PLTS Design for Big Industry Needs

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ABSTRACT

Solar cell is a device that converts radiation from sunlight into electrical energy directly, which is also called photovoltaic. The Solar Module (Photovoltaic), functions to convert solar energy into DC electric current which is forwarded to the Battery Control Unit (BCU) for further storage in the battery. In this research, a solar cell electric power system with a capacity of 10 MW on-grid will be designed for large industrial needs. The performance of a 10 MW on-grid solar cell power system was simulated using RETScreen Clean Energy Project Analysis software, designed by Natural Resources Canada. This research begins with a prefeasibility study of a 10 MW on-grid solar cell power system using RETScreen software which has an extensive database of meteorological data including daily horizontal solar global radiation as well as databases of various components of renewable energy systems from different manufacturers. The technical and financial performance of a 10 MW on-grid solar cell power system was simulated using RETScreen software. This design is expected to be used as a model to develop a Solar Power Generation System (PLTS) network for large industrial needs.

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1. INTRODUCTION

Electric power is one type of energy which very required in development. By because that with growth economy which estimated around 7%-10% per year until 2025, consumption electricity Indonesia will increase with fast. Needs will electricity good for circles industry, offices, as well as Public general and individual very increase. Electricity is wrong one eye world which no could seen with invisible, but can be enjoyed by the wearer (man that alone). However, enhancement needs electricity this is not accompanied by an increase in supply electricity for consumers so that the electricity company in Indonesia specifically PLN (Company Electricity the State) appeals to all consumers so that To do savings electricity from o'clock 17.00– 22.00. With method this expected crisis electricity doesn't happen or at least it can minimized as early as possible. Besides that crisiselectricity occurs because of the supply of fuel main like stone coal on PLTU (Generator Electricity Power Steam) and PLTGU (Generator Electricity Power Gas and Steam) supply already start thinning because it has been mined too often from stomach earth.

Researchers have alternative other so that crisis electricity could minimized. Based on this, the compilers try for designing a generator electricity withutilise energy sunlight (energy Sun).Electric energy is utilized as energy electricity alternative, especially for the needs of large industries. Energy Sun is energy which potential developed in Indonesia, considering that Indonesia is a country that located in area...
equator. Energy Sun which could resurrected for whole mainland Indonesia which have large 2 million km<sup>2</sup> is 4.8 kWh/m<sup>2</sup>/day or equivalent with 112,000 GWp which distributed.

Utilization of solar energy into electrical energy using the photovoltaic process, namely how to directly convert solar energy become energy electricity. Where Thing this only can carried out using a material that general named with name cell solar (solar cells). Cell this sun only can work with optimal if cell Sun this get ray sun. Solar cell is a device that converts radiation from sunlight into electrical energy directly, which is also called photovoltaic. Photovoltaic is a technology that functions to convert or convert solar radiation into electrical energy directly.

2. RESEARCH METHOD

Project this started with review literature system solar cells. Thing this is followed by pre studies appropriateness simple (to Use RETScreen) for get description about amout energy which will generated by system, estimate total area which required for system installation and access economy whole project. A design system solar cell on-grid until procedure standard developed which could used for copy design systemsolar cell on-grid scale big.

Draft Procedure consist from step-step following:

1. Assessment data radiation sun for location from various institution which help for estimate amoutelectricity which generated. Most simulation device soft also have data radiation sun which could used for destination which same this.
2. Assessment solar farm
3. Assessment system application PLTS.
4. Get information and election PV Cells, Inverters, Controllers and others which needed in PLTS from various source. Information this covers specification technical by complete from each equipment.
5. Get use land map location which used for project the. In this case it will be used something location in area Yogyakarta surroundings Mountain South.
6. Confirm various locations, usage map and information which needed.
7. Identify access network and needs for connection network.
8. Evaluation land and orientation field
9. Design system location system for every PVCell which chosen.

Simulation performance technical and finance of the design is done using RETScreen planning and software Clean Energy Project Analysis Software, the developed by Natural Resources Canada. Draft Procedure will updated based on with information which collected from various design components until procedure standard which could used to imitate solar system designs cell the on-grid is obtained.

