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Use Of Inverter Off Grid 2000 Watt For Household With Battery Storage

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Abstract. Solar energy is an environmentally friendly energy and the source of energy is available continuously. In this paper, an electrical energy source for residential houses with 1500 watts of power is designed. In the design of this system, 80 AH battery storage and 2000 watt off-grid inverter are used. The off-grid system design in residential houses with 200 wp PV sources and battery storage systems can be used to meet residential electricity needs. In addition, the design of the off-grid system is very suitable for residential houses in areas not covered by the electricity network. In testing this off-grid system, the PV output current fluctuates against changes in the sun's intensity. To overcome changes in PV output, the control of the battery can quickly regulate the power flow to the load. The charge process and battery discharge are controlled with a voltage sensor. The test results of the off-grid model show that the voltage at the load is always stable, which is 220.8 V. The use of renewable energy in the country of Indonesia is currently being carried out and continues to experience improvement along with the increase in population. Renewable energy sources that are widely available in Indonesia are solar energy, wind energy, and energy from waste waste. Especially for solar energy in Indonesia is widely used as a renewable energy source. This solar energy source can be obtained easily, because Indonesia is a tropical country. Solar energy is an environmentally friendly energy and the source of energy is available continuously. In this paper, an electrical energy source for residential houses with 1500 watts of power is designed. In the design of this system, 80 AH battery storage and 2000 watt off-grid inverter are used. The off-grid system design in residential houses with 200 Wp PV sources and battery storage systems can be used to meet residential electricity needs. In addition, the design of the off-grid system is very suitable for residential houses in areas not covered by the electricity network. In testing this off-grid system, the PV output current fluctuates against changes in the sun's intensity. To overcome changes in PV output, the control of the battery can quickly regulate the power flow to the load. The charge process and battery discharge are controlled with a voltage sensor. The test results of the off-grid model show that the voltage at the load is always stable, which is 220.8 V.

1. Introduction

The need for electrical energy for the use of electrical equipment at home lives as well as increasing along with the development of technology and various types of load models that are widely used. Therefore we need a source of electricity from renewable energy that is able to produce stable electrical energy in homes. In addition, the use of electricity with petroleum sources in Indonesia is decreasing, so the use of renewable energy is needed. At the present time the use of renewable energy

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when it starts to increase. Renewable energy sources that are easily found in Indonesia are sources of solar energy, because solar energy can easily be obtained. Much research is done to optimize the use of solar energy to meet the ever-changing needs of the load. According to [1] the increasing demand for electricity will accelerate the depletion of fossil fuel sources and will increase the cost of electricity generation, so that it will cause a negative impact on the environment. Renewable Energy Sources in Indonesia which is the best choice to reduce dependence on fossil fuels in generating electricity is wind energy and solar energy because the energy is clean and environmentally friendly. However, solar energy sources and wind energy have weaknesses that may not be able to meet the demand for the required load. This is because the RES (Renewable Energy Resources) output fluctuates with changes in the sun's intensity and wind speed. In this study modeling and simulation were carried out to analyze hybrid systems of solar energy sources (PV), wind energy, and batteries for residential electricity needs. The purpose of the system design is to optimize the use of renewable energy in meeting the burden of housing, with the location of Kuala Terengganu in Malaysia. System performance is shown in two modes, namely on-grid mode and off-grid mode. In on-grid mode the use of renewable energy sources exceeds load demand, while in off-grid mode the battery is used to store energy and help with energy shortages according to load demand. In both modes, the system works efficiently where the DC bus voltage is stable at 240 V and the DC bus current is stable at 54.8 A in on-grid mode and 47 A in off-grid mode. In addition the use of multi-port converters in hybrid systems can reduce system costs [2].

In another study of inverters, an inverter topology is used to meet load requirements. Inverters used have fewer switches when compared to other full bridge inverters. In this initial design, a three phase inverter with nine switches was used, with constant and variable frequency modes. The first mode cannot work when phase switching occurs between load voltages, while the second mode cannot work when the modulation index of both loads is above 0.5. Because these two modes have limitations, a dual-output four-foot converter that can produce power to be transmitted in a micro grid. In addition a single phase converter is also used, with the utilization of the maximum DC bus voltage and for the UPS application proposed system configuration, photovoltaic (PV) integrated with a grid that aims to stabilize the grid voltage [3]-[4].

