ANALYSIS OF POSSIBILITIES THE CURRENT SITUATION FOR USING AND ACCUMULATING GREEN ENERGIES IN GEORGIA

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Abstract
The present paper is dedicated to addressing the challenge of efficiently accumulating energy generated by solar modules and wind farms—a significant international issue that currently requires substantial financial investment. The paper emphasizes the feasibility of implementing this concept in countries equipped with operational hydroelectric power plants with dams. Such a strategy presents a cost-effective and efficient means of energy storage for these renewable sources. Furthermore, the paper delves into the potential for enhancing the energy efficiency of wind farms and solar panels through a comprehensive analysis of their structural design and component characteristics.

Keywords: Renewable Energy (RE), Green Energy (GE), PV Panel, Pumped – Storage Plant, Fill factor (FF)

I. Introduction. Global renewable energy (RE) trends

Renewable energy RE encompasses energy derived from continually replenished natural sources and environmental processes, such as wind, solar, and biofuels, in stark contrast to non-renewable sources like coal and fossil fuels, which require extensive time for replenishment. As detailed in reports from the International Energy Agency (IEA) [9], global trends in renewable energy adoption, including the expansion of solar photovoltaic (PV) capacity [5,8,16-17] (fig.1), exemplify the world's evolving energy landscape.

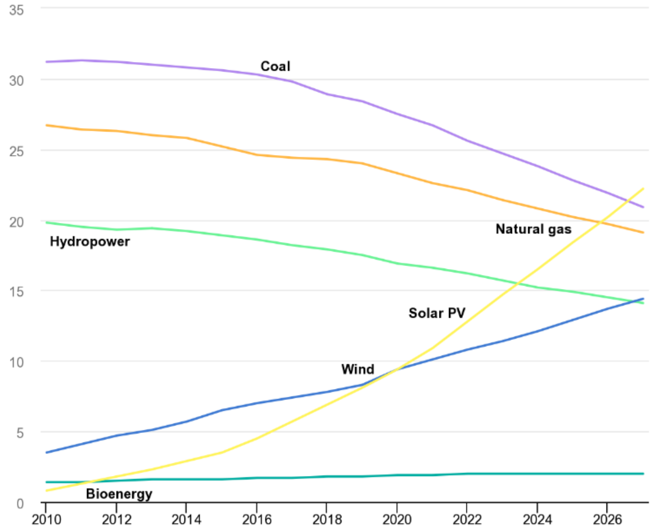

Fig.1. Global RE trends, including solar PV capacity additions [9]

Several studies have examined the economic aspects of wind energy, including cost competitiveness with conventional energy sources. The literature explores factors such as levelized cost of electricity (LCOE), subsidies, and financial incentives [1,22]. Wind energy is often lauded for its environmental benefits, but it also faces scrutiny regarding potential ecological and visual impacts. In [2,11] reviews delve into topics like bird and bat collisions, noise pollution, and visual aesthetics. As wind energy capacity increases, integrating it into existing electrical grids becomes a significant challenge. In [10,21] examine grid stability, energy storage solutions, and the role of smart grids in accommodating variable wind power. In [7,26] discusses the future of wind energy, including offshore wind farms, advancements in wind turbine technology, and policy frameworks that could support further growth. References [14,27] represent a starting point for a literature review on wind energy.

II. Creation of a multi-profile industrial-scientific-educational complex

All the aforementioned innovations and advantages are safeguarded by the patent held by Raul Turmanidze and his group, known as the "Wind and Solar Energy Accumulating Energy System U 2016 1906." It is noteworthy that the groundbreaking concepts outlined in this patent have already found practical application in a hydroelectric station constructed in the city of Haibei (2021) by China's largest corporation, the "CHINA ENERGY ENGINEERING CORPORATION LIMITED." Furthermore, there are ambitious plans for the serial construction of similar accumulative power plants, with a combined capacity of 120 GW.

Fig.2 presents a schematic representation of the energy system designed to accumulate hydro, wind, and solar energy. This integrated system comprises a hydroelectric power station (2) that interfaces with Energoline (1), which encompasses an upper basin (3) and hydrounits (5 and 6, comprising turbines and generators) situated within a hydrotechnical facility (4). These hydrounits are supplied with water through aqueducts (7). Additionally, the system is equipped with wind and solar energy conversion devices (8 and 9), a reversible pipeline (10), a pumping unit (11) integrated into said pipeline or connected to it, and a control unit (12). The wind and solar energy conversion devices are electrically connected to the control unit through the inventor (14) and the hydroelectric units of the hydroelectric plant. The control unit is designed to manage and direct the energy generated by these devices and/or hydro-units to either the energy storage cell and/or the pumping equipment. The schematic representation of the substation is indicated on (13).

