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A Review on Small Hybrid Power Plant with a Combination of Solar Wind

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Abstract: *Non-sustainable wellsprings of power are at present coming up short, so elective vitality sources are required, for example, sustainable power source that is ecologically inviting, generally economical, carbon nonpartisan, for instance, cross breed wind power plants with sun oriented vitality. This examination means to make a model of a crossover wind power plant with sun oriented vitality as an elective vitality source. The usage strategy is finished by making models of wind power plants and sun oriented force plants. Besides, the two plants are joined and are generally called cross breed frameworks. This exploration was directed at the Electrical Engineering Laboratory, Paulus Indonesia Christian University, Makassar. The consequences of the examination were acquired for each 120W force plant (PLTB), 100W Solar Power Plant (PLTS). Hence the greatest force delivered by the half breed framework is ± 220 W.*
Key words: *Wind Energy, PV, Hybrid Systems.*

I. Introduction

Indonesia as an archipelagic country has many islands scattered so that the electricity service from PLN cannot be reached as a whole. This condition requires alternative energy sources that can serve people who live in rural areas, especially isolated areas that are difficult to reach but have energy that can be used as a source of electrical energy, such as wind energy, solar energy, water energy and so on. Indonesia's geographical location in the equator is at latitude 600LU - 1100LS and 9500BT - 14100BT, and with regard to solar circulation in a year in the area of 23,500 LU and 23,500LS, the territory of Indonesia will always be exposed to the sun for 10 - 12 hours a day, of course is a blessing because this sun can be used as an alternative energy source. The use of wind energy in Indonesia has a very good prospect especially for coastal areas that have relatively large winds, which can be used as alternative energy using wind turbines.

1.1. Solar Energy

Solar radiation intensity is almost constant outside the Earth's atmosphere. The solar constant Gsc, is the energy from the sun per unit of time received on a unit of surface area perpendicular to the direction of solar radiation at an average distance of the sun-earth beyond the atmosphere. The World Radiation Center (WRC) takes the solar constant value (Gsc) of 1367 W / m2 with an error value of 1%.The effect of the sun's intensity on the power released by solar cells shows that the voltage is not too affected by solar radiation. Only the radiation intensity that is too low will affect the voltage.

Solar cells or internationally known as solar cells or photovoltaic cells are semiconductor devices that have a wide surface and consist of a series of p and n type diodes capable of changing the energy of the sun into electrical energy[1].

The photovoltaic itself is the process of converting light into electrical energy. Therefore the field of research related to solar energy is often known as photovoltaic research. The word photovoltaic comes from Greek, which means light and voltage are the names of Italian physicists who discovered the voltage. So language can be interpreted as light electricity and photovoltaic[2].

1.1.1. Photovoltaic solar power systems

The photovoltaic solar power system commonly used for lighting is an individual system or more commonly known as solar home system (SHS) [4].

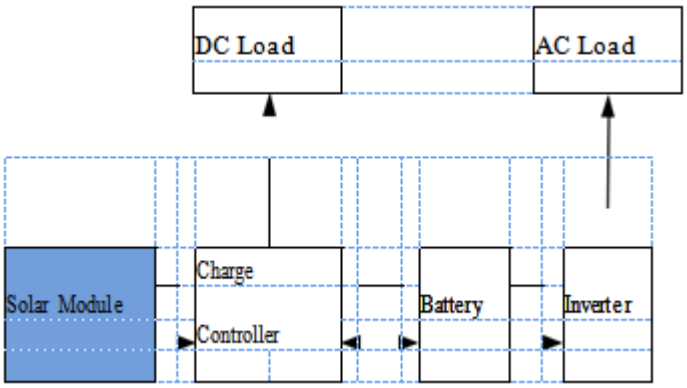

Figure 1 Simple block diagram of a PLTS system

Energy from sunlight that is converted into electrical energy by the module will be channeled to the charger controller to regulate this, electrical energy in the battery. From here the direct charger controller can also be directly used for direct current (DC load) or directly to the inverter to be converted into AC current voltage. Furthermore, the electrical energy produced by the battery will be converted by an inverter from direct current (DC) to alternating current (AC) so that it can be used in alternating current loads (AC Load).The most dominant meteorological conditions in designing the SHS system are daily radiation (Wh / m2 day), and ambient temperature, while the humidity and wind/wind speed are not very influential.

