Combination of solar and wind power to create cheap and eco-friendly energy

Zuraidah Tharo[1], Dharmawati[2], and M. Alfi Syahri[3]

[1]Department of Electrical Engineering, Faculty of Sains & Technologi, Universitas Pembangunan Pancabudi, Indonesia
[2]Department of Informatics Engineering, Faculty of Engineering, Universitas Harapan, Indonesia
[3]Department of Electrical Engineering, Faculty of Sains & Technologi, Universitas Pembangunan Pancabudi, Indonesia

[1]zuraidahtharo@dosen.pancabudi.ac.id, [2]dharmawati66@yahoo.com
[3]muhammaddalfi@gmail.com

Abstract. The Economic growth of North Sumatra is ideally 6% or more. Achieving this number is needed the investment in various sectors at Rp 120 trillion. The Energy isthe main factor for achieving the growth. A Deficit of electrical energy in North Sumatra, is depended by our increasing on imports of fuel, gas and electricity supply from diesel boat. This problem is added by the growth in energy needs of 6.86%. The use of rainy and dry seasons is as a reference in producing a combination of the wind and solar power. Both of these energy sources aim to complement each other in optimizing the electricity produced. The concept of a combination or hybrid between solar panels and vertical axis, wind turbines will accelerate more the charging and storage of energy into batteries for electrical the energy needs. From test performed with 100wp solar panels and vertical type wind turbines with low rpm < 300 which have been combined, it can produce 700 watts of electricit. These results have fulfilled for the needs or energy requirements in one simple house.

1 . Introduction

The use of the season is very helpful in producing a combination of the wind and solar energy, this combination is called hybrid power, which during the dry season, the sun will play a role, whereas in the rainy season the wind will be play more role in producing sources of electrical energy. Both of these energy sources aim to complete each other in optimizing the electricity produced. The hybrid concept between solar panels and vertical axis wind turbines is faster in the battery charging process than wind and sun energy made separately. The territory of Indonesia has great potential in the field of renewable energy, especially the sun, water and wind. The potential of renewable energy sources in Indonesia includes 4.8 KWh/m2/day of solar energy, 458 GW of biomass 3-6 M/sec of wind power, and 3 GW of nuclear (uranium reserves). Indonesia also has large hydro energy source with a potential total estimated at 75.67 GW. Although the potential of renewable energy such as biomass, geothermal energy, solar energy, water energy, wind energy, and ocean energy is relatively high, it isn't used significantly, that is less than 4% in 2007. Combination energy systems or commonly called hybrids are one of the renewable energies that are becoming popular as stand-alone electric power systems to obtain electricity supply. Hybrid power systems usually consist of two or more renewable energy sources that are used together to provide increased

system efficiency and a greater balance in energy supply. (Claire gin, Hybrid System, 2016). Electrical energy can be generated by converting solar radiation through a process called photovoltaic (PV). Photo refers to light and voltaic refers to voltage. This terminology produces direct current electrical energy from solar radiation energy. Photovoltaic cells are made of mainly silicon semi-conductive materials which are coated with special additives. If sunlight reaches the cell, the electrons will be released from the silicon atom and flow forms an electrical circuit so that energy can be generated. Solar cells are always designed to convert light into as much electrical energy as possible and can be combined in series or parallel to produce the desired voltage and current as stated by Chemi et. al. (2007). Wind turbines are a tool for converting wind energy into mechanical energy which is converted into electrical energy. The rotation of the wind turbine shaft is connected generator to produce electrical energy. Based on previous research, many types of wind turbines produced one example is vertical axis wind turbine (VAWT). VAWT is a wind turbine with a vertical or perpendicular axis and the rotor is parallel to the wind direction so the rotor can rotate in all wind directions. VAWT also has several advantages and disadvantages. The advantage is that it has high torque so that it can rotate at low wind speeds, the generator can be placed at the bottom of the turbine so that it simplifies maintenance and the turbine's work is not affected by wind direction

The disadvantage namely, the wind speed at the bottom is very low so that if you do not use the tower will produce low rotation, and efficiency is lower than the Horizontal Axis Wind Turbine (HAWT). By utilizing these two energy sources, it is expected to realize the government's plan to create cheap, environmentally friendly and independent energy.

