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Research Paper

Solar Power Generator as an Alternative Energy Source for the Propeller Driver Motor

Andy Wahyu Hermanto[1], Achmad Dzulfiqor[1]*

[1] Politeknik Ilmu Pelayaran Semarang, Indonesia

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Abstract

Solar Power Generation is one of the renewable energy modes currently being extensively developed. This is due to environmental issues caused by non-environmentally friendly fossil fuel sources. The purpose of this research is to support efforts in reducing the use of fossil fuels by designing a model of an electric main engine using Solar Power Generation (PLTS) and understanding the working system of this design. The research method used is the Research and Development method, consisting of 10 stages. These stages include information gathering, product planning, initial product form development, initial testing, initial revisions, main testing, major revisions, testing and validation, final revisions, and product implementation. The results of this research include designing the model, starting with assembling electronic and mechanical components and integrating them into the ship's body as a system. The working system of this design involves converting solar energy into electrical energy, which is then used as the energy source to drive the ship's propeller.

Keywords *Research and Development, Solar Power Plant, Solar Power Generation System, Propeller Driver Motor*

INTRODUCTION

Indonesia is an archipelagic country with a total of 16,766 islands. 67% of Indonesia's territory is maritime, covering an area of 3,257,357 square kilometers. As such, Indonesia is often referred to as a maritime nation heavily reliant on its marine sector. It is a tropical country with alternating rainy and dry seasons, and almost the entire Indonesian territory receives approximately 12 hours of sunlight each day throughout the year.

The continuous and sustainable use of fossil fuels in the maritime industry has significant negative impacts on the environment. For instance, the potential for oil spills at sea, air pollution, and the environmental consequences of fossil fuel extraction. A vessel with a GT (Gross Tonnage) of 63,000, equipped with a main propulsion engine generating 18,000 HP, can consume 30 tons of fuel daily. Hence, the demand for fuel in the maritime industry is indeed substantial.

Solar energy is one of the renewable energy sources with great potential to replace fossil fuels. Sunlight is converted into electrical energy by Photovoltaic cells in solar panels, producing direct current (DC), which is then regulated by a Solar Charge Controller (SCC) to control voltage and current output. The electrical energy produced is stored in batteries and used for various purposes. To use alternating current (AC) loads, an Inverter must convert DC to AC, adapting to the load requirements.

Solar power generator systems are implemented at various scales, from households to large corporations. In this context, the author utilizes a solar power generator system as the source of electrical energy for the motor propeller driver motor. Therefore, this research focuses on the design and construction of a solar power generator system as an alternative source of electrical energy for the propeller driver motor, along with understanding the working system of this prototype.

Corresponding author's email: achmad.dzulfiqor@gmail.com

LITERATURE REVIEW

a. Tharo's (2020) conducted research entitled "Design and Construction of a Motor Ship Simulator using Solar Panels." This research discusses the design of a motor ship simulator using the Solar Power Generation System (PLTS) as the energy source. PLTS is chosen as the energy source due to Indonesia's optimal solar energy potential, which has a tropical climate. Meanwhile, almost all ships sailing in Indonesian waters use diesel engines as the main propeller driver, with solar oil as the fuel. Therefore, it is expected that the PLTS system can replace the role of fossil fuels, especially solar, as the energy source and the electric motor can replace the diesel motor as the propeller driver.
b. Purwoto's (2018) research titled "Efficiency of Solar Panels as an Alternative Energy Source" aims to provide a clear overview of the efficiency of using solar panels as an alternative energy source compared to using a generator/Genset for electrical equipment. This research uses a 100 WP capacity solar panel, and the energy generated by this solar panel is stored in a 12-volt 70 Ah battery (accumulator). The electrical energy produced by the solar panel is in the form of direct current (DC). However, since most electrical appliances use alternating current (AC), an inverter is needed to convert the DC voltage generated by the solar panel into AC voltage. The inverter used in this study has a capacity of 2000 watts, converting the 12-volt DC to 220-volt AC, which will then be used as the electrical energy source for appliances such as a blender and light bulbs.
c. Sudiyono and Antoko (2008) research titled "Design and Construction of a Tourist Boat with Solar-Powered Electric Generator as an Alternative Energy Source for Propeller Drive" aims to design a tourist boat with a solar-powered electric generator as the energy source for an electric motor to drive the propeller. The weather conditions in the Surabaya region and its surroundings are highly favorable for harnessing solar energy as an alternative energy source, particularly in the tourism sector, especially water-based tourism, supported by flowing rivers within the city. The design and construction of a tourist boat offer a solution or effort to bring water tourism, especially river tourism, closer to realization. Building a solar-powered tourist boat can reduce pollution and promote a better environmental atmosphere.

