A Performance Of Electric Energy Generation Hybridization

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Abstract: Most of the energy used in Indonesia comes from fossil energy which is processed into petroleum or other forms and used for electrical energy. This makes it possible that in the future fossil energy which is continuously used will run out, plus the recent world energy crisis has made world oil prices even higher. Pollution caused by energy from fossils is also a problem for human life. Therefore, several solutions to overcome these problems are by utilizing renewable energy sources. Solar and wind energy are examples of renewable energy. One technology that utilizes renewable energy sources is by hydrolyzing solar and wind power or also called combining two energy sources at once. The design and innovation of hybrid power generation technology with solar and wind power as well as the analysis of voltage, current and rotation produced by hybrid power generation with solar and wind power are carried out in this study.

INTRODUCTION

Energy is a crucial part of human life, as nearly all activities require energy. For example, lighting, industrial processes, and household appliances need electrical energy, while vehicles—both two-wheeled and four-wheeled—depend on gasoline, a type of fossil fuel. Many aspects of daily life rely on some form of energy.

In Indonesia, most energy comes from fossil fuels processed into petroleum, natural gas, and other forms. The recent global energy crisis has caused oil prices to soar. High oil prices result from factors like increasing demand, dwindling reserves, rising living standards, more vehicles on the road, and rapid industrial growth.

Pollution from fossil fuel use is also a serious issue. To address this, the Indonesian government, through the National Energy Policy (KEN), has implemented several solutions, such as energy conversion, diversification, and intensification.

Promoting renewable, environmentally friendly alternative energy sources is highly recommended.

Utilizing renewable energy sources is one of the solutions to Indonesia's energy crisis. Solar and wind energy are examples of such sources, and Indonesia, as a tropical country, has considerable potential for both. Additionally, solar and wind energy are known for their eco-friendly qualities, making them suitable for reducing pollution.

Solar cells, or solar panels, are used to convert solar energy into electrical energy. These photovoltaic devices absorb sunlight, creating an electric charge [1]. Wind energy, on the other hand, is converted into electricity using wind turbines. As wind passes through the turbine blades, it generates rotational force, driving an electric generator [2].

Combining two different energy sources to produce electricity is known as hybrid or hybridization [3]. A hybrid system combining solar and wind energy is designed to optimize the overall system to meet varying load demands.

The purpose of integrating two energy sources is to overcome the limitations of single-source power systems, address weather variability, and sustain energy distribution during peak demand. This approach provides more reliable energy supply compared to single-source systems [4].

This study aims to design and develop technology to optimize electric power generation through solar and wind hybridization. It will investigate how the current and voltage output from hybrid solar and wind power systems can be adjusted to meet energy requirements.

LITERATURE REVIEW.

2.1. Solar Energy

Solar energy is energy obtained by converting rays and heat from the sun (sun) or in other words changing energy radiation in the form of heat and light emitted by the sun. Solar energy is obtained by converting solar heat energy through certain equipment into other forms of resources. Solar energy is one of the sources of electricity generation besides water, steam, biogas, coal and petroleum.

Without the energy that comes from the sun, our planet would not be able to support life and solar energy is one of the most abundant forms of energy available on the planet. The use of solar energy has been widely used in various parts of the world and if exploited properly, this energy source has the potential to meet the world's current energy needs for a long time. The future potential of solar energy is only limited by the desire to take advantage of the opportunity. The sun can be used directly to produce electricity or for heating or even cooling.

There are many ways to harness the energy of the sun. This energy can be harnessed by using a series of technologies such as solar heat, solar photovoltaics, solar thermal electricity, solar architecture, and artificial photosynthesis. The technique of utilizing solar energy began to appear in 1839, discovered by AC Becquerel. He used silicon crystals to convert solar radiation, but until 1955 the method had not been widely developed. During that period of more than a century, the energy sources that were widely used were petroleum and coal [5].

Efforts to redevelop new ways of utilizing solar energy only emerged again in 1958. Silicon cells used to convert solar energy into power sources began to be considered as a new method, because they could be used as a power source for space satellites [5].

2.2. Solar Cell

Solar cells or also often called photovoltaics are devices that can directly convert sunlight into electricity. Solar cells can be called the main actor to maximize the enormous potential of sunlight energy that reaches the earth. Solar cells are made of semi-conductor materials, the most common semi-conductor material used in photovoltaic cells is silicon, an element found in abundance in sand. All photovoltaic cells have at least two layers of such semiconductors, one positively charged and one negatively charged. When light shines on the semiconductor, an electric field crosses the junction between the two layers causing electricity to flow, generating DC current. The stronger the light, the stronger the electric current.

More clearly, solar cells consist of a junction of P and N type semiconductor materials (PN Junction semiconductor). Solar cells are one type of photovoltaic light sensor. namely a sensor that can change light intensity into voltage changes at its output. If the "Solar Cell" receives light radiation, then at both output terminals a DC voltage of 0.5 volts to 1 volt or even more will be output, depending on the specifications of the

Solar Cell or solar panel [6].

