Hybrid Energy Generation For Remote location Display Boards

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Abstract
The display boards can be powered by both solar and wind energy in existing system. In these context the wind turbine, which is used to produce energy is either horizontal or vertical axis and solar PV panels are utilised to produce solar energy. The hybrid energy generation system for remote location display boards is discussed in this research study. The proposed system consists of horizontal and vertical axis wind turbine along with solar PV. The charge controller collects the energy from the two wind turbines and solar PV panel and it store in a battery for continuous output generation. The hybrid energy generation contributes to cost savings, environmental sustainability, energy independence and increased brand exposure in outlying areas. The hybrid energy generation system design will able to provide a reliable and long-lasting source of electricity for commercial display boards and other applications while lowering carbon emissions.

Keywords: Horizontal axis wind turbine (HAWT), Vertical axis wind turbine (VAWT), Photovoltaics (PV), Hybrid Charge Controller, Display Board.

1. Introduction

Electricity is produced using two different forms of energy: solar and wind. These sources were chosen mostly because they are readily accessible in nature, cost nothing, and offer various benefits for producing power. The advantages of renewable energy sources for the environment and the economy has been increased in recent years. Hybrid energy generating refers to the utilization of two or more renewable energy sources to produce electricity throughout the day [19, 20]. Hybrid energy generation has gained appeal as a result of its ability to reduce dependency on a single energy source while enhancing energy efficiency [1]. Advertising, spreading information, and entertainment are just a few of the many uses for display boards. These notice boards are spread over a peak points in a remote location, which requires a constant flow of electricity to operate continuously.

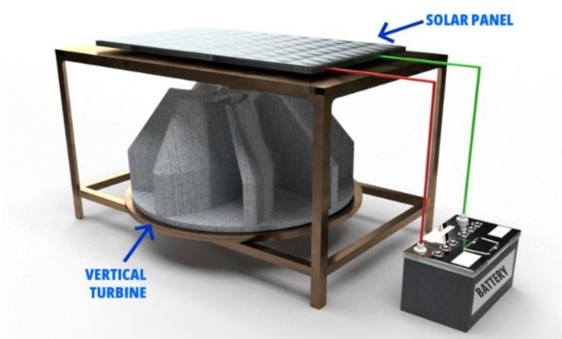

Figure 1. *Existing model of hybrid power generation*

The above (Figure 1) represents the existing model which consists of vertical axis wind turbine and solar panel. display board is mostly used in remote location like highways, hence it is concentrating on these applications. The numerous environmental, economic, and societal factors have a role in the choice to use renewable energy. The use of renewable energy technologies is anticipated to increase as they advance and become more accessible, resulting in a more sustainable and secure energy future [21]. Both conventional and unconventional energy sources can be used to produce electricity [2]. Conventional energy sources including coal, diesel, and nuclear energy are currently used to produce electricity. The main drawback of these energy sources is that they generate waste, such as ash in coal power plants and radioactive waste in nuclear power plants, and managing this waste is very expensive. [3] Additionally, the environment is harmed. Also very dangerous to people is nuclear waste. There is a sharp decline in conventional energy resources. We must find an alternative method of producing power because it will soon disappear from the ground [4]. The replacement source must be dependable, clean, and economical [5]. Alternatives to conventional energy sources that are also competitive should be non-conventional energy sources. There are many non-conventional sources of energy, including geothermal, tidal, wind, and solar [6]. Because it can only be used on seashores, tidal energy has this drawback. To extract heat from the earth, geothermal energy necessitates a considerably larger step. In all weather situations, solar and wind energy is easily accessible. Solar and wind power are examples of non-traditional energy sources that can be a useful replacement [7]. Solar energy has a disadvantage in that it cannot produce electrical energy during the rainy and gloomy seasons. To counter this disadvantage, we can combine two energy sources such that if one fails, the other will continue to generate [8]. In good weather conditions, we can use both sources simultaneously [9].

Environmental Benefits: Renewable energy is clean and produces little to no greenhouse gas emissions, which are a major factor in climate change [10]. Using renewable energy will help us minimize our dependency on fossil fuels and our carbon footprint. Energy Security: Compared to fossil fuels, which are scarce and susceptible to supply disruptions, renewable energy sources are more abundant and accessible, making them a more secure source of energy [11]. This could lead to lower costs for consumers and companies, as well as the creation of new jobs in the renewable energy industry [12].

