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LOW POWER ENERGY SYSTEM FOR GENERATING ELECTRICITY FROM SOLAR AND WIND SOURCES

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Abstract: *The article refers to the presentation of a technical solution for combining two renewable sources from which to obtain the electricity needed to supply a low power consumer. The system was developed at the demonstration model level and has as generating elements a solar panel and a wind turbine. The novelty of the system is not only that it uses two different energy sources, but also that the wind power was realized from an original idea of the specialists of the institute, which contains 2 rotors, which work at different wind speeds (the internal rotor at low speeds, and the outside at higher speeds).*

Keywords: *Energy, renewable sources, solar; wind, combined system*

1. Introduction

In recent years, there has been a significant increase in energy consumption, well above the level of discovering new traditional resources, which has made specialists to pose the problem of replacing fossil fuels, in an extremely short term. As mankind always had at hand, renewable sources such as solar power, wind power, biomass, etc., the transition to their industrial exploitation became an absolute priority. In this regard, it was decided at EU level that by 2020 it will reach a share of energy obtained from renewable sources at 20% of total consumption, and by 2030 at a weight of at least 27%. One of the areas of interest for the use of energy obtained from renewable sources has been established at EU level as rural areas.

Energy security is, in short, the capacity of a country to provide the necessary energy resources for the well-being of the population, at stable prices. Currently, conventional methods of heating and lighting of homes are not only disappearing due to overcrowding, but also harmful to the environment, and this phenomenon is beginning to make its presence felt in Romania. The definition of green energy or renewable energy is based on the fact that it is non-polluting, that it is within the reach of man and especially it is restored due to natural processes, thus becoming inexhaustible at the historical level from the immediate or medium term perspective. It should be noted that there are periods when the share of renewable energy in general consumption and as a result and in the development of new production units slows noticeably, either for technical-financial reasons, or for political reasons or often for eco-technological reasons. However, it is found that the sector of wind energy and photovoltaic solar energy currently have the largest share in the production of electricity from renewable sources. According to a map prepared by the National Meteorological Administration, Romania's energy potential is zoned, as follows:

Danube Delta - solar energy; Dobrogea - solar and wind energy; Moldova - micro-hydro, wind power and biomass; Carpathian Mountains - high potential for biomass and micro-hydro; Transylvania - high potential for micro-hydro; Western Plain - opportunities for harnessing geothermal energy; Subcarpathians - potential for biomass and micro-hydro; Romanian Plain - biomass, geothermal energy and solar energy.

This map shows that there is a very large potential of solar, wind and plant biomass sources in large areas, so we only have to find the technical-economic solutions to use. For the communities that have the wood biomass resource, the solar-biomass hybrid systems represent a feasible solution for providing thermal energy in the community for the two main functionalities: domestic hot water and heating. The design of the solar-biomass system for the total use of the thermal energy obtained by the solar-thermal conversion and the use of the biomass for filling the thermal energy requirement in the community ensures the optimal functionality of the system by using only the solar energy during the warm period and using the biomass only when the energy solar does not provide the necessary thermal energy in the community. However, the strongest combination solution is the one in which a mixed solar-wind system is realized, as in fig.1.

Fig. 1. Mixed solar-wind system [5]

2. The demonstration model of electric combined system

Within the IHP, a mixed solar-wind panel has been designed and realized at the functional model level, which has 4 main components (fig.2):
1. Solar panel with axis orientation system
2. Wind turbine with rotors Darrieus (outside) and Savonius (inside)
3. Industrial fan
4. Addition electric block