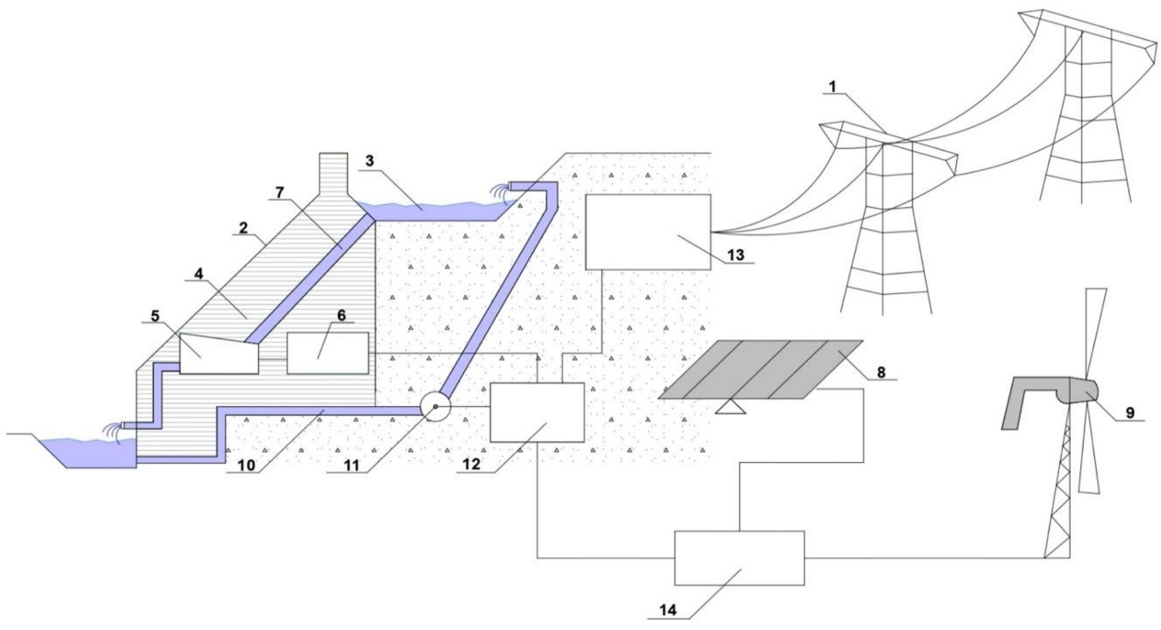

Fig.2. 1- Energoline, 2 - hydroelectric power station, 3 - upper basin, 4 – hydrotechnical facility, 5 turbine, 6 – generator, 7 - aqueducts, 8 – wind generator, 9 – solar panels, 10 - reversible pipeline, 11 - pumping unit, 12 - control unit, 13 – substation, 14 - control unit

III. Prospects for increasing Solar Panels manufacturing research and study its characteristics

On another front, the research group at Batumi University is actively engaged in studying the characteristics of solar panels [6,20].

Efficiency comparisons were conducted among solar panels from different manufacturers, specifically between the NURZAMAS solar cell and the STC solar module. The NURZAMAS solar cell boasts dimensions of 90x60x2 mm and a surface area of 54 cm². It achieves a maximum voltage of 6V and a maximum power output of 0.6W. In contrast, a typical solar module adhering to STC specifications encompasses an area of 1 square meter and operates under standard test conditions (STC) of 1000 W/m² and 25°C (Fig.3). The module's maximum power output varies according to the specific model and manufacturer.

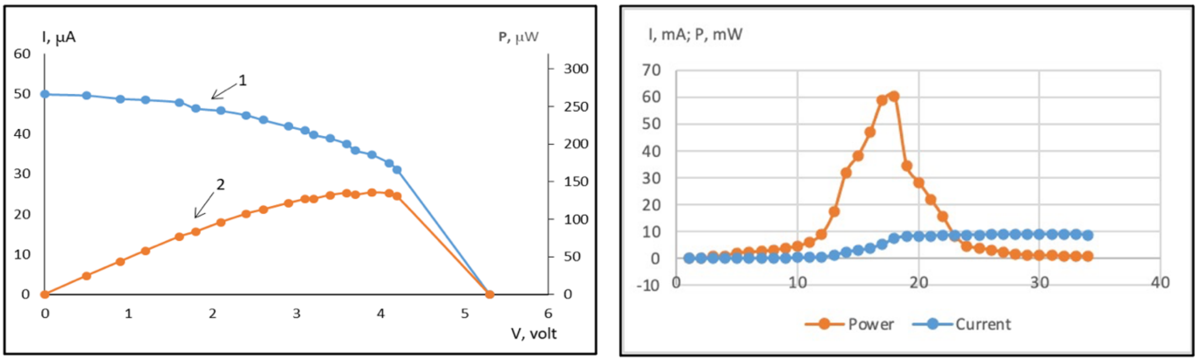

Fig.3. a) characteristics of solar cell manufactured with NURZAMAS: I-V (1) and P-V (2) I_{SC} = 49.9 µA, u_{OC} = 5.1 V, I_{mpp}=34,8 µA, u_{mpp}=3,9 V; b) characteristics of solar module with the specification of the PV module at STC (1000 W/m 2 and 250C): P_{max} = 50 W, u_{mpp}= 18.2 V, I_{mpp} = 2.7 A, u_{OC} = 22.7 V, I_{SC} = 3.1 A

Conclusion

The focal point of this research has been the effective accumulation of energy harnessed from wind aggregates and solar modules, achieved at relatively modest costs. This endeavor addresses a critical international challenge, one that necessitates the allocation of hundreds of millions of US dollars annually for its resolution.

Within the context of constructing a multifaceted production complex encompassing the aforementioned autonomous enterprises, it is substantiated that wind stations and solar modules produced in Georgia, utilizing local and cost-effective raw materials along with novel designs and technologies pioneered by Georgian scientists, will yield significant cost reductions in the resulting products.

In closing, it's noteworthy that the performance of a solar cell can be substantially enhanced through the application of various techniques. These include the use of anti-reflection coatings, surface texturing, and material doping. These methodologies serve to augment light absorption, mitigate reflection losses, and enhance the collection of charge carriers, thereby contributing to the overall efficiency and effectiveness of solar energy conversion.

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