Utilizing renewable energy will help us reduce our reliance on fossil fuels as well as our carbon footprint. Energy Security: Because renewable energy sources are plentiful and readily accessible, they are more secure than fossil fuels. Economic advantages: Renewable energy sources are sometimes even more affordable than fossil fuels when it comes to cost. This might reduce prices for both consumers and companies, while also generating new jobs in the renewable energy industry [13]. Employment growth and economic stimulation: The renewable energy industry is growing and has the potential to support employment and economic stimulation. By investing in renewable energy, we can promote the expansion of new industries and open up new employment opportunities. Energy demand satisfaction: As the world's energy demand increases, renewable energy sources can aid in providing energy in a sustainable and environmentally appropriate way [14].

Long-term power generating alternatives in stand-alone applications may include hybrid energy systems. Evaluation of additional critical aspects, such as improved system dependability and emissions reduction, is becoming more and more important in addition to cost-cutting criteria [15]. Although there may be advantages, some analysts and members of the wind industry have criticized VAWTs for being unreliable and incapable of producing wind energy in urban areas. The Darrius type and its VAWT designs are roughly 80 years old, it should be noted. Less efficiency and relative prices for large projects are the main factors favoring HAWTs over VAWTs in terms of popularity [17, 18]. It is anticipated that VAWTs will contribute significantly to the production of power for cities as they become more and more cost-effective [16].

This paper presents the novel idea and prototype model of a combined of both wind vertical and horizontal axis turbine and solar energy producing system. This might be positioned obliquely on a roadway. The airflow created by automotive motion is used to produce energy. The same architecture can be utilized to deliver electricity to places with difficult terrain, impassable roads, and limited on-grid connectivity. A device that changes kinetic energy into mechanical energy is a wind turbine. The mechanical energy generated by a wind turbine is converted into electrical energy using a DC generator and solar radiation is converted into electrical energy by using solar panel.

2. Literature Survey

A. O. Ciuca, I. B. Istrate, and M. Scripcariu, explains on the (Wind/Diesel/Battery) off-grid system has mainly been researched at a South Sinai site in Egypt for home-scale usage due to the unpredictable nature of renewable energy sources. According to the various demands of electrical loads and season weather data, eight various systems, each of which comprises of a small windmill, battery storage, and gasoline generator, are explored. The main objective

is to determine how adding wind power as a source of energy will impact the cost of the electricity generated while accounting for the cost of decreasing CO2 emissions as an environmental advantages of the wind turbine, which releases no pollutants while in operation, a neighborhood, or a commercial enterprise than the main grid connected to a large centralized power plant [8].
Yang et al. illustrated a study to examine the reliability of hybrid photovoltaic-wind power generating systems that incorporate a battery bank and provides a model for simulation for estimating the likelihood of a power supply breakdown. The complimentary qualities of solar radiation and wind energy for Hong Kong are examined. Local meteorological data patterns research reveals that solar and wind energy can complement one another effectively and can offer a strong utilisation factor for green energy applications [9].

V. K. Gajbhiye et al. described on any nation to flourish economically and socially, energy is a must. A difficulty with power generation exists in the developing countries. It is important to use fossil fuels responsibly because they are finite resources. The greenhouse effect grows as a result of the power produced. Utilising a system that combines wind and solar energy can provide greater advantages and be used all year long [10].

Tina et al. presented on the purpose of evaluating the long-term sustainability of a hybrid wind/solar power system for both stand-alone and grid-dependent applications, a review of the literature is conducted. A probabilistic approach is used to model the unpredictability of the load and resources [11].
Deshmukh and Deshmukh research on renewable energy technologies progress and petroleum prices rise, renewable energy systems that are hybrid (HRES) are becoming more and more common for remote region power production applications. These technologies' economic benefits make it worthwhile to incorporate them in efforts to increase the capacity of developing nations' power plants. In order to improve their performance, develop methods for precisely forecasting their production, and successfully integrate them into different conventional generating sources, research and development activities in solar, wind, and other sources of clean energy must continue [12].