Design PLTS 10 MW on-grid

The 10 MW on-grid PV mini-grid design is based on on procedure which developed in methodology. Dataset radiation sun which used from data satellite American space Agency NASA (used in Software RETScreen). Component PV cell which used directed facing to North because region yogyakarta is at next to south equator, could accept radiation with amount highest. Evaluation component PV Cell is then performed with the information from various manufacturers from which components cost which most effective chosen. Table 1 gives summary from a number of parameter design base which used in PLTS 10 MW on-grid.
Table 1. Parameter design base PLTS 10 MW on-grid.

| Meteo Data                  |          |
|-----------------------------|----------|
| Radiation sun daily horizontal | 4.80kWh/m2/day |

| PV Module & Inverter            |          |
|-------------------------------|----------|
| Type Module                   | Monocrystalline (mono-si LPC250SM) |
| Capacity module               | 250Wp    |

| PV Module & Inverter            |          |
|-------------------------------|----------|
| Efficiency Module             | 15.6%    |
| Total capacity installed      | 10000kWp |
| Amount module                 | 40000    |
| Capacity Inverter             | 100kW    |
| Inverter Efficiency           | 97%      |
| Number of inverters           | 100      |

3. RESULTS AND DISCUSSIONS

Analysis results beginning covers analysis technical and financial for "Design and Analysis from 10 MW Surya Solar Power Plant On-Grid" and this is done with the help of two planning and simulation software PC.

Table 2 PV Module Specifications

| Performance at Standard Test Conditions (STC) : Irradiance 1000 W/m², AM 1.5, and cell temperature 25 °C Maximum power |          |
|---------------------------------------------------------------|----------|
| Maximum power voltage                                        | Vmp (V)  |
| Maximum power current                                        | Imp (A)  |
| Open circuit voltage                                         | Voc (V)  |
| Short circuit current                                        | isc (A)  |
| Module efficiency                                             | 15.62%   |

Measurement power solar module which listed in the technical specifications can only be conducted in laboratory with follow Standard quantity International measurement Output Solar Module as following : Illumination (light) 1 kW/ m² on distribution spectral AM 1.5; Temperature cell 25°C; Power peak solar module Wp ( Watt peaks )

In this centralized PV mini-grid with Array to Load Ratio (ALR) is 1, then the solar panel which must provided amount 40000pcs. For system protection use cable ground from copper
which connect system panel direct to ground (soil) and surger arrester which there is in panel box. So that if occur advantages payload by suddenly, like lightning, then the charge is direct neutralized, the protection system can be seen in Figure 1.

![Protection system](image)

**Figure 1. Protection system**

Election map location land which used is around region districts Mountain south, by geographical districts Mountain south located between 07° 16’30” – 07° 19’30” LS and 110° 19’30” – 110° 25’30” BT with large region 1.485 km². Election system application PLTS is centralized on-grid system assuming land which there is in the mountain district south still there is land large which can utilized.

### Table 3 Specifications of inverter

| Type designation         | PVS800-57-0100kW-A       |
|--------------------------|--------------------------|
| **Input (DC)**           |                          |
| Recommended max input power (PPV) | 120 kWp                |
| DC voltage ranges, mpp (UDC) | 450 to 750 V (-825 V+)  |
| Maximum DC voltage (Umax (DC)) | 900 V (1000 V+)         |
| Maximum DC current (Imax (DC)) | 245 A                  |
| Voltage ripple            | < 3%                     |
| Number of protected DC inputs (parallel) | 1 (+/-)-/4          |
| **Output (AIR CONDITIONING)** |                      |
| Nominal air conditioning output power (PN (AIR CONDITIONING)) | 100 kW                |
| Nominal air conditioning current (IN (AC)) | 195 A                 |
| Nominal output voltage (UN(AC)) | 300 V                 |
| Output frequency          | 50 / 60 Hz              |
| Harmonic distortion, current | < 3%                   |
| Power factor compensation (cos) | Yes                  |
| Distribution network type | TN and IT              |
| Efficiency                |                          |
| Maximum                   | 98.0%                   |
| Euro-eta                  | 97.5%                   |
Then analysis technical conducted with help software PVSYST, package device soft PC for studies, size, simulation and analysis data from system PV complete. Device soft this have database which large from data meteorology for different locations, system components and specification producer and simulate performance of the PV system, taking into account right various possibility loss.

The simulation of this software can sir PV module which used with specification complete from various producer, inverter, the tilt angle of the PV module and radiation received by the PV module, shading, laying PV module as well as configuration, number of PV modules, number of inverters, and etc. So that will produce energy maximum and large region which needed.