The electrical voltage produced by a solar cell is very small, around 0.6V without load or 0.45V with load. To obtain a large electrical voltage as desired, several solar cells are needed in series or parallel. If 36 solar cells are arranged in series, it will produce a voltage of around 16V. This voltage is sufficient to supply a 12V battery. To obtain a larger output voltage, more solar cells are needed. The combination of several solar cells is called a Solar Panel or solar module. An arrangement of around 10 - 20 or more Solar Panels will be able to produce sufficient high current and voltage for daily needs [7]. The physical form of a solar cell and solar panel can be seen in Figure 1.

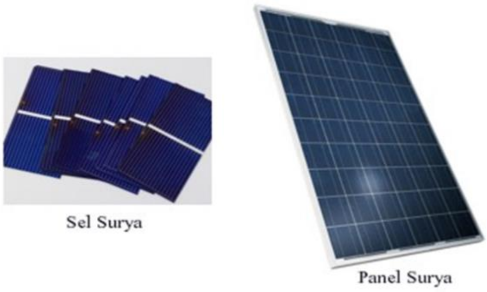

Figure 1. Physical form of solar cells and panels solar

General construction of solar cells is a unit of solar cell devices in order to function properly. It is necessary to know the general construction or general parts of a solar cell to make it easier to understand the working principle of solar cells. The general parts of solar cells can be seen in Figure 2.

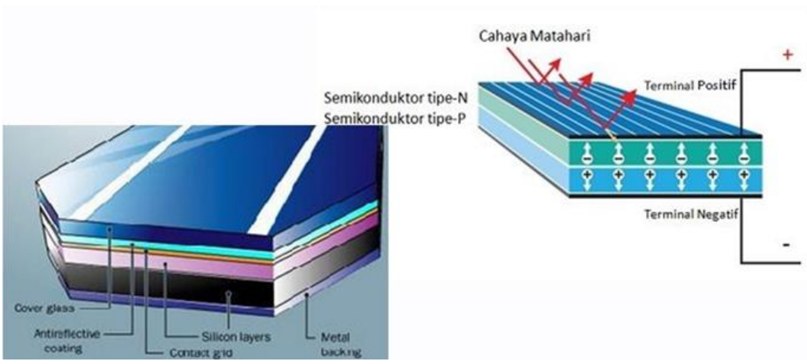

Figure 2. General parts of a solar cell

2.3. Wind Energy

Wind is a collection of air that moves with horizontal air movement or parallel to the earth's surface which occurs due to differences in air pressure and the rotation of the earth. Wind moves from low temperatures to high temperatures or moves from high pressure to low pressure. This wind apparently consists of several types, not just one type. [6]

Electrical energy is an energy that cannot be seen directly but can be felt, just as wind energy is **an** energy that cannot be seen directly but can be felt. In this hemisphere we can easily feel the wind everywhere. Wind is one of the renewable energy sources that is endless when used as a source of electrical energy.

Wind is one form of energy available in nature, which can be used as electrical energy. Wind Power Plants convert wind energy into electrical energy using wind turbines or windmills. The way it works is quite simple, the wind energy that rotates the wind turbine, is forwarded to rotate the rotor on the generator at the back of the wind turbine, so that it will produce electrical energy. This electrical energy is usually stored in a battery before it can be used. In Figure 3, a simple sketch of a windmill can be seen.

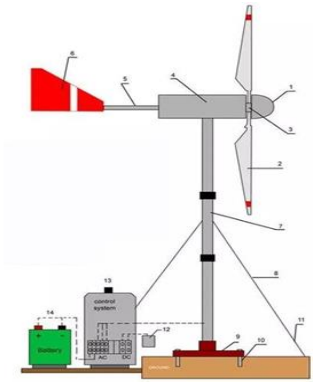

Figure 3. Sketch of a windmill

The energy produced by a wind turbine is expressed in a sequence of mathematical equations that will be described. The kinetic energy produced by a moving object can be calculated using equation 1.

$$E_{Kinetik} = \frac{1}{2} m v^2 \quad (1)$$

Where :

E= kinetic energy
½= constant
m= mass of air (kg)
v = wind speed (m/s)

The mass of air m can be derived using equation 2.

$$m = \rho(Ad) \quad (2)$$

Where :
ρ = Density of air
A = Area swept by the turbine wind (m2)
d = Distance traveled by the wind (km/h)

The power generated by a wind turbine (Pw) is the kinetic energy per second which is expressed by equation 3.

$$P_w = \frac{E_k}{t} = \frac{\frac{1}{2}\rho A d v^2}{t} = \frac{1}{2}\rho A v^3 \quad (3)$$

Where :
Pw = Wind turbine power
Ek= Kinetic energy
ρ = Density of air
A= Area swept by the turbine (wind m2)
d = Distance traveled by the wind (km/h)
v = Wind speed (km/h)