Ahmed et al. discussed about, An analysis of the research on an innovative hybrid model that combined the generation of fuel cells with wind and solar energy is done. The wind and solar power systems served as the main energy sources, and the system of fuel cells was used as a backup option. The findings demonstrate the system's dependability and ability to supply the load with high-quality energy even in the absence of wind or sunlight [13].
S. Ravikumar and H. Vennila proposed a new concept of hybrid power system, which combines solar and wind energy sources, is the most widely used renewable energy technology since it is dependable and complementary in nature. In distributed generation (DG), wind / PV hybrid systems are frequently used. The innovative approach suggested in this research results in higher voltage stability and higher power output. In the design model, the voltage produced by the photovoltaic panels and the wind energy conversion system (WECS) is delivered to separate DC - DC converters that are connected to a shared DC bus and independently regulated [14].

A. Gupta, R. P. and Saini M. P. et al.. express the research views on rural areas benefit from hybrid power plants (HES), which combine renewable energy sources including wind, sun, biomass, small/micro hydro, and diesel or petrol generators to provide electricity. This article provides a broad methodology framework for creating an action plan for a remote region small-scale hybrid energy system. the reduction in the cost of producing energy forms the foundation of cost-effective modelling in remote rural areas [18].

A review of the various solar and wind-related hybrid systems is conducted in this study. The concepts regarding various strategies that are usefully employed in model design are gleaned from the literature study.

3. Proposed Methodology

The energy from a single source will not sufficient to run the display boards. The hybrid power generation by solar panel, horizontal and vertical turbine design, which provides sufficient power throughout the day as shown in (Figure 2). The hybrid controller receives the energy supply from both sources and is in charge of removing power from both sources and delivering an uninterrupted supply to the DC-DC converter. As it supplies the voltage for storage of batteries in accordance with the needs of the battery system, the DC-DC converter also serves as a voltage regulator. When less energy is produced from natural sources of energy, the battery system is utilized to store the excess energy generated at a particular point in time to maintain a consistent output of energy. The (Figure 4) represents the proposed model consisting of solar and wind hybrid system.

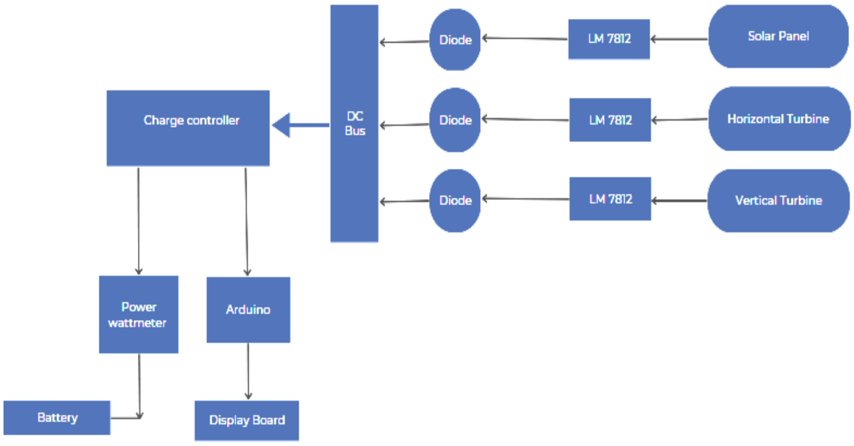

Figure. 2. *Hybrid energy generation for display boards.*

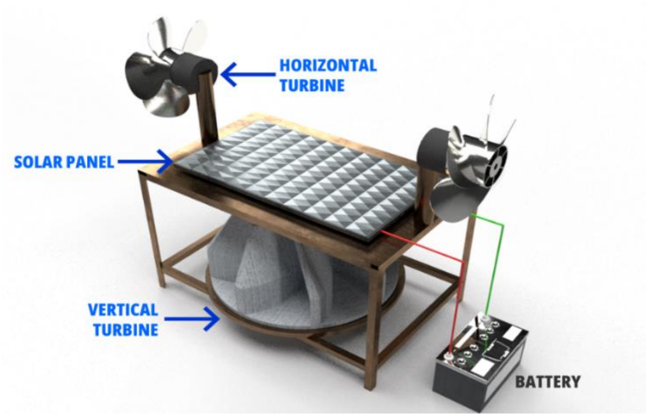

Figure 3. *Experimental setup of Hybrid Generation System.*

4. Experimental Results

4.1 Case 1: Setup on the Ground Floor

A hybrid energy generation system is experimentally put up on the ground level to evaluate energy generation depending on the wind and solar conditions as shown in (Figure 4). The quantity of power generated on the ground at various times (morning, afternoon, and evening) is shown in the [Figure 5, Figure 6, Figure 7].