In another study of off-grid inverters known as standalone inverters also used to convert DC sources from other sources of electricity such as solar energy, wind energy becomes AC voltage. These sources are reliable, because they are environmentally friendly and these sources can be available continuously. In the design with this off-grid inverter, batteries are used to store energy, as energy reserves. The occurrence of an increase in the electricity load in Indonesia is caused by industrial needs and population growth. To meet electricity needs in certain areas and separate from the main grid a PV model is used with an inverter, with the aim of generating AC voltage from solar energy sources. AC voltage is used for certain areas, which are separated from the main grid [5]. In this paper I design the electricity needs for residential houses with a power capacity that is widely used by the middle class. In this design used solar cell 300 Wp, 80 AH battery, and 2000 watt inverter. In chapter (1) discussed about previous research which is the background of this paper, chapter (2) discusses the PV system, chapter (3) discusses the battery model, chapter (4) discusses the design of an off-grid system model, chapter (5) discuss the test results, and chapter (6) discuss the conclusions of the results of the testing and analysis.

2. Basic Theory

2.1. *A PV System*

To understand the PV system can be done by making a model in the form of an equivalent circuit, shown in fig 1. By looking at the equivalent circuit can be derived the PV current equation, in equation (1).

$$I_{sh} = I_0(\exp(\frac{V_{pv} + R_s I_{pv}}{nKT/q}) - 1) - \frac{V_{pv} + R_s I_{pv}}{R_{sh}}$$

$$I_{pv} = I_{ph} - I_D - I_{sh} \qquad (1)$$

I_{PV} is the current (A) output of solar sell, I_{ph} is the current (A) which is affected by light intensity, I_D is current (A) of Shockley diodes, I_p is current (A) shunt, I_o is saturation current (A) of PV cells, q is electron charge (q = 1, 6 10^{-19} C), K is Boltzmann's constant (k = 1.38 10^{-23} J / K), n is the ideal factor for solar sell, T is the temperature of solar sell, R_{sh} is the shunt resistance (Ohm) and R_s are internal series resistance (Ohm) [1].

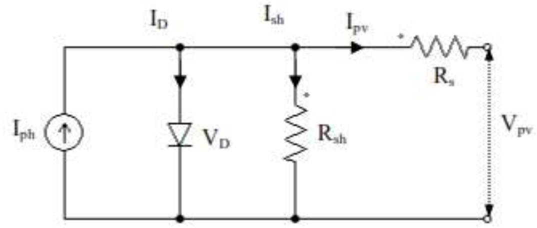

Figure 1. Solar sell equivalent circuit

The I-V curve is basically affected by changes from two inputs which are solar insolation and array temperature. Adaptation of equation (1) to various levels of solar insolation and temperature can be represented by equations which can be expressed in equation 2 [6].

$$\Delta I = \beta\left(\frac{E}{E_r}\right)\Delta T + \left(\frac{E}{E_r} - 1\right)I_{SC} \tag{2}$$

$$I = I_r + \Delta I$$

$$\Delta V = \gamma\Delta T - R_S\Delta I$$

$$V = V_r + \Delta V$$

2.2 Battery Model

The battery model is done by modeling the load state (SOC), voltage equation, and temperature effects. The instantaneous state of charge battery is stated by:

$$SOC(t) = SOC(t_0) - \frac{1}{C_{bat}}\int_{t0}^{t} I_{bat}.dt \tag{3}$$

where SOC (t_0) is the initial state of charge, Cbat states the battery capacity above the discharge requirement at a constant current of 10 A, in a span of 10 hours [7] [8]. The energy storage system unit in a PV system is designed to provide a stable voltage to the load under changing load conditions. Because the power provided by the PV panel is not always in accordance with load demand, the battery that functions as a PV energy storage can help meet load demands. In this case, SOC is assumed the battery is in a range that can absorb and supply energy.