1.1.2. Battery Capacity

To ensure the system can operate properly and in accordance with the needs of the load, it is necessary to take into account weather conditions without sunlight (autonomy days) which is generally calculated for 5 days. To calculate battery capacity using the following :

Cb = Battery Capacity

Eb = energy needed by the load in a day (W-hours) V = battery working voltage = 12 Volts or 24 Volts d = number of days without radiation / year = 5

Kb = charging and discharging battery efficiency = 0.8

1.2. Wind Energy

Wind is air that moves in the environment around us because there is a movement of air to the surface of the earth. The main cause of wind is the temperature difference, this difference causes a difference in pressure from high air pressure to lower air pressure, so the higher the air pressure the stronger the flow of wind. The difference in air pressure is the result of exposure to sunlight in relation to the nature of the surface of the earth between another place and place, for example, differences in the level of reflection. In addition, the rotation of the earth on its axis also winding process. Wind speeds that can be used as wind power plants are 3-8 wind classes with speeds of 3.4 - 20.7 m / s.

Figure 2 Form of Wind Power Plant

Wind Power Plants or often also referred to as Wind Power Plants (PLTB) are one of the renewable energy power plants that are environmentally friendly and have good work efficiency if compared to other renewable energy power plants. The working principle of the PLTB is by utilizing wind kinetic energy that enters the effective area of the turbine to rotate the propellers/ windmills, then this rotating energy is passed on to the generator to generate electricity. The conversion of electrical energy to this PLTB requires a continuous wind blast to rotate a wind turbine. This rotating wind turbine will be connected with a mechanical transmission (optional) to produce a higher or lower rotation to then rotate the generator. Power in this PLTB system consists of several types that can be classified into:

1. Wind Power
2. Wind Turbine Power
3. Power Generator

1.2.1. Wind Power

Wind power is the amount of energy that can be produced by the wind at a certain speed that hits a windmill with a certain area. This wind power formula can be written by:

ρa: wind density at a certain time (1.2 kg/m^2)
v: wind speed at a certain time. (m / s)

A: area of wind sweep (m2)
The area of the wind sweep can be searched by the following formula:

$$A = \pi.r^2 \qquad (3)$$

With:
A: area of wind sweep (m2)
r: The radius of the turbine circle/turbine display (m)

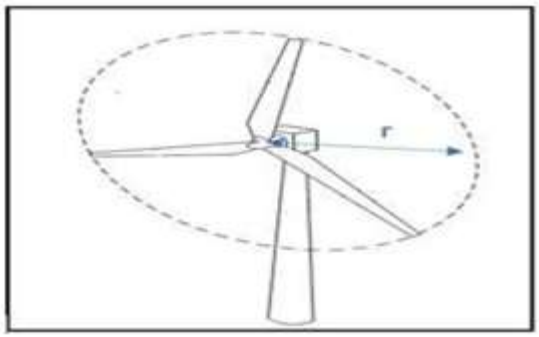

Figure 3 Turbine model with radius r

1.2.2. Wind Turbin Power

Wind turbine power (PA) is the amount of mechanical energy that can be generated by wind turbine rotors due to obtaining power from wind gusts. Wind turbine power is not the same as wind power because the power of the wind turbine is affected by the power coefficient. This wind power formula can be written by:
with:
C_p: Power coefficient

The design of wind power plants usually has a power coefficient (CP) which has a value below the cost of the law, because of losses such as copper losses, iron losses, bearing losses, and others. The CP value has a value between 0 - 0.6 and also depends on the type of turbine that will be used.

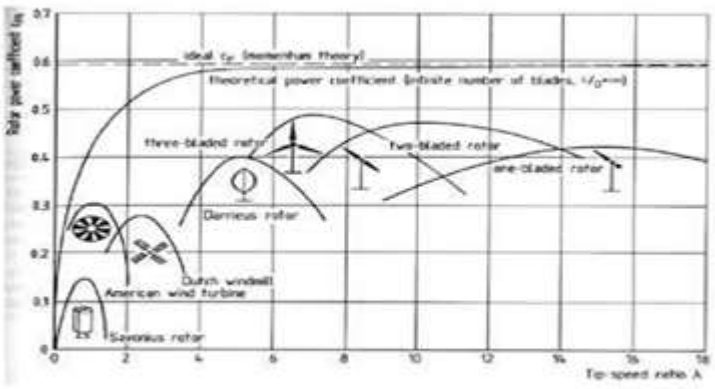

Figure 4 Relationship of turbine rotor power coefficient with speed ratio

1.2.3. Power Generator

Power generator (Pgen) is the amount of electrical power that can be generated by the generator due to the rotation of the coupled generator rotor with the turbine shaft. The power of this generator depends on the efficiency of the generator and the efficiency of the mechanical transmission so that the power that can be generated by the generator is calculated by:With:

$H_{gearbox}$: Gearbox/mechanical transmission efficiency η_{gen}: Generator efficiency

From equations (4), (5) and (6) above it is concluded that the electrical power that can be generated by the generator, then used for electrical equipment is not proportional to the wind power obtained. The difference between the power produced by the wind and the power produced by the generator is very large. This is due to the power coefficient, gearbox efficiency, and generator efficiency.