RESEARCH METHOD

The research methodology employed in this study is Research and Development, utilizing the Borg and Gall model. This developmental study follows the ten research steps outlined by Borg and Gall (Rohmaini et al., 2020).

a. Research and information collecting
   This step involves the exploration of pertinent literature concerning the research issue under investigation and preparing for formulating the research framework.
b. Planning
   This phase encompasses the formulation of competencies and skills relevant to the encountered issue, delineating objectives to be achieved in each stage, and, in certain instances, undertaking a preliminary feasibility study if deemed necessary.
c. Develop a preliminary form of product
   This phase entails the preliminary development of the resultant product. It encompasses the preparation of supporting components, the compilation of guides and instructions, as well as the assessment of the viability of the utilized auxiliary tools.
d. Preliminary field testing
   This stage involves initial field trials on a limited scale, encompassing the participation of 6-12 subjects. Data collection and analysis can be conducted through interviews,

observations, or questionnaires during this phase.

e. Main product revision
This step involves refining the initial product generated based on the outcomes derived from the preliminary trials. This improvement process can be executed in segmented phases, corresponding to the findings acquired from the limited trials. The objective is to attain a primary draft version of the product that is poised for broader-scale testing.

f. Main field testing
The main trial involves a larger number of respondents compared to the initial trial. This is carried out to acquire broader and more specific data.

g. Operational product revision
This involves refining or perfecting the outcomes of broader-scale trial runs, thus rendering the developed product an operational model design ready for validation.

h. Operational field testing
This step pertains to the validation testing of the generated operational model.

i. Final product revision
This involves finalizing refinements to the developed model to produce the end product.

j. Dissemination and implementation
This step encompasses the dissemination phase of the developed product or model.

FINDINGS AND DISCUSSION

The photovoltaic cells present in a solar panel undergo the reception of photon radiation, subsequently converting it into electric energy. The photovoltaic phenomenon facilitates this conversion. Additionally, the voltage generated by the solar panel typically surpasses the battery's voltage capacity, necessitating the deployment of a Solar Charge Controller (SCC). The SCC regulates the voltage output from the solar panel, aligning it with the battery's voltage specifications to enable effective battery charging. This regulatory function of the SCC becomes paramount due to the inherent voltage disparity between the solar panel and the battery, exacerbated by the considerable fluctuations in the solar panel's voltage output.

The electrical power stored within the battery is harnessed to propel the electric motor-driven ship's propulsion system, a design devised by the researcher. The 12-volt battery voltage is directed to fulfill the power requisites of the load, encompassing the Electronic Speed Controller (ESC). The ESC serves the pivotal role of regulating the speed of the DC motor, the propulsive element, in addition to the battery's contribution to powering the receiver, tasked with receiving control signals from the transmitter. Furthermore, the battery's energy is allocated to the motor servo, which actuates the electric ship's steering mechanism.

The Solar Photovoltaic Power Generation system employed in this study is an alternative energy source to provide power support for the electric motor-driven ship. In conjunction with the alternative energy source derived from the Solar Photovoltaic Power Generation system, the researcher incorporates an additional 12-volt battery unit to simulate an emergency power supply scenario. This battery unit addresses exigent situations when the electrical output generated by the Solar Photovoltaic Power Generation system proves inadequate to meet the demands of the entire load configuration.

In this stage of development, the researcher initiates the creation of an initial product design, which serves to facilitate the subsequent crafting of the design for the Main Engine Electromotor with Solar Power Generator. The Wiring Diagram and preliminary design of the product to be assembled are presented below.