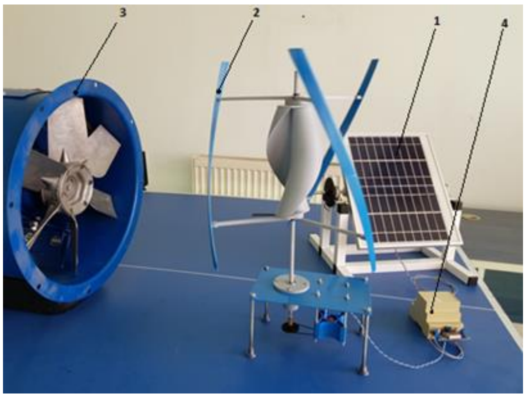

Fig. 2. Demonstrative model of electric combined system

The demonstration model of the combined electric system has the role of highlighting the advantages arising from the combination of the two sources of renewable energy, solar energy and wind energy. For this purpose, the system can present both the amount of energy produced by each of the sources and in the combined system. The small photovoltaic panel 1 (0.5 A) is provided with a system of orientation and indexing on an axis (rotating around the horizontal axis); with the help of this guidance system the influence of the angle of incidence on the power of the panel can be highlighted. The wind turbine 2, made according to the idea patented by the IHP specialists, contains 2 rotors, which work at different wind speeds (the internal rotor at low speeds and the external rotor at higher speeds). The wind energy is provided by an industrial fan 3. The summing block 4 adds up the current from the 2 sources.

3. Wind turbine construction

To make the wind turbine within the demonstration model, a 3D printer was used to print the blades of the Darrieus rotor and the Savonius rotor after a geometry designed using SolidWorks

software.
Printing was done with the BCN3D SIGMA R19 (FFF) printer with the following facilities:
- Architecture: Two independent extrusions (IDEX);
- Print volume: 210 mm x 297 mm x 210 mm;
- Maximum temperature of the heated bed: 100 ° C;
- Positioning resolution (X / Y / Z): 1.25 um / 1.25 um / 1 um;
- Firmware: BCN3D Sigma - Marlin;
- Extruder system Extruder Bondtech ™ high technology double gears; Hotends: optimized and manufactured by e3D ™;
- File preparation software: BCN3D Cura.

In fig. 3 and 14 show the 3D printer and 3D drawings for the wind turbine made in SolidWorks.

