Hybrid Power Plant Solar and Wind Power As An Alternative Source In Facing the Fossil Energy Crisis in Sumatera

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ABSTRACT: *Indonesia's primary energy consumption is dominated by oil, gas and coal. The use of fossil fuels for conventional plants continiously will have a serious impact on Indonesia's electricity system. By developing consumption rapidly, it is estimated that without rewenable energy resources and energy efficiency efforts, Indonesia can become an importer of pure oil soon. To reduce fossil fuels consumtion, especially for electricity power generation, the use of environmentally friendly renewable energy must optimized by utilizing the potential of wind and sun as a renewable energy source for rural electrification. The use of the season is very helpful in production hybrid energy, which during the dry season, the sun will play important role, whereas in the rainy season the wind will have more role in producing a source of electrical energy. Both of these energy sources aim to complete each other in optimizing the electricity produced. The concept of a combination or hybrid between solar panels and vertical axis wind tubrine will greatly help accelerate energy charging into battery storage rather than wind and solar energy made separately. From the measurements result of 100wp solar panels and vertical type wind turbines with low rpm <300 which have been combined can produce 700 watts of electricity, which using such power can turn on electricity in one house.*

KEYWORDS: *Hybrid Power Plant, Renewable Energy, Solar panel, Wind turbine.*

I. INTRODUCTION

The final energy consumption in Indonesia is dominated by oil, followed by gas, coal and hydro energy. Oil imports and petroleum products will increase for domestic demand. By developing consumption rapidly, it is estimated that without renewable energy resources and energy efficiency efforts, Indonesia can become a pure oil importer in the future. To reduce the fossil fuels, especially for electricity generation, the government has taken the initiative to increase the use of renewable energy sources. The use of renewable energy for rural electrification in Indonesia has potential, because thousands of islands make difficult to build an electricity distribution system, both physically and financially.

The renewable potential in Indonesia consists of Potential 4,8 KWh/m2/day of solar energy, 458 GW biomass 3-6 M/second of wind energy, and 3 GW nuclear (uranium reserves). Indonesia has high hybrid power plan with ±75.67 GW. Although the potential of renewable energy like biomass, geothermal, solar energy, water energy, wind energy, and ocean energy are high, but they don't use significantly that is less than 4% in 2007. The indonesian nasional energy policy aims to reduce dependent on oil and gas and to create variations of enegy mixture by improving energy resources like renewable energy. (Training Modul PNPM Mandiri, 2011). Indonesia has targeted to fulfill the share of renewable energy up to 17% in 2005, as stated in the 2007-2025 National Energy Implementation Program Blueprint (ESDM, 2007).

Hybrid energy system is a renewable energy which has popular as independent electrical energy system. Hybrid enery system usually consists of two or more renewable energy which can use together to fulfill improvement (Claire gin, Hybrid System,2016).

II. LITERATURE REVIEW

In this research, the writers use the potentiaol of sun and wind. Electrical energy can be generated by converting solar radiation through a process called photovoltaic (PV). Photo refers to light and voltaic refers to voltage *photovoltaic (PV).* The terminology produces electric current flow energy from solar radiation. *Photovoltaic cell* is made of semiconductor like silicon which is coated by special additional materials. If the sun's light reaches the cell, the electrons will be released from the silicon atom and flow forms of an electrical circuit so that energy can be generated. Solar cells are always designed to convert light into as much as electrical energy and can be combined in series or parallel to produce the desired voltage and current as stated by Chemi et. al. (2007). Wind turbineis a tool to convert wind energy into mechanical energy which is then converted into electrical energy. The rotation of the wind turbine axis is connected to the generator to produce electrical energy. Based on previous research, many types of wind turbines produced like vertical axis wind turbine (VAWT). VAWT is a wind turbine with a vertical or perpendicular axis and the parallel rotor to the wind direction, so the rotor can rotate in all wind directions. VAWT also has several advantages and disadvantages. The advantage is 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 facilitates maintenance and the work of the turbine is not affected by wind direction. The drawback, 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).

