Design PV Standalone System in Electrical Engineering Laboratory of Musamus University Using PVSyst 6.7.0 PRO30

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Abstract, The engineering design systems solar power plant is beginning to be done, procedure to reduce the occurrence of a mistake and the installation of a series of connecting in PV standalone system that result in the low absorption of energy sources the sun and the performance location in electrical engineering laboratory (EEL) of Musamus University of Merauke. In the analysis and this design use PVSyst 6.7.0 pro30 as equipment help, with variable input data that is sourced from the area of the climate system design solar station instalment area and references peak load at EEL. The result was in accordance with the characteristics of the location of the location and the capacity of a load on research object. Based on the capacity and the operational time EEL, mounted on a then obtained power capacity system solar station required in EEL is 6,75 kWp with a power capacity of the burden of daily 5,98 kWp in temperature 50°C or 80% of the nominal required. The array PV standalone system in the area 43,9 m² area module to the north.

1. Introduction
Statistical results show that more than 60% of energy wasted worldwide is mostly waste heat [1]. The amount of wasted heat energy that comes from environmental heat, electronic devices, automotive exhausts, and industrial processes all produce wasted heat energy that can be converted to electricity using thermo eletrics. The thermoelectric effect refers to the ability to produce electric current from temperature differences between one material side and another. Conversely, applying a thermoelectric power voltage can cause one side of the material to heat while the other side remains cold or one side cools while the other remains hot. The heat sink is used to help increase heat release on the cold side, thereby increasing the efficiency of the module. The potential for power generation from a single thermoelectric module will vary depending on the size, construction and temperature difference. The greater temperature difference between the hot side and the cold side of the module will result in greater voltage and current. Thermoelectric modules can also be connected either in series or parallel like a battery to produce a voltage or electric current.

The use of thermo eletrics is limited to the low efficiency that occurs because materials that have good electrical conductor properties tend to be good heat conductors. This means that at the same time the temperature difference produces a voltage, the temperature difference also decreases, thus weakening the current. Materials that have high electrical conductivity and high thermal conductivity behave badly in changing temperature differences into voltage sources. Therefore an effort is made to increase the efficiency of the thermoelectric module.
2. Study Literature

2.1. Solar Power Station

Radiation array the sun received by PV module that serves change energy and to energy the sun gets electricity produces alternating current so energy output PV module is converted through inverter. Phenomena energy conversion sourced from energy the sun produce electric energy called solar power generating photovoltaics system. Here diagram block process of working energy change energy the sun gets electricity, is presented shown in Fig. 1 [1].

![Solar power generation diagram](image1)

**Figure 1.** Solar power generation diagram

2.2. Standalone PV System

As shown in Fig. 2 a stand-alone solar PV system for a typical rural household is expected to comprise the following:

- a. Solar module(s);
- b. Charge controller;
- c. Storage system;
- d. Inverter;
- e. DC and AC loads.

The system stand alone consists of solar module PV, charge controllers and battery in the system stand alone PV system can also connected with generator that used to anticipate when the occurrence of surplus encumbering. In system stand alone specifically PV system generally used to meet the needs of the day. At the same time PV stand alone system also filling in battery, that can be used to load needs at night. Charge control system used to control the flow of charging and discharge on the battery Fig. 2 shows PV stand alone system.[2].

![Layout System Stand Alone](image2)

**Figure 2.** Layout System Stand Alone [3]

![I-V curves](image3)

**Figure 3.** I-V curves [5]
2.3. Module PV Characteristic
Solar cell received irradiating the sun in one day vary widely. This is because the sun having great intensity during the day in the morning. The resulting, power capacity it can be seen through the measurement of voltage (V) and current (I) cluster in solar cells called a panel or Module the current maximum committed by both of terminals of module made the hyphen short so voltages to zero and its waters cast maximum named current. Isc or short circuit Measurement of voltage (V) carried on the positive and negative solar cells of module to connect with other components. solar cells this measure is called open or Voc. voltage circuit characteristic I-V as shown in Figure 3 [4].

2.4. Module PV Characteristic
The model and the performance of PV standalone system who representative and real system calculated mathematically in making the design and plan. A calculation that done aimed at to foretell behavior and the model that in accordance according to the measurement result and observation. Based on a model system pv cell in principle the prop made to know and predict the potential energy produced by pv cell module according to the location of the deployment and the installation of, its design, the condition of the situation the deployment of PV cell sert module. The determination of their performance PV cell based on a model that is planned in accordance with the capacity to do with minutely based on the characteristics of a model PV cell planned. When in plan and the design of a model PV stand alone system has not been carried out carefully, it would impact on the outer covering of the performance of PV stand alone system from losses system. As for the needs on data required in the measurement of PV cell system to determine its performance of them are voltage, the temperature, the slope of a, the azimuth angles [6].