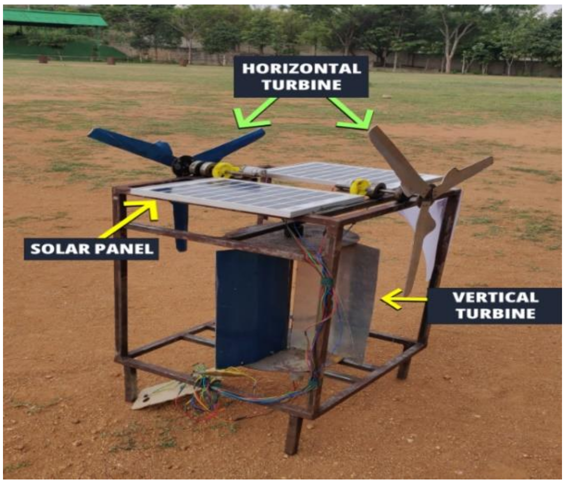

Figure. 4. *Experimental setup at ground floor.*

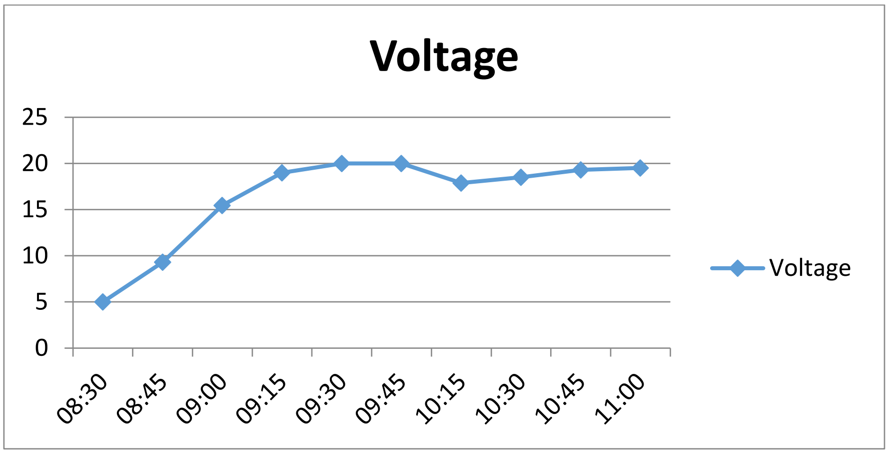

Figure. 5. *Hybrid power generation in the morning, with the X-axis representing time and the Y-axis representing voltage (V).*