2. Method

The method used is to design a hybrid power plant with capacity of 1200 watts that will support electricity needs for household loads. This is shown in the following block diagram:

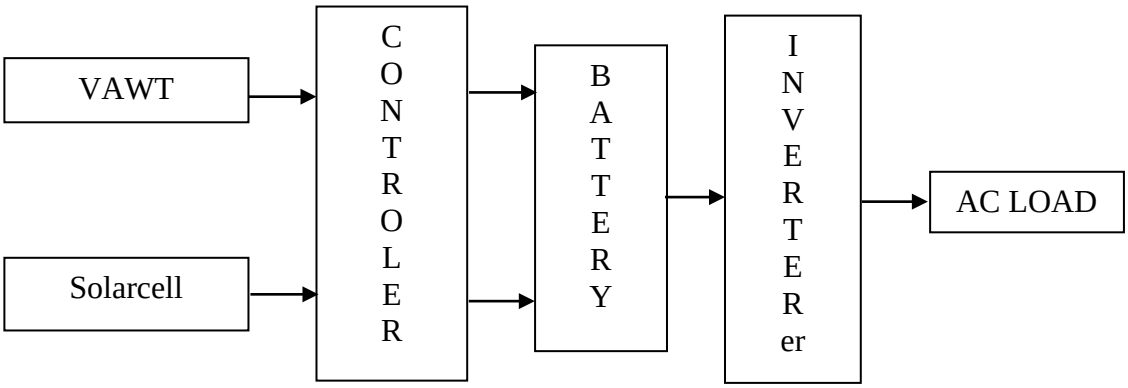

Figure 1. Hybrid Power Plant Block Diagram

Where:

1. *VAWT* or *Vertical Axis Wind Turbine*, which is a device that functions as a turbine driver to produce *electrical energy* through wind media. The type of turbine used is the *Girromil Type.*
2. *Solarcell or Photovoltaic,* which is a device that functions as receiving solar radiation to produce electrical energy that will be stored in the *battery.*

3. *Controller*, which is a device that is used as a *gateway* to connect wind turbine devices and solarcell in charging *battery*
4. *Battery*, *Battery*, has function as a storage current obtained from wind and solar turbines to be channeled to the load.
5. *Inverters*, is as a means of changing the DC current in the *battery* so that it can be used on an AC current at a load. Inverters that are used use *sine wave* full wave, so that load devices that use rolls, will operate properly.
6. *AC Load*, is electrical load, at the writing of this thesis, the author limits the usage power of 1200 Watts.

The working system of this generator is drawn in the following flowchart:

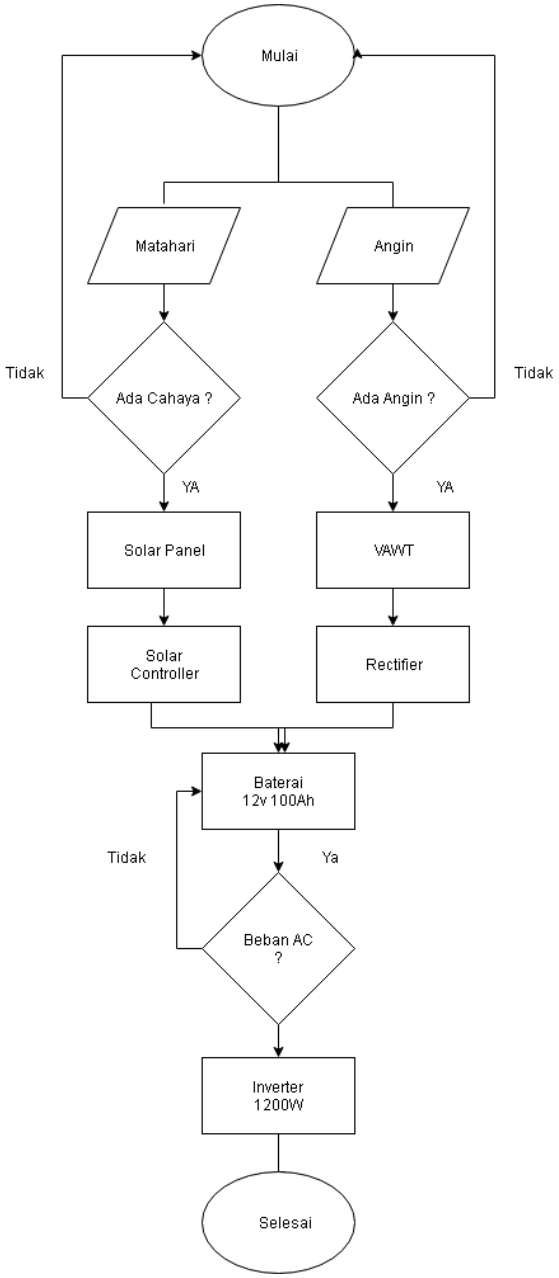

Figure 2. Flowchart

Designing is started by :

1. Designing Rotor

In designing the rotor, what needs to be prepared is 12 pcs of permanent magnets, each of which is determined, 12 pcs of magnets will surround the stator and form a series of stars.

Figure 3. Rotor Model

2. Designing Stator

   In designing of the stator for a 12VAC 3 phase voltage, what is needed is a coil of as many as 9 pcs, each of which has a coil of as many as 60 turns. To cover the stator, it coveres with resin.

Figure 4. Stator Model

3. Designing Blade

   In designing vertical model wind turbines must be prepared are 9 pcs of blades, each wing has 3 blades, the total number of blades is 9 blades of blade. This blade blade serves as a wind trigger in pushing the turbine into the wings.

4. Designing Turbin Frame

   The turbine skeleton design uses Holo iron material with 5cm dimensions, turbine height in this system is 4ft or 1.20m calculated from the bottom shaft to the top shaft. For the width of the turbine, it has a diameter of 3ft or 0.90cm.

5. Disigning Wind Turbin

   The turbine design model has 3 wings that serve as a trigger to rotate turbines that can produce energy from the electric force of the permanent magnet generator. The turbine specifications are listed in the following table:

Table 1. Turbin Spesifications

Type	VAWT
Diamater Blade	90 cm
Blade Height	1.20 m
Number of Blade	3
Speed	± 3 ms
Wing Material	Alumunium
Frame Material	Holow

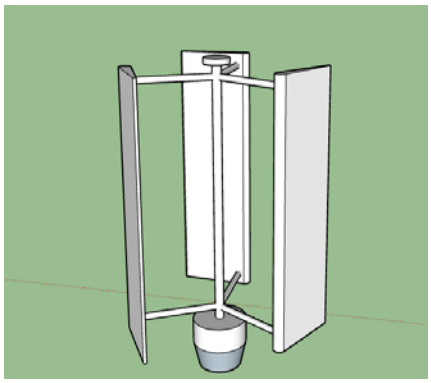

Figure 5. Disigning Wind Turbin

6. Disigning Solar Panel

   The type of solar panel used is monocrystal type which is more efficient than polycrystalline, monocrystal has a lot of electron space to flow with the following specifications:

Table 2. Solar Panel Spesifications

Type	50 Watt Peak
Power Toleransi	± 3%
Open Circuit Voltage	21.6V
Short Circuit Current	3.06 A
Dimension	630mm x 540mm x 18mm