2.5. PV Panel Operation System
This approach in determine the sequence of performance and planning standard step modeling PV standalone system prefixed to know and determine the availability of the potential energy the sun that can be rising on PV cell module as a modifier the light of the sun became energy electricity. With every step the process of irradiating the light of the sun in module pv cell composed in a system PV stand alone system not all the light of the sun are able to find employment maximally because the resulting losses in the heat of the sun heat. In the preparation of the standard step performance and parameter PV aimed at planning for calculating and estimating the results of changes in energy the sun in energy electricity. As for steps performance and parameter that used to know duration of time and losses to changes in energy the sun became energy electricity [6]. In general the measures as follows:

- **Step 1:** Determine PV parameter
- **Step 2:** Determine iradian and weather data
- **Step 3:** Measuring iradian and the arrangement of PV module
- **Step 4:** Predicted effect hotspot that occurs on the surface PV module
- **Step 5:** Effective iradians estimate
- **Step 6:** Estimating the temperature PV module
- **Step 7:** Estimates of the current and voltage characteristic PV module
- **Step 8:** Estimate losses and that taking into the dc series
- **Step 9:** Predicts changes DC to AC losses
- **Step 10:** Estimating losses AC circuit and transformer

2.6. Design and Parameter PV Standalone System
Parameter that used in the design and the determination of the performance of pv cell panel covertly designed to make the model and the working system power station the sequence of steps. Where the installation of PV cell panel will be connected through a series circuit or parallelecircuit, who will be linked in components other in accordance with its function of the two currencies plts system.
The manufacture of simulation on solar power system, is one of a way to make a comparison with the results of the measurement and calculation in the planning solar power system. To make the simulation use data PVsyst required in a sequence as follows [7]:

a. Database location: latitude, longitude and elevation
b. Database components system: model and specifications inverter, model and specifications module PV, number of the PV module connected series and parallel on solar power system, Type and a length of cable connecting any components, the angle tilt and azimuth the module PV on solar power system (or tracking angle algorithm for tracked arrays), albedo on the surface of land and maps potential shadow as a barrier the data the sun on the panel on PV module solar power system.

3. Database and Parameters

Engineering design is a step in a preliminary work to do development PLTS, because through the design engineering will information was obtained and required parameter in accordance with the location the capacity of the burden attached, load factor, needs equipment and components. As for database obtained in performing engineering design and simulation PLTS to areas of the LTE-UNMUS, outlined in the database and PVsyst. Parameters.

3.1. PVsyst Database

A database PVsyst represents data for the threshold of what must be first arranged before emptying into the in the choice of a system patients outside the system that will be used. Figure 6, shows about databases to be filled to the detailed regulation of based on the access to locations and an object to the research done by the meteo databases. Meteo data is data sourced from geographical site in accordance with the research sites, are described as follows in the EEL location. Parameters describing energy quantities for the PV system and its components have been established by the International Energy Agency (IEA) Photovoltaic Power Systems Program and are described in the IEC standard 61724 [8]. The performance parameters of the PV system are specific yield, performance ratio, and capacity utilization factor. The total generation (kWh) has been recorded and extracted through Sunny Web-Box. The reference yield YR is the total in-plane irradiance H divided by the PV's reference irradiance G. It represents an equivalent number of hours at the reference irradiance. The target yield is the theoretical annual energy production (on the DC side of the module), only taking into account the energy of the incoming light and The system yield YF is the net energy output obtained divided by installed DC power capacity of the system. Its unit is kWh/kWp [9].

$$\text{Specific Yield} = \frac{\text{Actual Energy From Plant (kWh)}}{\text{Total Plant Capacity (kWp)}}$$  \hspace{1cm} (1)

The performance of a PV power plant is often denominated by a metric called the capacity utilization factor. It is the ratio of the actual output from a solar plant over the year to the maximum possible output from it for a year under ideal conditions [9]. Capacity utilization factor is usually expressed in percentage.

$$\text{CUF} = \frac{\text{Actual Energy From Plant (kWh)}}{\text{Plant Capacity (kWp) x 24 x 365}}$$  \hspace{1cm} (2)

The ratio of actual to theoretically possible energy output is known as performance ratio. The performance ratio is a measure of the quality of a PV plant that is independent of location and it therefore often described as a quality factor. The performance ratio (PR) is stated as percent and describes the relationship between the actual and theoretical energy outputs of the PV plant.

$$\text{PR} = \frac{\text{Actual Energy From Plant (kWh)}}{\text{Calculated Nominal Plant Output} \text{ in kWh}}$$  \hspace{1cm} (3)
EEL located in Merauke, Papua as shown in Error! Reference source not found. and Error! Reference source not found.. It on -8.53 °N latitude and 140.42 °E longitude, 6 meters above sea level, and area EEL ±200 m². Site location selected has great potential of solar radiation. Besides, the potential of ambient temperature and wind resources also the main factor in generating reliable PV system.