Tabel 1. Kondisi Kelistrikan Regional Sumatera 2015 – 2018

SUMATERA	SATUAN	10 OKT 2015	20 OKT 2017	18 MEI 2018
Beban Puncak	MW	4684	5368	5219
Daya Mampu Pasok	MW	4474	5826	6297
Transfer Antar Unit	MW	0	0	0
Cadangan	MW	-210	458	1078
Reverse Margin	%	-4	9	21

SBU	SATUAN	10 OKT 2015	20 OKT 2017	18 MEI 2018
Beban Puncak	MW	1841	2057	2043
Daya Mampu Pasok	MW	1651	2403	2447
Transfer ke SBT	MW	-63	0	-58
Cadangan	MW	-253	346	465
Reverse Margin	%	-14	17	23

SBT	SATUAN	10 OKT 2015	20 OKT 2017	18 MEI 2018
Beban Puncak	MW	1213	1500	1485
Daya Mampu Pasok	MW	967	1321	1220
Transfer dari SBU	MW	-63	0	-56
Transfer dari SBS	MW	226	280	534
Cadangan	MW	43	101	211
Reverse Margin	%	4	7	14

SBS	SATUAN	10 OKT 2015	20 OKT 2017	18 MEI 2018
Beban Puncak	MW	1630	1811	1654
Daya Mampu Pasok	MW	1856	2102	2630
Transfer ke SBT	MW	-226	280	534
Cadangan	MW	0	101	402
Reverse Margin	%	0	7	24

Based on the table above, it can be seen that the highest annual burden occurs in October, while the peak load in May 2018 is still lower than in October 2017 with a difference of 149 MW. The following data obtained from PT. PLN (Persero) in Sumatra Region:

Figure 1. The Data on Generator Development Plan in North Sumatra 2018-2027

Figure 2. Development EBT Plan in North Sumatera

III. RESEARCH METHODS

This research was done in Laboratorium of electrical engineering Science and technology faculty in Pembangunan Panca Budi University. This research was also done in some area of Samosir.

Research Equipments

a. Solar panel
b. Battery
c. Inverter
d. Wine Turbine
e. Measuring instrument

Reseach Prosedure

This research started by doing literature review to determine hybrid parameter, collecting data in the field, data anlaysis, discussion and conclusion. The steps of research can be seen in the figure 1 below:

Figure 3. Research Procedures

Flowchart

The flowchart can be seen in figure 2below:

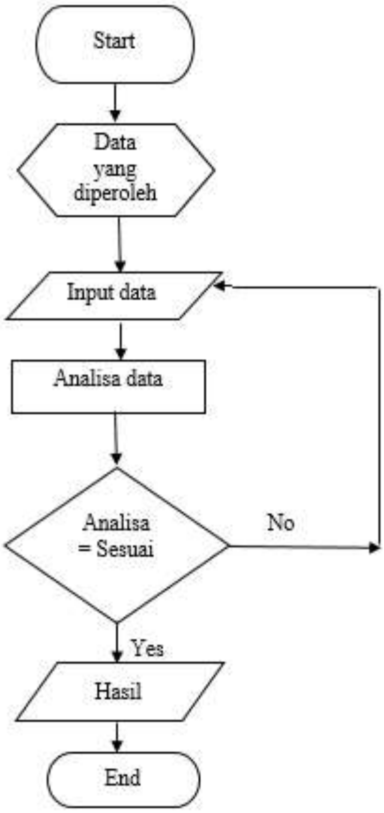

Figure 4. Flowchart of Research

Based on the data, it can be calculated with the pattern (1):

PE = TE x ME x TC x PF x SF x A ...... (1)

Where :

PE = solar cell energy/ day (kWh).

TE = total solar radiation radiation (kWh/m^2).

ME = module efficiency, 8% - 20%.

TC = temperature efficiency correction factor, usually15^0 C s/d 35^0 C higher than average temperature

PF = paking factor, usually it has been calculated in efficiency module

SF = fouling factor

A = area (m^2).

To project the amount of energy produced by the solar cells in a day. And using equation (2) to obtain the plan power as the basis for determining the rotor diameter.

$P = 0.5\ \rho\ \pi r^2\ v_r^3\ Cp\ \eta_t\ \eta_g$ [W] ...... (2)

where :

r = Diameter rotor (m)

□□= Air dencity (1,2 kg/m3)

Cp = Maximum power coefficient

Vr = Wind Velocity (m/det)

□t = transmission efficiency

□g = generator efficiency

The speed of the plan can be determined by calculating of the average wind speed (V) at the location to be planned

IV. RESULTS & DISCUSSION

Systems support Hybrid solar and wind power plants are solar cell systems, energy conversion systems, battery systems, inverter systems, and control systems. Inverter quality is a determination of the quality of power produced by a system. The inverter functions to change the DC battery or rectifier-charger circuit to AC voltage.