3. Research Methods

3.1. Off Grid System Model Design

The residential electricity network is designed using an off-grid system, with an inverter capacity of 2000 watts. While the battery capacity as an energy storage system is 80 AH. To convert solar energy into DC electrical energy, PV is used at 300 Wp. The function of the DC-DC converter is to regulate the flow of energy from PV to the inverter, from PV to battery, or from battery to inverter. This converter can directly regulate the battery's energy flow to the inverter during current fluctuations from PV. Lamp, TV and water pump loads in the residential electricity network are a widely used burden.

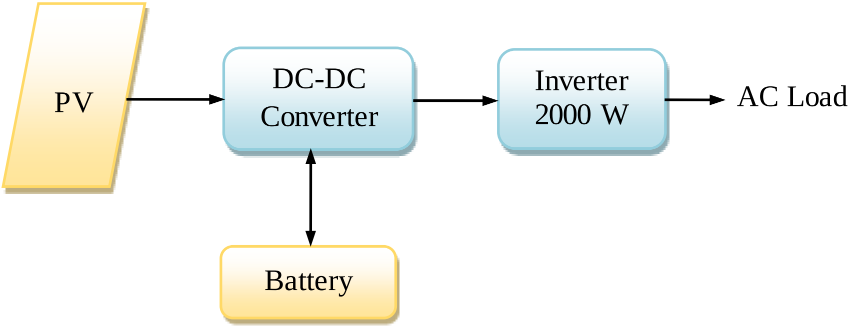

Figure 2. Block design diagram of the off-grid system model

3.2. Design Simulation Matlab

In designing this off-grid system, the simulation model shown in fig.3 is also used. In this model 300 Wp PV is used and to regulate the change of use of DC sources to the inverter a voltage sensor is used. To regulate the battery charging process is also used a voltage sensor, so that when the battery capacity is full the controller will break the voltage from the PV source.

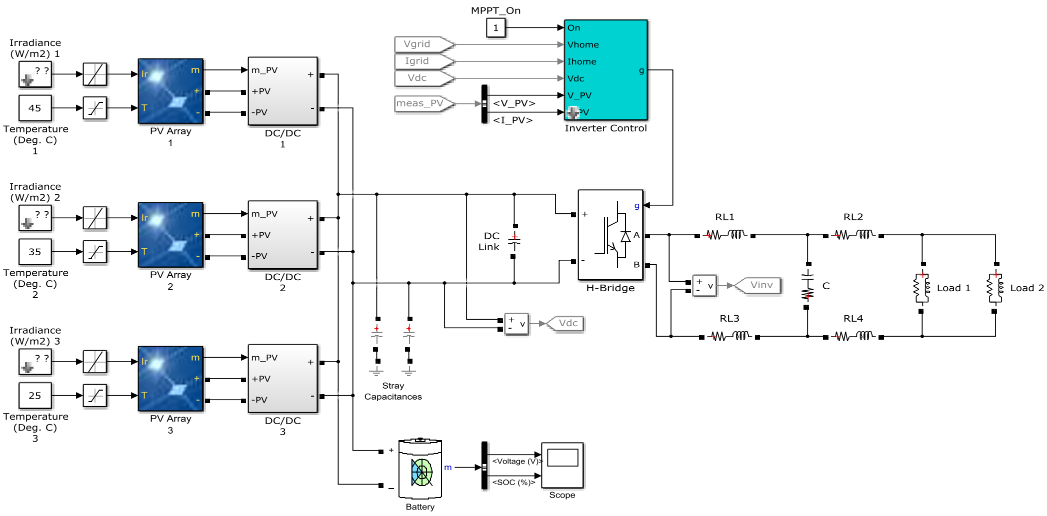

Figure 3. The design of the off-grid simulation system for residential systems

4. Results and Analysis

Testing off-grid networks at home is done at 7.00 in the morning using PV sources. Load testing is carried out using lamp loads, fans, cooling machines, and water pumps.

