PLTS Design for Big Industry Needs

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ARTICLE INFO	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. *This is an open access article under the CC BY-NC license.*

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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 crisis electricity 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 with utilise 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$<^2$ is 4.8 kWh/m^2/day or equivalent with 112,000 GWp which distributed.

Utilization of solar energy into electrical energy using the photovoltaic process, namely by 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 amount 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 system *solar 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 amount electricity 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 PV Cell 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)	30.5
Maximum power current	Imp (A)	8.20
Open circuit voltage	Voc (V)	37.6
Short circuit current	isc (A)	8.66
Module efficiency		15.62%

Performance at Standard Test Conditions (STC) : Irradiance 1000 W/m2, AM 1.5, and cell temperature 25 °C Maximum power		
Maximum power		200
Maximum power voltage	Vmp (V)	30.9
Maximum power current	Imp (A)	6.51
Open circuit voltage	Voc (V)	37.6
Short circuit current	isc (A)	6.90

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

whichconnect 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.
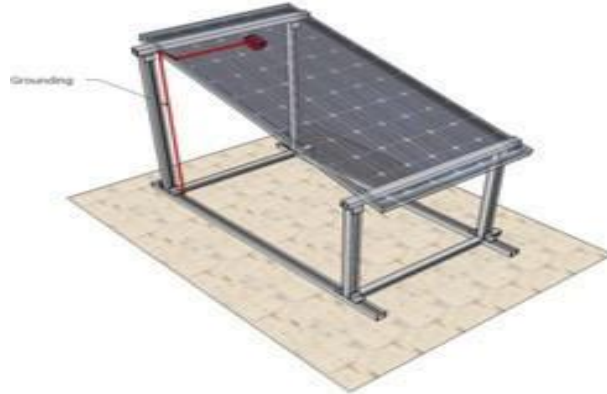

Figure 1 . Protection system

Election map location land which used is around region districts Mountain south. by geographical districts Mountain south located between 07 ^{o} 16'30" –07 ^{o} 19'30" LS and 110o $^{19'30}$ " – 110o $^{25'30}$ " BT with large region 1.485 km ^{2}. 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
	100 kW
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
Type designation	PVS800-57-0100kW-A
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%

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

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 placement *solar cell (PV cells)* installed with tilt 15 ^{o} 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 m ^{2} or about 6.4 hectares. With shading 0, because planning assumed system *on-grid* centered so that laying PV on the ground open.

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.
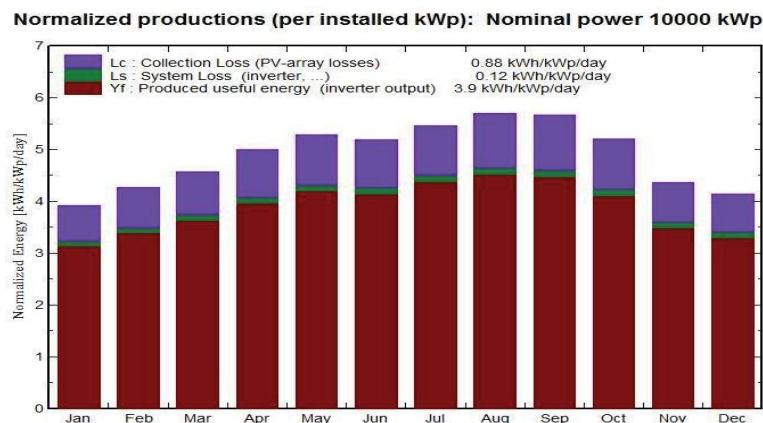

Figure 2. Results average energy monthly

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

Grid-Connected System: Main results

Project : **proyek 10 mw di yogyakarta**

Simulation variant : **New simulation variant**

Main system parameters				
PV Field Orientation	System type	**Grid-Connected**		
	tilt	15°	azimuth	0°
PV modules	Model	LPC250SM-06	Pnom	250 Wp
PV Array	Nb. of modules	40000	Pnom total	**10000 kWp**
Inverter	Model	PVS800-57-0100kW-A	Pnom	100 kW ac
Inverter pack	Nb. of units	100.0	Pnom total	**10000 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**14237 MWh/year**	Specific prod.	1424 kWh/kWp/year
	Performance Ratio PR	79.6 %		
Investment	Global incl. taxes	17595000 US$	Specific	1.76 US$/Wp
Yearly cost	Annuities (Loan 5.0%, 20 years)	1411868 US$/yr	Running Costs	0 US$/yr
Energy cost		**0.10 US$/kWh**		

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

Initial costs (credits)	Unit	Quantity	Unit cost	Amount	Relative costs
Feasibility study					
Feasibility study	cost	1	$ 15,000	$ 15,000	
Subtotal				$ 15,000	0.1%
Development					
Development	cost	1	$ 15,000	$ 15,000	
Subtotal				$ 15,000	0.1%
Engineering					
Engineering	cost	1	$ 60,000	$ 60,000	
Subtotal				$ 60,000	0.3%
Power system					
Photovoltaic	kW	10,000.00	$ 1,760	$ 17,595,000	
Road construction	km			$ -	
Transmission line	km			$ -	
Substation	project			$ -	
Energy efficiency measures	project			$ -	
User-defined	cost	1	$ 500,000	$ 500,000	
				$ -	
Subtotal				$ 18,095,000	90.4%
Balance of system & miscellaneous					
Spare parts	%			$ -	
Transportation	project			$ -	
Training & commissioning	p-d	10	$ 500	$ 5,000	
User-defined	cost			$ -	
Contingencies	%	10.0%	$ 18,190,000	$ 1,819,000	
Interest during construction		12 month(s)	$ 20,009,000	$ -	
Subtotal				$ 1,824,000	9.1%
Total initial costs				$ 20,009,000	100.0%

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.
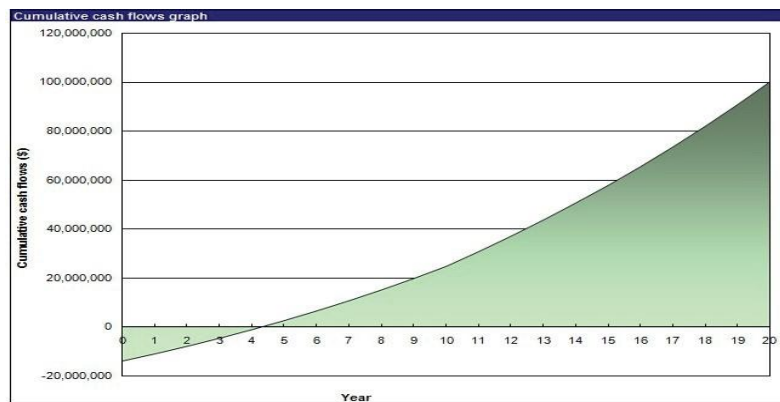
Figure 3. Chart *cumulative cash flow*

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 PVSyst *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 CO_2 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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