How the Hybrid Generator Works

The hybrid system power plant works from all the energy produced by all existing power sources the solar cell system and wind energy system is distributed into the control unit.The energy entering the control unit is direct current electricity. If there is an energy extra, the energy will be stored in the battery, then before being distributed to the consumer, direct current energy is converted into alternating current energy by the inverter. After being converted into alternating current energy, energy is flowed through the distribution of alternating current to consumer consisting of various types and needs. The block diagram of hybrid power plant circuit can be seen in the following figure:

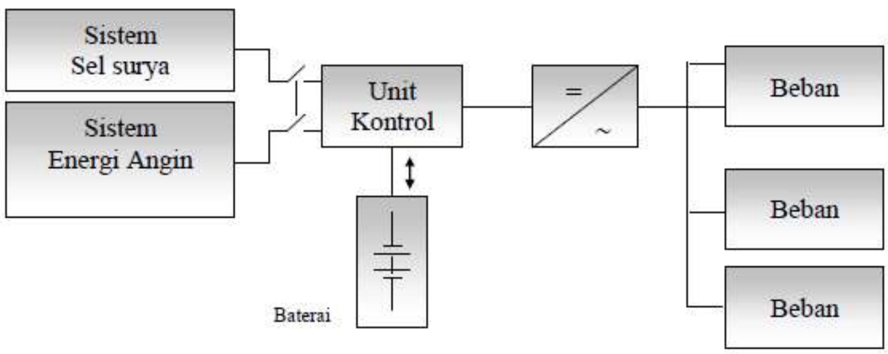

Figure 5. The Blok Diagram of Hybrid Power Plant Circuit

Solar Cell Calculation

Power 1 cell (M0) = 1,96 Wp
Material = Silicon crystal
Size = 10 x 10 cm
Voltage (V) = 0,5 Volt
Arus (I)= 0,98 Amper
Temperature (T)= 25 ^{0} C
Power planned = 500 watt
In the first analyze, we find out module area used
By using equation:
P = A x 1000 W/m2 x ME x PF
Where :
Power (P) = 1000 Watt
Module Efficiency (ME) = 20%
Pecking Factor (PF) = 98 %
Area (A) = ?

Answer :

$$A = \frac{P}{1000\ W/m2\ x\ ME\ x\ PF}$$

$$A=\frac{1000\ W}{1000\ W/m2x0,2x\ 0,98}$$

$$A=\frac{1000\ W}{196}$$

$$A = 5,10\ m^2$$

The number of module will be used :

Area = 5,10 m^2
Size in 1 module 10 cm x 10 cm = 0,01 m^2
Number of module = $\frac{5,10}{0.01}$
Number of module = 510 pieces
Solar cell can be calculated by PE = TE $\frac{MO}{1000}$ xTC x N
PE = 1000 Wh/m^{2}x 1,9 W /1000 W x 25^0 C x 510
= 24,225 Kwh
The next analyze is to get voltage from the data above:
1 module voltage = 0,5 volt
Voltage wanted = 24 volt

So Module arrangement = 24 / 0,5 = 48, So module installed in parallel is 48 pieces
Power wanted 1000 Watt,
voltage 24 Volt. Based on the power pattern P = V . I
so : I = $\frac{p}{v}$ = $\frac{1000}{24}$ = 41,66 Ampere
In cell flow data at standard temperature 25^0 C is 0,98 Ampere,
so module arrangement is = $\frac{41,66}{0,98}$ = 42,5 ~ 43
To get current wanted, module installed series is 43 pieces.

The calculation of wind energy conversion

This calculation will be calculated in analyzing about wind speed Cut-in (Vci), wind speed Cut-off (Vco) and wind speed plan (Vr).

V =5 m/dt
Wind speed Cut-in
Pattern : Vci = 0,7. 5 = 3,5 m/s
Wind speed Cut-off
Pattern : Vci = 3. 5 = 15 m/s
Wind speed plan
Pattern : Vr = $\frac{3.5+15}{2}$ = 9,25 m/det
To know the wind in rotor blade with assumsion that the angle is 2/3 from the wind velocity Analysis
V = 5 m/dt ----→ V = $\frac{2}{3}$ 5
= 3.3 m/det
To determine number of rotor blade turning as the same as power plan
V = 5 m/dt
U = 7.1 . 5 m/dt = 35,5
W □√(35,5)^2□□(5)^2 = 11,28
The blade rotor diameter is obtained from:
$D^2 = \sqrt{P/0.086V}$
= 7,6 m---→ r = 3,8
So in planning a diameter of the gear and the rotation needed for transmission in turning the generator can be determined
U = 35,5
D = 7,6 meter
n = $\frac{35,5(60)}{3,14(7,6)}$ = 32,9 rpm
so the power produced is : P = $\frac{16}{27}\frac{1}{2}$ (0,2925)(1,226)(3,14) $5^2.5^3$ = 1042,60 Watt

V. CONCLUSION & SUGGESTION

1. The potential of solar and wind energy are still very available in the world as an alternative energy for fossil energy.
2. The Hybrid Power Plant has great potential in solving the crisis energy in Sumatra.
3. Based on Hybrid energy calculations, it can produce power of ± 1000 W, and can meet the power needs of one house.

VI. REFERENCES

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