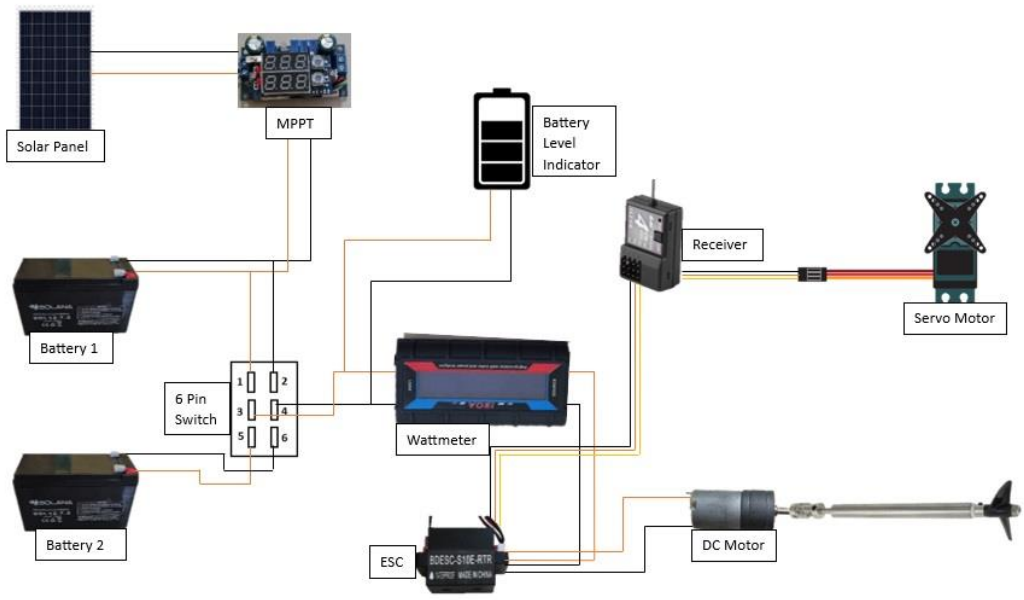

Figure 1. Wiring diagram

The assembly phase represents the final stage within the design and development process, wherein all mechanical and electronic components are integrated into a comprehensive and functional entity. The assembly process can be subdivided into several stages as follows:

a. Mechanical components assembly

The assembly process of mechanical components comprises two distinct segments: the ship's propeller propulsion system utilizing a 12V DC motor as the primary driving mechanism and the design of the ship's steering system employing a servo motor to actuate the rudder blade.

b. Electronic components assembly

Within this process, two distinct electronic subsystems will ultimately be amalgamated into a unified system. These subsystems encompass the Solar Power Generator and the mechanical component control system. The Solar power generator is an energy source to provide power, subsequently stored within a battery. Meanwhile, the mechanical component control system regulates the speed of the DC electric motor and steering control of the ship.

The method for operating this prototype involves connecting the solar panel to the charging port to recharge the battery. In sufficient sunlight, the solar power generation system will proceed to charge the battery. The vessel's control is facilitated through a remote control, which, when activated, establishes a connection with the receiver installed on the ship. The thrust lever regulates the propeller's rotational speed, while the steering wheel controls the ship's rudder.

The following figure is the data derived from the testing concerning the power generated by the Solar Power Generator for battery charging and the ship's speed during testing, with the load condition operated continuously. Partly cloudy skies characterized the weather conditions during the execution of this testing.