1.3. Hybrid Generating System

Theterm Hybrid is defined as the use of two or more power plants with different energy sources, to obtain synergies that provide benefits, economic and technical, which means the reliability of the supply system. The main purpose of a hybrid system is to combine two or more energy sources (generating systems) so that they can cover their weaknesses and can achieve supply reliability and economic efficiency in certain load profiles. The type of load (load profile) is an important keyword in a hybrid system. For each different load profile, a hybrid system with a certain composition is needed, so that the optimal system can be achieved. Therefore, system design and system size play an important role in achieving the target of a hybrid system. For example, a relatively constant load profile for 24 hours can be supplied efficiently and economically by a Wind Power Plant (with an appropriate capacity), but a load profile where daytime electricity usage is much different than at night, will utilize an Electric Wind Generator itself is not optimal. The following is a typical load profile for rural electricity consumers, that is, during peak loads, the use of Wind Power Plants reaches the optimum point, but at the base load, the efficiency of the Wind Power Plant is greatly reduced. In load profiles such as hybrid systems are very needed. Hybrid systems can involve 2 or more power generation systems, such as PLTS-Wind Power Plant, PLTS-Micro hydro, Micro hydro-Wind Power and so on. Combination or Hybrid PV-Power Plant Power will increase electricity storage to accumulator so that it can provide large electricity, so it is necessary to design battery requirements that are tailored to the needs of this hybrid system [5], but a large amount of initial investment is needed compared to other plants such as generators for the long term, the PV Hybrid Wind Power Plant system saves more O & M costs, and no fuel costs.

II. Research Method

To make a prototype of a hybrid energy generator between wind energy and solar energy carried out in several stages, namely:

- Study of literature; At this stage the researcher collects information relating to wind power generator components and solar power plants from journals and books
- Prepare components for each power plant and special components of hybrid systems such as solar panels, charging control devices, accumulators, generators, turbines.
- Create a hybrid generator prototype
- At this stage, researchers made a hybrid system prototype with 120 Watt wind energy sources and 100 W. solar energy.

- Test the prototype that has been made to find out the hybrid system works:

Preparation :
1. material / component of Wind power plant (PLTB)
2. solar power plants (PLTS)
3. Accessories and hybrid system equipment