The actual energy that can be absorbed by a wind turbine depends on the efficiency of the wind turbine expressed in Cp (λ, β) which is a function of λ (tip speed ratio) and β (pitch angle). The pitch angle β is the angle between the turbine blade and the longitudinal (horizontal) axis. While the tip speed ratio λ is defined as the ratio between the turbine rotor speed and the wind speed, which can be calculated using equation 4.

$$\lambda = \frac{\omega R_{rotor}}{v} \quad (4)$$

Where :

ω = Angular velocity of the wind turbine
R = Radius of the wind turbine
m = Air mass

Therefore, the actual power that can be absorbed by the wind turbine can be calculated using equation 5.

$$P=,1\text{-}2.Cp(\lambda.\beta)\rho A,v\text{-}3. \quad (5)$$

Where Cp (λ.β)/λ is equal to the torque coefficient of the wind turbine, ρ is the density of air, A is equal to the area swept by the wind turbine in units (m^2) and v is the wind speed (km/h).

By using the equation above, the torque which is defined as power divided by angular velocity of rotation can be calculated using mathematical equation 6.

RESEARCH METHODS

This research is a development or Research and Development, namely research with modeling as a function of creation and innovation in efforts to solve the energy crisis problem. This research was conducted at the Faculty of Engineering, Medan Area University with stages from the literature study process of data collection, data analysis, and conclusions.

In collecting data in a study, the method is important for the success of the research, therefore it is necessary to plan properly in choosing a method for data collection.

The equipment used in this research is as follows:

1. Electrical measuring instruments (multitester, ampere clamp, etc.)
2.Tool Kit
3. Screwdriver Set
4. Ring wrench
5.Lebtop
6.Calculator
7. Stationery

To design innovations in hybrid power generation technology with solar and wind power, precision in component selection is required. If the component selection is not right, there will be problems with the working system of the tool to be made. The accuracy and tolerance of the components greatly affect the accuracy of the tool's work.

Usually, the determination of the components to be used is the type of components that are easily available on the market. In addition to being easy to obtain, components also have economic value so that the manufacture of the tool does not require expensive costs. In addition to determining the right components, the layout of the components in the circuit also needs to be considered, so that later in the placement of the components according to the circuit and the components can work according to their functions.

This research takes data from the results of the design of hybrid power generation technology innovation with solar and wind power by measuring the current, voltage and rotation of solar panels and wind turbines from hybrid power generation technology innovation with solar and wind power.

In general, the system design can be seen in Figure 7. where the system is designed to consist of solar panels, windmills, charge controllers, batteries, inverters and loads.

RESULTS AND DISCUSSION

The results and discussion will be presented in this chapter, namely, the design and innovation of hybrid power generation technology with solar and wind power, how the current, voltage and rotation produced by the hybrid power generation with solar and wind power are obtained from the measurement results on the designed system.

The prototype design for the hybrid power generation technology innovation using solar and wind power has been completed and tested and is shown more clearly in Figures 4 and 5.

Figure 4. Solar Panel (Solar Cell)

Figure 5. Windmill Prototype

The results of current (Ampere) and voltage (Volt) measurements on solar panels observed for 5 days from 09.00 to 15.00 can be seen in table 1.

Table 1. Voltage and Current Measurement Results On Solar Panels

Day No.	O'clock 09.00		O'clock 10.00		O'clock 11.00		O'clock 12.00		O'clock 13.00		O'clock 14.00		O'clock 15.00	
	V	A	V	A	V	A	V	A	V	A	V	A	V	A
1	15	0.8	16	2.0	16	1.9	16	2.2	16	2.2	15	2.1	15	2.0
2	15	1.7	16	1.9	16	1.9	15	2.1	16	2.1	16	2.1	15	1.9
3	15	1.7	16	1.9	16	1.8	15	2.1	16	2.1	15	2.0	16	1.9
4	14	1.0	15	1.2	14	1.2	15	1.6	15	1.8	14	1.6	15	1.6
5	15	1.6	16	1.8	16	1.8	16	2.0	16	2.1	16	2.1	15	1.9

The measurement results for rotation, voltage and current on the wind turbine generator for five days can be seen in table 2.

Table 2. Rotation and Voltage Measurements

No Load Generator

Day No.	Rotation (rpm)	Voltage)
1	450	15
2	500	21
3	500	21
4	550	24
5	450	18

Meanwhile, the measurement results for rotation, voltage and current on the wind turbine generator for five days can be seen in table 3.

Table 3. Rotation and Voltage Measurements Burdened

Day No.	Rotation (rpm)	Voltage)	Current (Ampere)
1	450	12	2.3
2	450	11	1.9
3	450	12.5	2.4
4	450	11	1.7
5	450	12	1.8

CONCLUSION

The design of a hybrid power generation system with solar and wind power has been successfully implemented. And is ready to be implemented or applied.

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