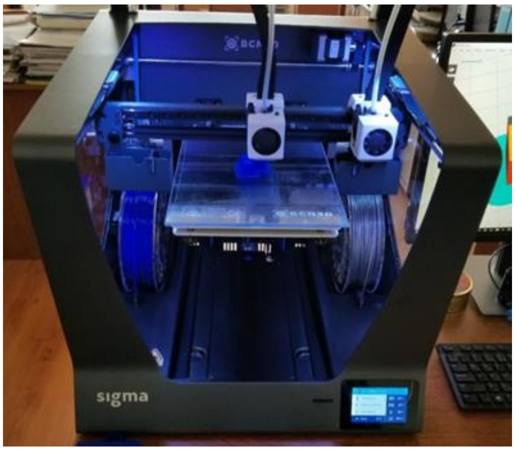

Fig. 3. SIGMA R19 printer and BCN3D Cura software

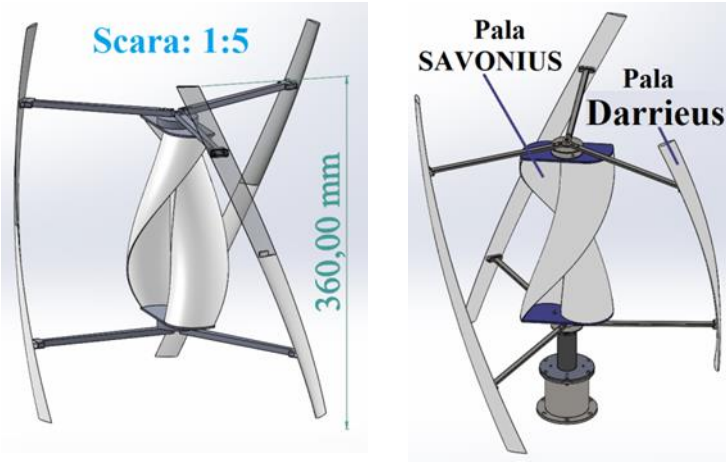

Fig. 4. 3D drawings for the wind turbine

Most of the components of the wind turbine were printed with PLA and for the parts that needed support was used PVA, which dissolves easily in water.
3D printing process parameters: filament diameter was 2.85 mm, casing diameter 0.4 mm, layer height 0.2 mm, filling density of 35% or 100%, printing temperature 205 ° C, temperature 60 ° C plate and a conservative print speed of 50 mm / s.
Because the blades of the Darrieus turbine are larger than the printer can produce, they were divided into two pieces and, due to their curvature, in two planes, it was necessary to print with support material. Fig. 5 shows the parts that needed support material, including the arms to support the Darrieus turbine; 2 holes were necessary for screw assembly.
Fig. 6 presents the parts that did not need support material during the printing process; they are: the covers of the Savonius turbine, which have practiced a channel that rigidifies the entire subassembly, the Savonius turbine itself, as well as the bearing base, which has the supporting role for the hexagonal shaft and the turbine.

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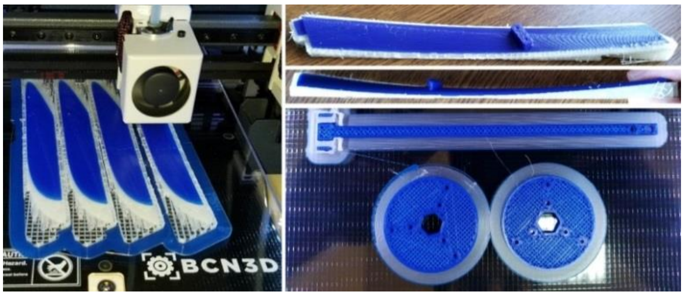

Fig. 5. Printed pieces that needed support material

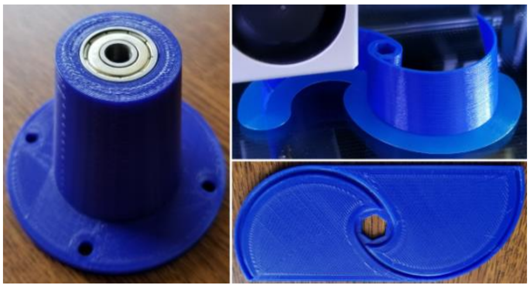

Fig. 6. Components that did not need support material during the printing process

The physical object resulting from the wind turbine of the demonstration model of electric combined system is presented in fig.7:

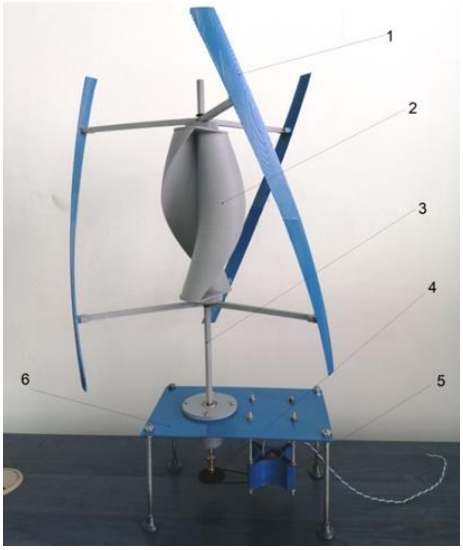

Fig. 7. The wind turbine of the demonstration model of electric combined system

The wind turbine made as a component of the demonstration model consists of:
1. Darieus rotor (outside)
2. Savonius rotor (inside)
3. Rotor support axis, which also has the role of transmitting the movement
4. Speed multiplication system
5. Minigenerator
6. Supporting framework

The outer rotor Darrieus - item 1 - has 3 blades that have in section NACA 0018 profile, and ensures the operation of the turbine at speeds over 5 m / s.
The inner rotor Savonius - item 2 - has the role of putting the turbine in motion at lower wind speeds, starting from approx. 3 m / s; In this way, at wind speeds over 5 m / s, both rotors work to convert the kinetic energy of the air into mechanical energy.
The 2 rotors are mounted on the support shaft 3, which is widened at the bottom by means of 2 radial-axial bearings; the shaft has a large diameter wheel end, which together with another smaller diameter belt wheel, mounted on the minigenerator shaft 5, forms the speed multiplication system. This system combines the reduced axle speed with the 2 rotors (50 ... 200 rpm) with the minigenerator (1000 ... 1500 rpm). The wind turbine components are mounted on the supporting metal frame 6. The main components, the 2 rotors, were made by 3D printing. The wind turbine of the demonstration model is a small (1: 5) copy of the turbine of the experimental model.