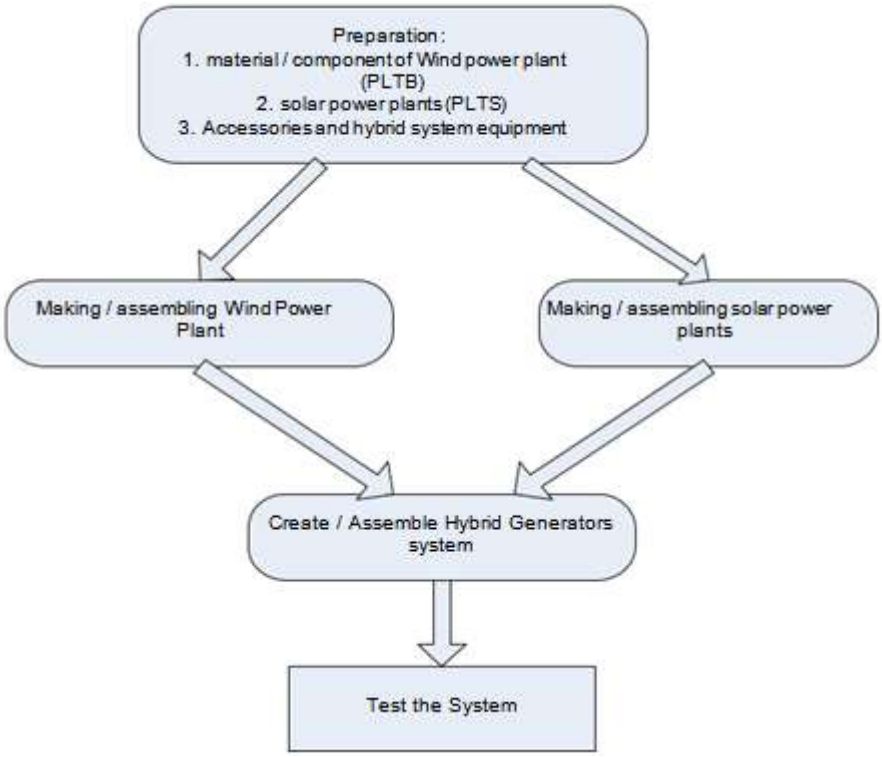

Figure 6 Stages of research

III. Results And Discussion

3.1. Research Results

3.1.1. Electric power plant (PLTB)

The design of the electric power plant that has been made as shown in Figure 7 below

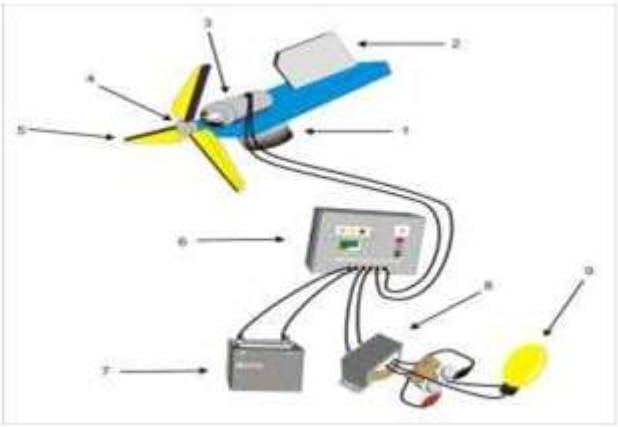

Figure 7 Components supporting wind power plants

With:
- Alternator holder
- Tail fin
- DC 12/24 V alternator

- Blade Fins
- Solar Charge Controller
- Accumulator (accu)
- DC inverter to AC
- Load (Light Bulb)

Figure 8 Wind Power Plant

3.1.2. Solar Power Plant (PLTS)

The design of a solar power plant is shown in Figure 9

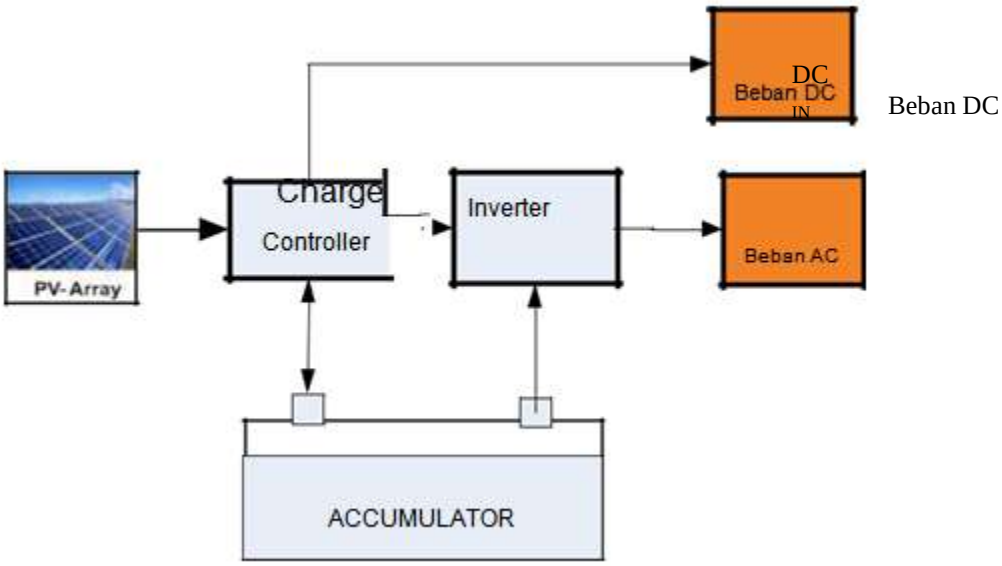

Figure 9 Block Diagram of Solar Power Generation (PLTS)