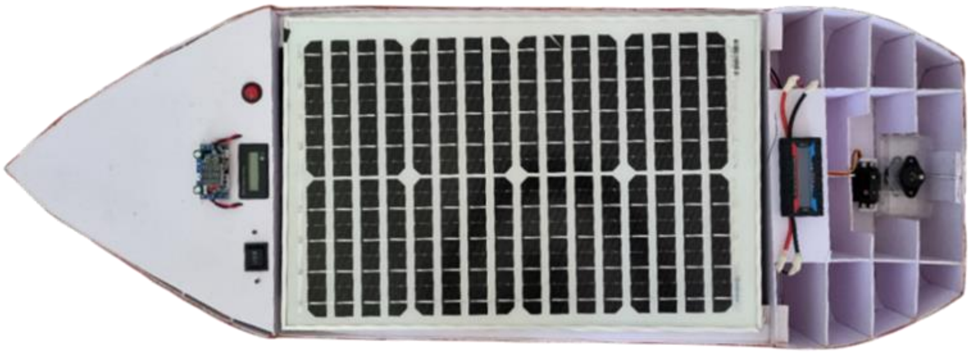

Figure 2. Preliminary design after assembly

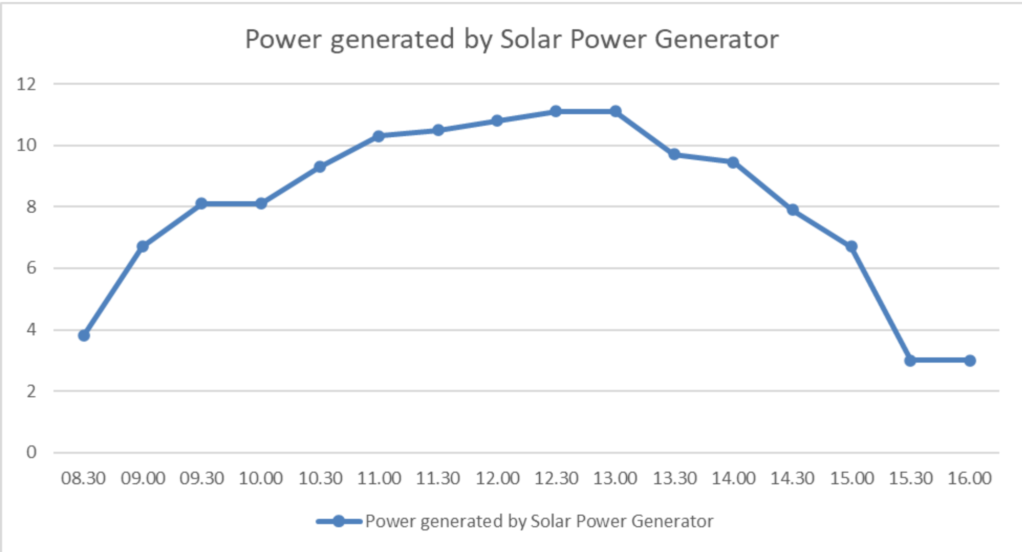

Figure 3. The power generated by Solar Power Generator

Based on the data provided above, it is evident that the maximum power output generated by the solar power generation system is 11 watts at 01:00 p.m., while the minimum power output is 3 watts during the timeframe of 03:30 p.m. to 04:00 p.m. This power range is amply sufficient to supply the demands of the maximum load, quantified at 6 watts, allowing surplus power to be effectively stored within the battery unit.

The following data presents the vessel's velocities observed during testing. The vessel's velocities were evaluated with respect to the electrical power input employed and the deployment of a payload weighing 4 kilograms positioned within the cargo compartment.

The researcher conducted the testing at the PIP Semarang swimming pool from 08:30 a.m. to 04:00 p.m. The weather conditions during the testing were partly cloudy. Meanwhile, the testing location received direct sunlight from 09:00 to 15:00, as some buildings around the swimming pool slightly obstructed a portion of the pool area from sunlight. This time frame coincides with the period when the Solar Power Generation System produces power exceeding the power requirements of the maximum load, which amounts to 6 watts.

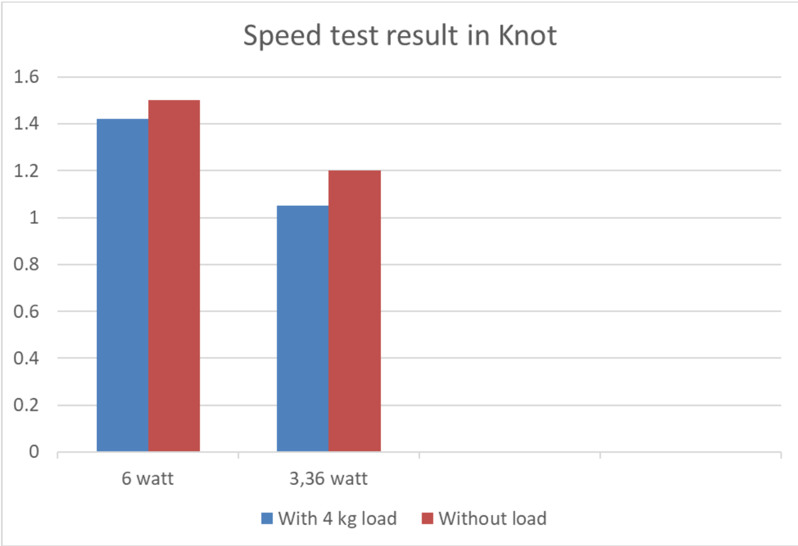

Figure 4. Speed test result in Knot

CONCLUSIONS

Developing this prototype involves assembling mechanical and electronic components and then integrating the mechanical and electronic systems into the vessel's structure. Precise assembly is essential to avert circuit malfunctions. Furthermore, waterproofing procedures for the vessel's structure are imperative to prevent leakage that could lead to water ingress.

This prototype's operational mechanism entails converting solar energy into electrical energy, a process facilitated by the solar power generation system. The generated electrical power is stored within a battery. The power from the battery is utilized to drive a DC motor, which functions as the propeller's driving mechanism for the ship. The vessel's control system employs a remote control, which transmits signals subsequently received by a receiver. The receiver then transmits signals to an Electronic Speed Controller (ESC) for regulating the speed of the DC motor and to a servo motor for adjusting the ship's rudder angle in accordance with commands issued via the remote control.

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