Figure 4. Display the voltage at the load

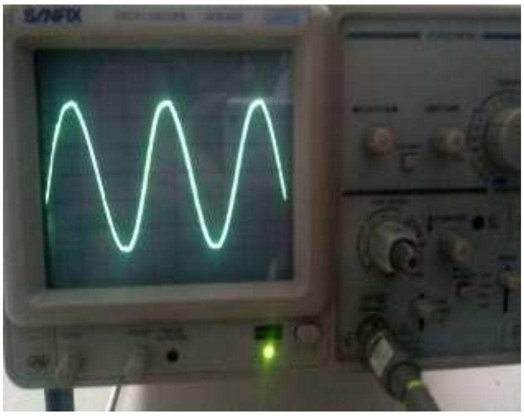

Figure 5. Off-grid inverter output voltage

The test results on the off-grid device are shown in fig.4, while the waveform is shown in fig.5. The AC output voltage of the inverter has an amplitude of 221.16 Volt, with the system off grid shown in fig.6.

Figure 6. Device system off grid

The resulting no-load voltage approaches the standard voltage requirement in Indonesia, which is 220 V, this is also affected by the PV intensity used during the day. Then the test was carried out with a 150 watt lamp load, 550 watt cooling engine, 100 watt fan and 563 watt submersible pump. The load used does not exceed the inverter capacity used and the maximum load usage is 70% of the inverter power capacity. In testing the 150 watt lamp load and 100 watt fan there was no decrease in the inverter output voltage. When added to the load of the 550 watt cooling engine and the submersible pump 563 watts the voltage at the load was 220.8 V. This indicates that the inverter off grid used was able to meet the load requirements of the house. But at 13.50 there was a decrease in inverter voltage of 192.56 V, in this case the PV source has not been able to provide power at a large enough load. The inverter output voltage will continue to decrease in accordance with reduced solar radiation. To overcome this problem DC voltage for inverters other than PV can also be obtained from the battery. Using a DC source from the battery is obtained an inverter output voltage of 220.79 V. Thus when the battery source is fully charged it can provide the expected inverter output voltage. So to maintain the stability of the off grid network voltage can be done with the help of a battery source, this is done when the inverter output voltage drops below the 200V voltage.

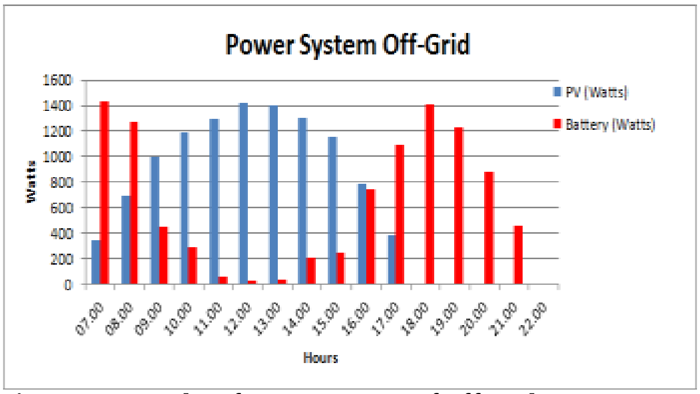

Figure 7. Results of measurement of off-grid system power

Based on fig.7, it can be seen that the power (wattage) with the PV source reaches the peak at 12.00 to 13.00, so that in addition to these hours the load will experience a power shortage. To overcome this power shortage, a battery source is used, the battery source will provide power to the load when the PV source is not optimal.

5. Conclusion

By using an off-grid network system with PV sources and a battery storage system can help with the electricity needs of the house. Off-grid networks are very suitable for residential homes that are not covered by the electricity network. Because PV sources are affected by the intensity of the sun, PV output power also fluctuates. In the off-grid network of the home, to help the stability of the voltage on the load can be done by providing a battery source. When is the battery source supplied or not with a DC-DC converter, which is controlled by a voltage sensor. Likewise in the battery charging process is also regulated with a voltage sensor. The test results show the inverter output voltage is stable when the battery source helps PV to provide a DC source to the inverter, which is 220.8 V.

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