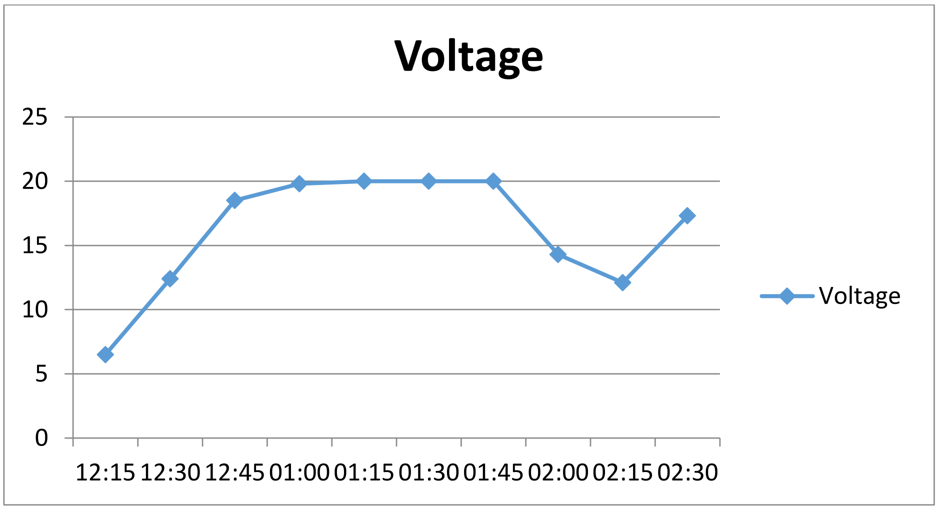

Figure 6. *Generation of hybrid power during afternoon.*

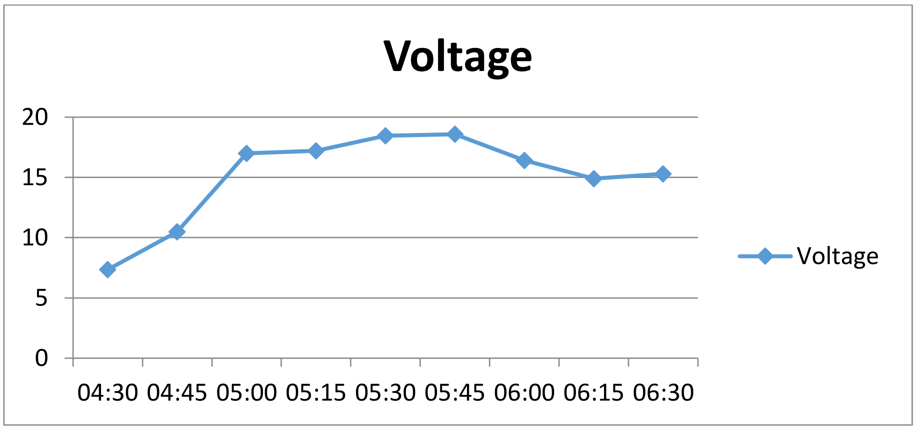

Figure 7*. Generation of hybrid power during evening.*

4.2 Case 2: Setup on the Fifth Floor

On the fifth floor, a hybrid power generation system is installed experimentally to assess how much energy can be produced based on wind and solar conditions as shown in [Figure 8]. The [Figure 9, Figure 10, Figure 11] display the amount of electricity produced on the fifth level at different periods (morning, afternoon, and night time).

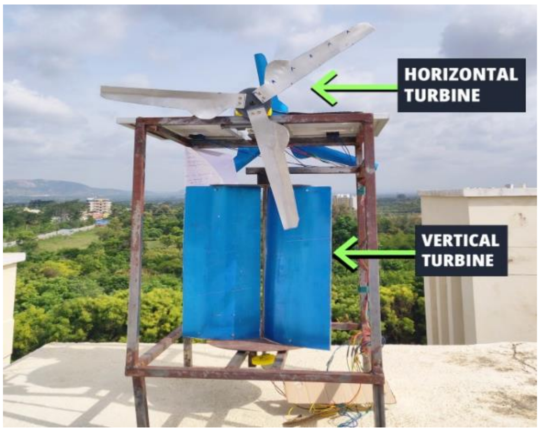

Figure. 8. *Experimental setup at fifth floor.*

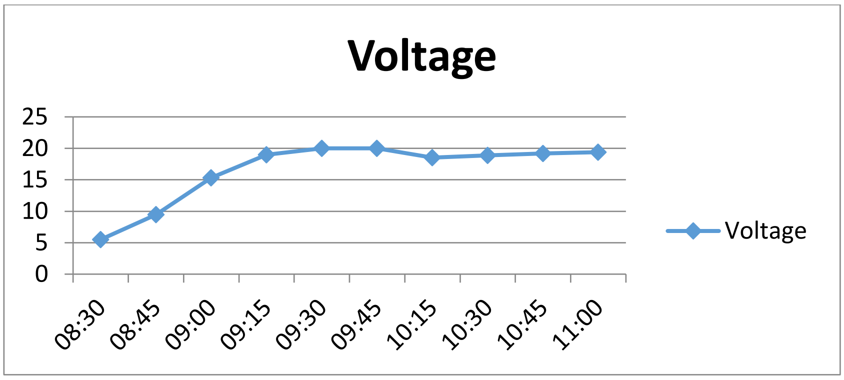

Figure. 9. *Generation of hybrid power in the morning (fifth floor), where the Y-axis is representing Voltage (V) and the x-axis is time.*

