \eta_{gen} \cdot t \quad (5)$$

where: ρ – hair flow density, kg/m ^{3} ; S –cross-sectional area of the wind power plant, m ^{2} ; V –average wind speed, m/s; η_{gen} – elefficiency of the generator, annual operating time of the wind power plant.

The reliable operation of solar photovoltaic cells depends mainly on solar radiation and external temperature, and the efficiency of solar modules is highest when the nominal temperature is 25 ° C. We present theoretical calculations of the efficiency of solar photovoltaic cells at different temperature regimes. The dependence of the power of solar photovoltaic cells on external temperature is determined by the following mathematical expression [6]:

$$P = P_{sts} + P_{T-coeff} \cdot (T_c - T_{NOCT}) \quad (6)$$

where: nominal power of P_{sts} –the solar photovoltaic cell, W; $P_{T-coeff}$ – hspecific power factor depending on the temperature, 0.4 %/ ° C (500 W, -2 W/ ° C); T_c –external temperature, ° C; T_{NOCT} –nominal temperature of the solar module, 25 ° C.

Figure 6 shows the daily variation of the power curves of the proposed combined solar-wind power plant.

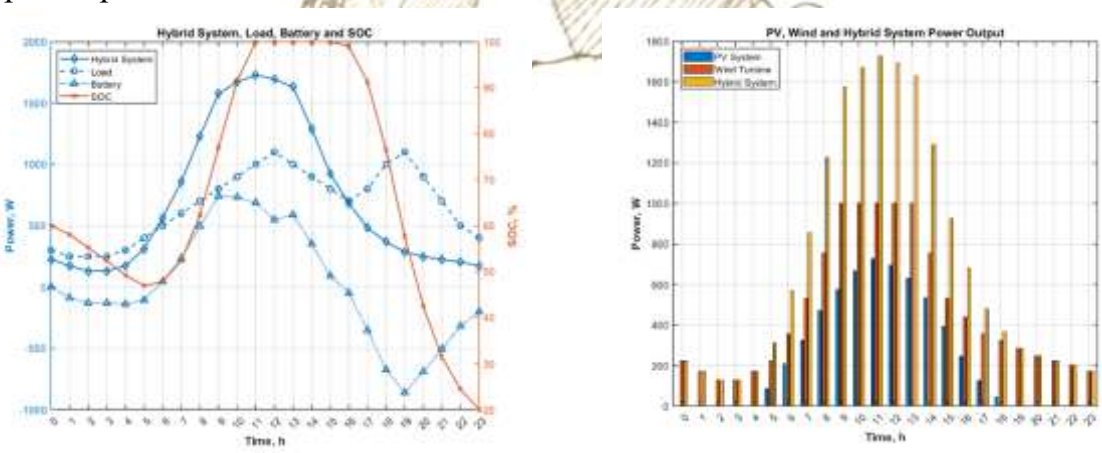


Figure 6. Power curves of a combined solar-wind power plant.

Conclusion: As a result of the analysis of scientific research conducted on combined solar -wind energy devices, the following conclusions were reached:

Existing combined solar-wind power plants complexity of construction, high cost, efficiency This is due to the low cost of production and the fact that wind energy devices cannot withstand climatic conditions, and the high purchase and transportation costs due to the lack of localization of production. devices limits its use.

that by implementing the proposed combined solar-wind power plant with an installed capacity of 2 kW, it is possible to generate 172…1729 W of electrical power during the day, when the wind speed varies within the range of 5…12 m/s and solar radiation varies within the range of 0…1000 W/m ^{2}.

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