4. The solar panel and the summing electric block

The solar panel with an axis guidance system (fig.8) has the following characteristics:
• Voltage at maximum power: 17.49V
• Current at maximum power: 580mA
• Maximum power: 10W
• Short circuit current: 610mA
• Material: polycrystalline silicon
• Outside dimensions: 290 x 330 x 25mm
• Mass: 1.5kg
• Panel adjustment angle 0… 90°

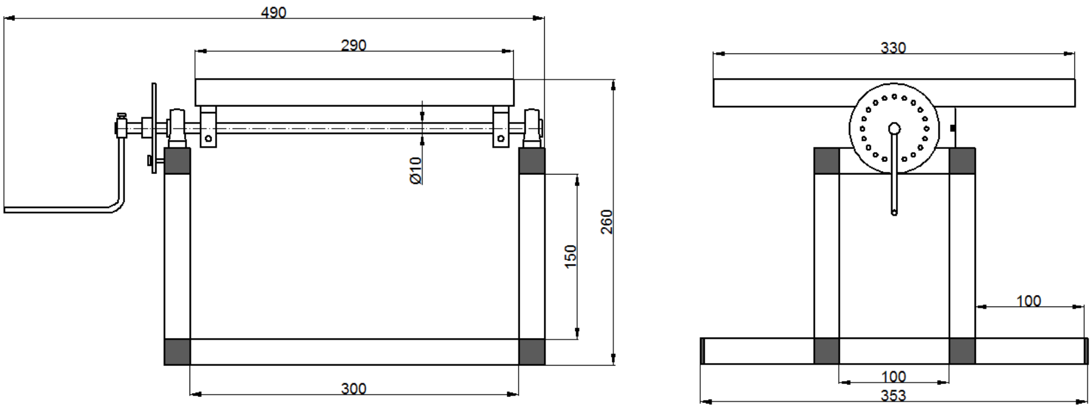

Fig. 8. Overall drawing of the photovoltaic panel with guidance system

The characteristics of the industrial fan used in the model are:
• Power supply voltage: 230 V
• Power: 1.1 kW
• Air flow: 7850 m3 / h

The summing electric block (fig. 9) consists of:
- 1 solar controller with maximum power point tracking (MPPT) with the output voltage 3.4 V;
- 1 voltage regulator with output voltage 3.4 V;
- 2 Schottky diodes;
- 1 bulb or LED consumer.

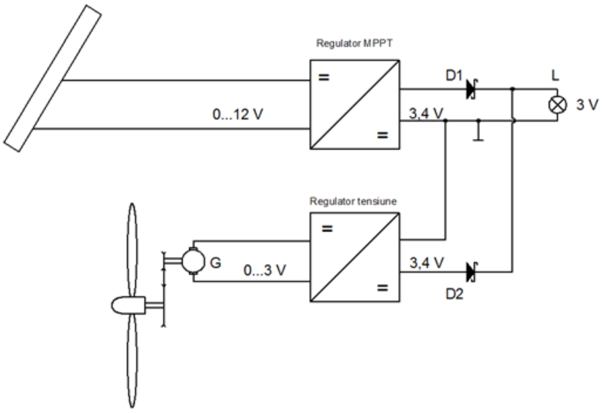

Fig. 9. Diagram of the summing electric block

5. Conclusions

For the most part, small communities rely on wood biomass and fossil fuel consumption. The official trend, but even the particular one, is the shift to energy production systems green, from renewable resources that are usually solar wind and plant biomass. Given that usually the resources listed above are not available 24 hours a day, it is necessary to make some combinations, especially between the 3 sources that are available longer and especially at different times of the day such as solar-wind.
The demonstration block realized by IHP allows obtaining important data necessary for the manufacture of composite (mixed) systems.

Acknowledgements

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