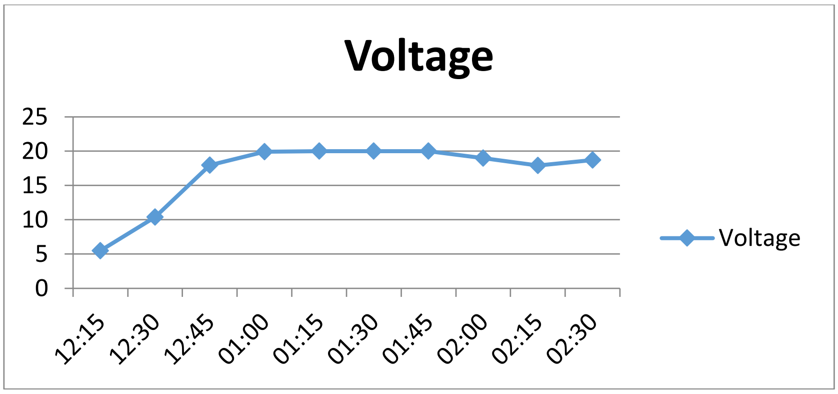

Figure. 10. *Generation of hybrid power during afternoon.*

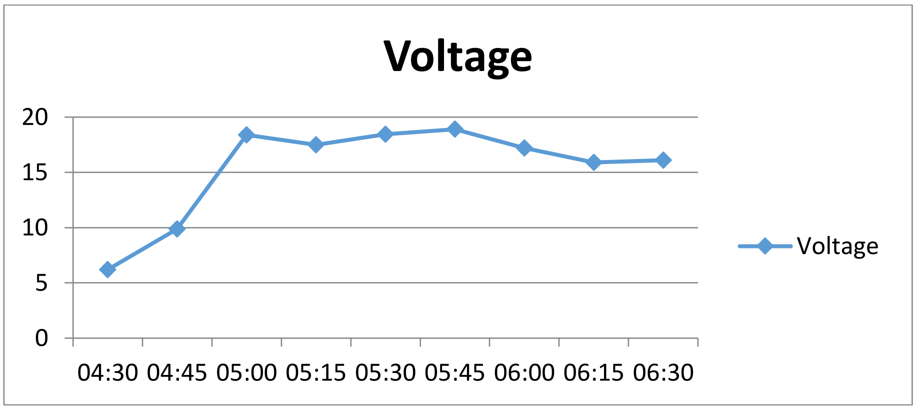

Figure. 11. *Generation of hybrid power during evening.*

4.3 Case 3: Model Setup on the Highway

To analyze the production of energy depending on wind direction, vehicle motion, and solar radiation conditions, an experimental hybrid energy production system has been installed on a highway is shown in (Figure 12). The amount of power generated on the highway at various timing (morning, afternoon, and evening) is shown in the (Figure 13), (Figure 14) and (Figure 15).

Figure. 12. *Experimental setup at highway.*

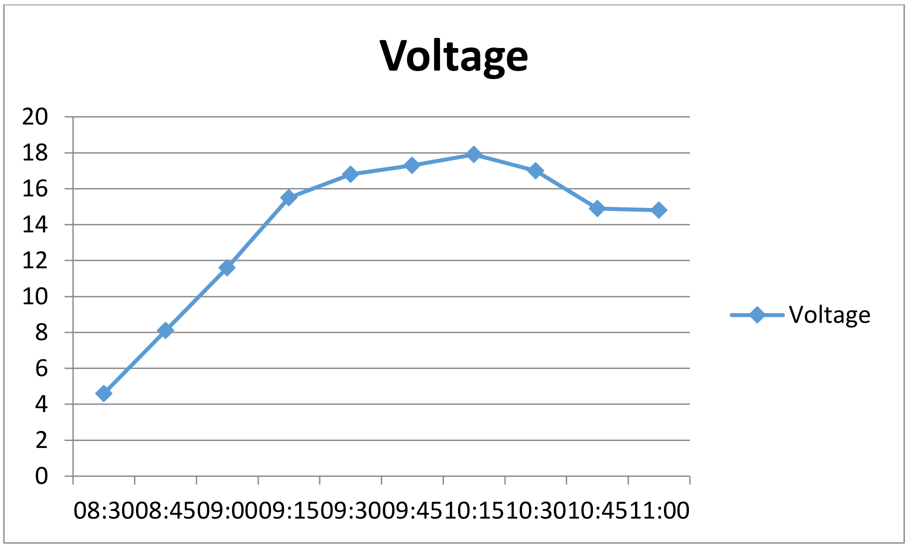

Figure. 13. *Hybrid power generation in the morning, with the X-axis representing time and the Y-axis representing voltage (V).*