3.1.3. Hybrid Generator System

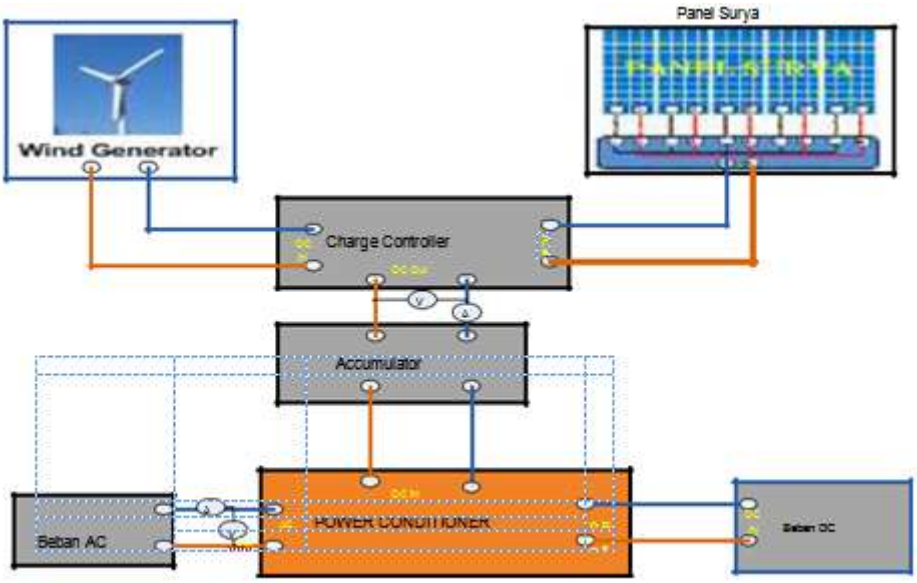

Figure 10. Sequence block Hybrid generator

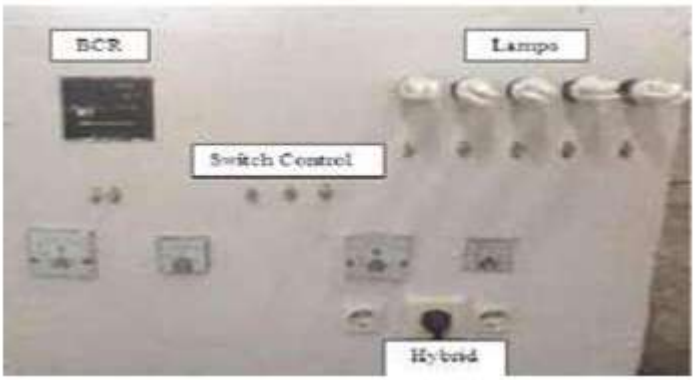

Figure 11 The Prototype of the Hybrid system

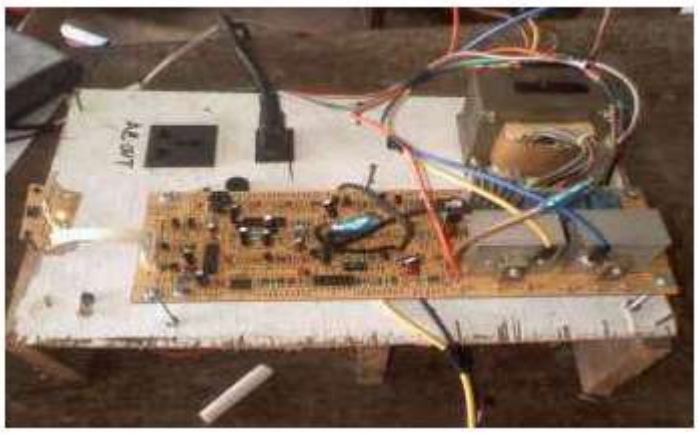

Figure 12 Power Conditioner

3.2. Discussion

From the results of the prototypes that have been made it is shown that:

- For wind power plants, the maximum capacity that can be produced is ± 120 W
- For solar power plants, the maximum capacity that can be produced is ± 100 W.

- For hybrid plants, the maximum power that can be produced is a combination of wind power plants and ± 220 W solar power plants

Testing the prototype is done by installing a 2 x 18 Watt lamp and 3 x 28 Watt lamp or about 120 W. Thus this prototype can work well and produce electrical energy which can later be utilized.

IV. Conclusions

Based on a hybrid energy system prototype between wind energy and solar energy, it can be concluded that:

- Hybrid prototype systems for wind power plants (PLTB) and solar power plants (PLTS) have been made and are functioning properly. The maximum power that can be produced by a PLTB is 120 W and 100 W from PLTS. Thus the maximum power produced by a hybrid system is ± 220 W.
- The prototype of wind and solar energy hybrid generator can turn on a 2 x 18 Watt lamp, and 3 x 28 Watt lamp or 120 Watt.

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