3.2. Load Information and Profile Load
Before we purpose of solar capacity of Solar power plant, we must collect or make a planning for energy needed at user or load. In this case, we will make design for total load capacity of the Electrical Laboratory Musamus University or facility. After we estimate or collect energy needed, we can calculated Solar Power Capacity and battery by Special program for Solar Power System. We used PVsyst V6.70 to calculated. For decide capacity of solar panel, we must to know how much energy used per day as shown on table 1 and figure 8.
Table 1. Estimation energy needed of EEL

|                | Number | Power (Watt) | Use     | Energy      |
|----------------|--------|--------------|---------|-------------|
| Lamps (LED or Fluo) | 98     | 1960         | 5 h/day | 9800 Wh/day |
| PC / Printers    | 19     | 1558         | 3 h/day | 4674 Wh/day |
| Wind Fan        | 12     | 300          | 3 h/day | 900 Wh/day  |
| AC / Dispenser  | 6      | 300          | 24 Wh/day | 5760 Wh/day |
| Laptop / HP     | 40     | 2            | 2 Wh/day | 4400 Wh/day |
| Electrical Plug | 2      | 8            | 4 Wh/day | 30 Wh/day  |
| Standby consumers|       |              | 14 Wh/day | 360 Wh/day |
| **Total daily energy** |       |              |         | 25924 Wh/day |

Figure 8. Energy Demand Consumption in EEL

4. Result and Discussion

Based on data and information obtained in accordance with the data geography and needs energy in the LTE-UNMUS, so the results to give a simulation PV Syst6.70 PRO30 about arrangement of mounting PLTS Stand Alone system were obtained from the potential availability of energy data based on geography and also obtained the losses what happens to standalone solar power system that are were planned. Following sequence in accordance with the data and analysis required parameter. Based on setting databases on PV Syst but the results the simulations for power capacity, a circuit and characteristic Solar PV Stand Alone system in EEL. This part discussed the output from the simulation tool such as the potential energy resources, system component sizing, and energy production from the standalone solar power system as well as system losses.

The Energy average available solar energy (E avail) injected into the PV array for the whole year is 9481,1 kWh. But with the amount pv module that is attached to the array PV 6.75 kWp, so energy in from the stand alone by array PV system can be produced shows in Table 10 of 10176,2 kWh. The decrement energy occurs due to some losses such as module quality loss and ohmic wiring loss. However, the energy produced by PV array is sufficient to meet the load requirement for the entire year. The total energy needed supplies to the user (Eload) is 9462,4 kWh for the whole year, as shown on figure 9 and figure 10.
Energy productivity of PV standalone system during a year and then performance ratio at 0.746 and solar fraction 1, had been shown on figure 11 and 12.

Standalone PV system failed to generate 100% the energy delivered from the sun because of some losses. Explored the overall system loss diagram for site installation. The figure defined the details losses occur in the stand alone PV system. A collector plane received about 1872 kWh/m² of global incident radiation. But the effectiveness plane receives the irradiances only at 1801 kWh/m². The biggest losses happen in PV array production energy. Energy produced from the PV array affected by several factors such as ambient temperature, solar incidence, manufacture mismatch and ohmic wiring. The output energy of PV array proved strongly affected on the potential of solar radiation and ambient temperature. The actual energy supplied to the load can identify after through the losses of regulator and battery storage. The overall system losses can be shown on figure 13.
5. Conclusion
Technical design of standalone PV system using PVsyst6.70 PRO30 on EEL based on potential energy supply and demand the burden. The simulation of PV capacity needs standalone system is nominal (stc) 6.75 kWp operations on the temperature of 5.98 kWp. From the total capacity for standalone PV system to produced, requires 27 PV modules connected in 3 series and 9 parallel. Besides pv module, stand-alone PV system on the capacity of was also connected on a series of control and power bank. Based on the construction where system need to cover area about 43.9 m² with panel elevation 20°C facing toward the north. Based on parameters PVsyst simulation, EEL recommended to install standalone PV system and could serve electrical load on operating conditions.

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