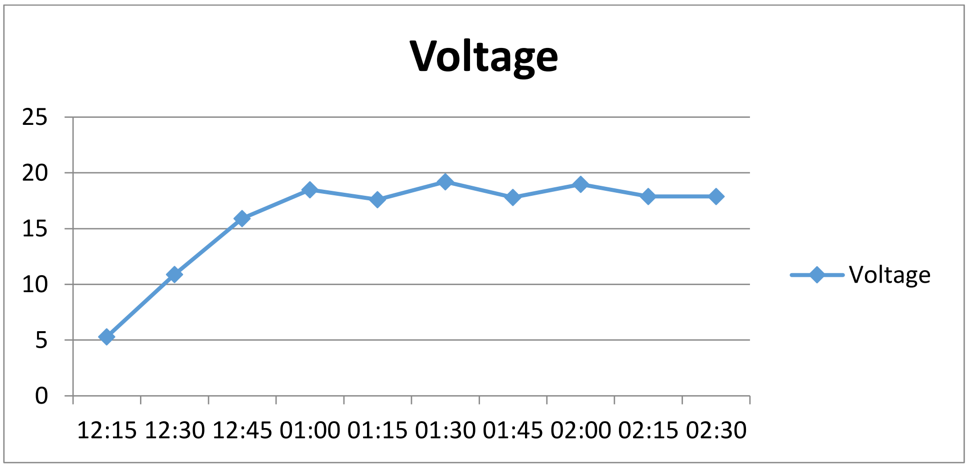

Figure. 14. *Generation of hybrid power during afternoon.*

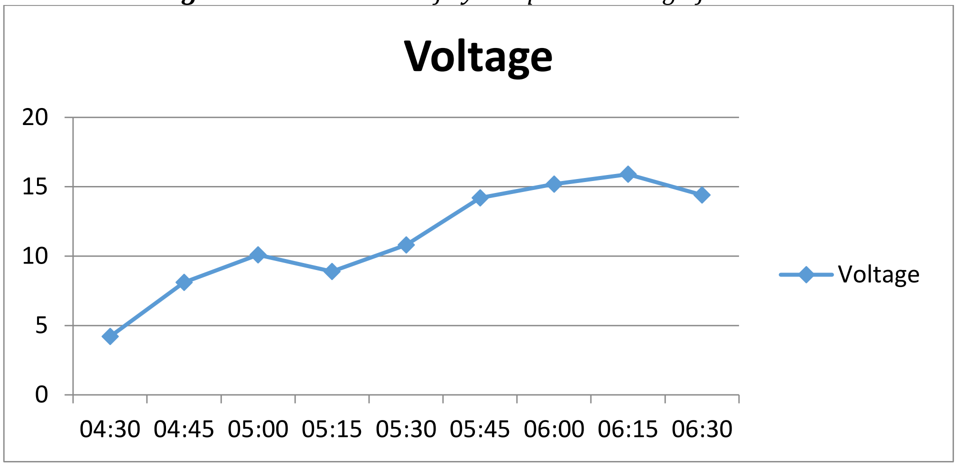

Figure. 15. *Generation of hybrid power during afternoon.*

The experimental results obtained were observed from different levels of the ground i.e. ground floor, fifth floor and at highway. Observations were recorded at different intervals of time during the day. The particular day when the readings were noted down was a slight cloudy day. Variations could be observed if day was a normal sunny day.

5. Conclusion

The hybrid energy generation for display boards is an innovative approach that combines renewable energy sources with traditional energy sources to power display boards. The proposed system offers several advantages, including reduced dependency on grid electricity, lower operational costs, and environmental sustainability. As the market size is growing, driven by increasing awareness of sustainability, government initiatives promoting renewable energy, and advancements in energy storage and power management technologies has to be considered. The solutions may involve the integration of solar panels, wind turbines, energy storage systems, and efficient power management techniques. Emerging trends in the hybrid energy generation for display boards market can include the integration of smart technologies for energy management, the use of advanced materials for more efficient solar panels or wind turbines, and the development of scalable and modular solutions. However, challenges remain, such as the initial investment costs, limited scalability for large-scale display installations, and the need for effective maintenance and monitoring of hybrid energy systems.

Overall, hybrid energy generation for display boards presents a promising solution for powering display boards in a sustainable and efficient manner. As technology continues to advance and costs decrease, the adoption of hybrid energy solutions is expected to increase, driving the market further and contributing to a greener future.

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