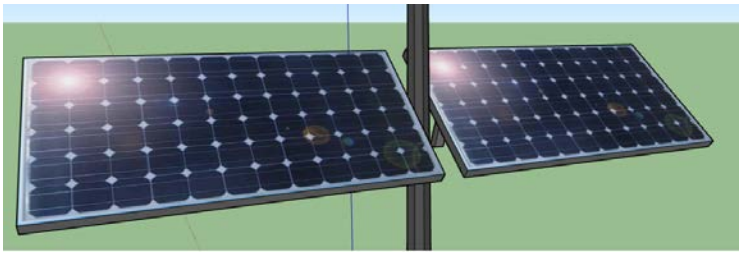

Figure 6. Solar Panel

3. Result and Discussion

3.1 How a Solar Power Works

The Solar power is present in the form of heat and light. Energy in the form of heat can be used directly or indirectly. Light is another form of energy emitted from the sun. Light is

converted into electricity by using photovoltaic modules called by PV modules or solar panels. Photons from sunlight hit electrons in PV cells so that they provide enough energy for some electrons to move from semi-conductor junctions and cause electrical pressure caused by electrical imbalances, too many electrons (negatively charged) on one junction side, and there are too lots of positive charges on the other side. When electrons flow from one side to the other, the pressure will decrease. This occurs when there is interconnection between cells. When cells are interconnected, a solar module that produces Direct Current (DC) is created, for the use of alternating current (AC), the inverter is used.

3.2 How a Wind Power Works

Wind turbines use kinetic energy from the wind and convert it into electrical energy. The axis orientation and rotation axis determine the classification of wind turbines. Turbines with shafts that are horizontally installed parallel to the ground are known as horizontal axis wind turbines or (HAWT), while the vertical axis wind turbine (VAWT) has a normal axis parallel to the ground. High rotor efficiency is used to extract wind energy and must be maximized within affordable production limits. The energy (P) carried by moving air is expressed as the amount of kinetic energy (EK).

$$KE = \frac{1}{2} pAV^3 \quad (1)$$

where:

V = Wind Speed
A = Large of Wipe Turbin Area
p = Air Mass (1.225 kg/m)

$$K.E = \frac{1}{2} mv^2 \quad (2)$$

where:

K.E = Kinetic Energy
m = Mass
v = Speed

$$K.E = \frac{1}{2} pAV.V^2 \quad (3)$$

$$K.E = \frac{1}{2}\, pAV^3 watts \quad (4)$$

where:

A = Large of Wipe Turbin Area
p = Air Mass (1.225 kg/m)
V = Wind Speed

The voltage that comes out of the solar panel will go into the Controller Charger and it will immediately charge a 12V 100Ah battery as well as the voltage generated by the wind turbine, 12V output voltage with a low RPM. So that winds ranging below 5 m /s can produce voltage. The charged battery is ready for load testing. Next is to convert the DC 12V battery energy to 220V AC voltage by using a 1200 Watt inverter.

Table 3. Load Testing

Equipment	Number of Unit	Power	Total Power
Lamp	6	20	120 Watt
Fan	4	98	392 Watt
Total Power			**512 Watt**

From the load testing table, it can be seen that the combination of solar and wind power plants can be used as alternative energy sources in realizing cheap and environmentally friendly energy, no pollution and noise that occurs in this plant.

4. Conclusion

1. The result of a combination of solar and wind power plants depends on the weather conditions, the voltage increases when the sun is right on the surface of the solar panel and the wind blows hard
2. A combination of solar and wind power plants can complate each other in contributing to battery charging, during the daytime the sun is more dominant, while nighttime winds contribute.
3. Small wind turbines with a capacity of 3kW can produce electrical energy up to 7,000 kWh/ year
4. A combination of solar and wind power plants does not produce waste or emissions
5. An angina turbine with a capacity of 3kW can avoid C02 emissions up to 5 tons per year
6. Requires higher wind speeds to be able to produce electricity
7. Requires a high tower to capture enough wind speed

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