The simulation results show the placementsolar cell (PV cells) installed with tilt 15° facing to north will produce energy which maximum. PV the required module is 40000 module, 100 inverters with each capacity each inverter 100 kW. Large land which required is 64026 m² or about 6.4 hectares. With shading 0, because planning assumed system on-grid centered so that laying PV on the groundopen.

The simulation results show that, total energy produced by 10 MW PLTS on-grid estimated 14237 MWh/year. Figure 2 shows average _ produce energy monthly for system.

![Graph showing energy production](image)

The performance ratio (Performance Ratio) is defined as amount actual energy PV sent to grid on something period certain, shared with amount theoretical according to STC data module. Ratio performance 79.6% and considered system performs very well. The summary of the performance ratio simulation results can be seen in Table 4.

Table 4. Summary of simulation results

| Power consumption                        |
|-----------------------------------------|
| Own consumption in operation            | < 350 W                           |
| Standby operation consumption           | < appr. 55 W                      |
| External auxiliary voltage              | 230 V, 50 Hz                       |

| Dimensions and weight                   |
|-----------------------------------------|
| Width / Height / depth, mm (W / H / D)  | 1030 / 2130 / 644                   |
| Weight appr.                            | 550 kg                             |
**Financial Analysis**

Analysis economy from PLTS 10 MW on-grid conducted for evaluate cost and benefit from this project. This is done with RETScreen software help. Software this easy used and have ability simulation *net present value* and *payback period* is simple and estimate savings from potency effect house glass (*greenhouse gas*) project - project energy renewable During operate.

From results calculation based on simulation, with enter all cost which required is known cost total investation which must issued is as big as $20,009,000. Cost total investation consist from components following: module, inverters, cable, structure installation, technique and management project, labor and cost etc. Cost from various component PV Sun which used for study this based on estimation international taken from research company PV solar *online*. Charge modules and inverters just make until around 90% from total cost investation. Estimated cost calculations can be seen in Table 5.

| Table 5. Estimated cost calculation |
|-------------------------------------|
| **Component**                      | **Unit Cost** | **Volume** | **Total Cost** | **Amount** | **Relative%** |
|-------------------------------------|---------------|------------|----------------|------------|--------------|
| Feasibility study                   | $3,230        | $10,183    | $32,771        | $13,420    |              |
| Development                        | $15,000       | $15,000    | $15,000        | $15,000    |              |
| Engineering                         | $10,000       | $10,000    | $10,000        | $10,000    |              |
| Reliability                         | $17,456,000   | $17,456,000| $17,456,000    | $17,456,000|              |
| Balance of system & miscommunications | $55,000      | $55,000    | $55,000        | $55,000    |              |
| Total initial costs                 | $20,009,000   | $20,009,000| $20,009,000    | $20,009,000|              |

Analysis economy for profession this conducted with more formerly develop a base case scenario that consist from cost electricity moment this and parameter finance other. Scenario next developed from case base this for help analyze implication from various choice financing on project. A number of choice considered including grant/subsidy capital, *feed-in rate* (fit) and credit financing carbon.
4. CONCLUSION

Draft procedure which developed for planning PLTS required consideration in design system network large scale. These design steps is evaluation from data radiation sun for location, identification and evaluation location which will used, election component system PV Sun and finally, designing the layout of the on-grid PV mini-grid.

In designing PLTS 10 MW on-grid for large industrial needs, planning technique simulated with use PV Syst software. In this design used PV module which is at marketed with output power per module of 250 Wp it takes about 40000 PV module and 100 fruit inverter 100kW. Election inverter 100 kW this expected on moment operation and maintenance will more easy, and when occur disturbance no need turn off all units, only units which need extinguished just.

The required land area is about 6.4 hectares to generate 10 MW of PLTS. Assumption system PLTS which used is a centralized PV mini-grid system (Grid-connected centralized), because it is assumed that this PLTS will be opened on land open with shading 0.

Analysis results simulation show that, when the project is implemented it will supply around 14237 MWh electricity per year. Project this also chance for saved about 6465 tons CO2 that should be emitted by generator electricity with ingredient burn fossil for produce amount electricity which same. Cost total investation which must issued is for $20,009,000. Around 90% from cost total investment is for module PV and inverters. With simulation simple use RetScreen, project this could considered worthy by financial.

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