



10 KW GRID CONNECTED ROOFTOP SOLAR PV POWER PLANT

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ABSTRACT:

With the intent of reducing carbon footprints on the energy used for a Medical unit in Visakhapatnam, Andhrapradesh, India has been considered by going with a 10KW Solar PV Power Plant connected to Grid with a Grid Intertied Inverter to convert generated DC power from Solar to AC Power. Thus, latest of Photovoltaic Technology called Mono PERC has been used with 470Wp PV Module has been utilized to generate desired energy from the system.

Proposed plant is at a location in Gajuwaka, Visakhapatnam District with 10 Deg Fixed tilt and detailed aspects of Engineering, procurement and construction were considered to generate minimum 14000KWh per year and the same is captured within this paper.

1. INTRODUCTION

The electricity sector in India supplies the world's 6th largest energy consumer, accounting for 3.4% of global energy consumption by more than 17% of global population. the Energy policy of India is predominantly controlled by the Government of India's, Ministry of Power, Ministry of Coal and Ministry of New Renewable Energy and administered locally by Public Sector Undertakings (PSUs).

About 70% of the electricity consumed in India is generated by thermal power plants, 21% by hydroelectric power plants and 4% by nuclear power plants. More than 50% of India's commercial energy demand is met through the country's vast coal reserves. The country has also invested heavily in recent years in renewable energy utilization, especially wind energy. In 2010, India's installed wind generated electric capacity was 13,064 MW. Additionally, India has committed massive amount of funds for the construction of various nuclear reactors which would generate at least 30,000 MW. In July 2009, India unveiled a \$19 billion plan to produce 100,000 MW of solar power by 2023.

According to a research report published by Citigroup Global Markets, India is expected to add up to 113 GW of installed capacity by 2017. Further, renewable capacity might increase from 15.5 GW to 36.0 GW. In the private sector, major capacity additions are planned in Reliance Power (35 GW) and CESC (7 GW).

Average per capita consumption of energy

SL.NO.	COUNTRY	POWER CONSUMPTION	
		MWh/Year	Watts
1	India	488,500,000	489
2	USA	3,816,000,000	3816
3	Japan	974,200,000	974
4	Germany	545,500,000	546
5	China	2,859,000,000	2859

Sl.No.	Source of Energy	Programme Capacity in MW		
		9 th Plan	10 th Plan	11 th Plan
		(1997-2002)	(2002-2007)	(2007-2012)
1.	Solar Photovoltaic	200	400	600
2.	Solar Thermal Power	300	600	900
3.	Wind Power	3000	6000	9000
4.	Small Hydro	1000	2000	3000
5.	Biomass Co-generation	1000	2000	3000
6.	Bioenergy/Biomass Power	1000	2000	3000
	Total	6500	13000	19500
Source: CEA report on Fourth National Power Plan				

2. Solar PV Potential

Solar Power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates.

With about 301 clear sunny days in a year, India's theoretical solar power reception, just on its land area, is about 5 Peta hour/year (i.e. = 5000 trillion kWh/yr ~ 600 Tera Watt). The daily average solar energy incident over India varies from 4 to 7 kWh/m² with about 2300 - 3200 sunshine hours per year, depending upon location. This is far more than current total energy consumption. For example, even assuming 10% conversion efficiency for PV modules, it will still be thousand times greater than the likely electricity demand in India by the year 2015.

Exploitation of the abundant solar energy resources available in our country is therefore, being accorded a high priority by the Ministry of New and Renewable Energy. The Ministry has come forward to support Solar PV based Power Plants in big way throughout the country with a host of fiscal incentives. For encouraging investment by the private sector in power generation through renewable energy, MNRE has formed nodal agencies in all the states, and has issued a set of guidelines for their consideration.

3. Proposed Power Plant

Considering the good potential available and also the thrust given by the Government of India and State Government to this national endeavor of exploiting renewable source of energy for power generation and with the availability of abundant Solar Power HOSPITAL is proposing to set up a 10KW Grid connected Roof Top Solar PV Power Plant in Andhra Pradesh.

The proposed Power Plant site is well connected & all necessary infrastructure facilities are available in & around the site. The proposed plant will have crystalline modules, module mounting structures, inverters and all accessories as the major components. The power generated will be evacuated to the LT panel. Thus in Promoter's perception, setting-up of the above power plant will go a long way to meet the growing energy demand and also benefit the state.

4. Site Selection

The site selection for a Solar Power Plant is pre-dominantly determined by solar insolation availability & grid connectivity for exporting power. Equally important are other essential factors/considerations such as:

- i. Availability of adequate roof top space for Power Plant and green belt development
- ii. Availability of water and power during construction
- iii. Availability of labor force in the proximity
- iv. Availability of load centers (towns) within vicinity
- v. Easy accessibility of the site

The proposed site where Power Plant is to be located in Visakhapatnam city of Andhra Pradesh state and is found favoring all the above factors to a reasonable extent.



5. Proposed Location and Land Availability

Visakhapatnam is the largest industrial city in Andhra Pradesh.

Topographical & Geological Conditions

SH IST is located 17.69N and 83.21E

Building has an average elevation of 39 meters.

Electric Power

The power generated from the Power Plant will be connected to the existing grid line within the Hospital premises.

IRRADIATION DATA

Visakhapatnam irradiation level is in the level of 5.0 to 5.3 kWh / Sq.m and since the site is very close to the

Gajuwaka town, the Irradiation data of the Gajuwaka town is considered for all design purpose. The following are the actual site co-ordinates.

Latitude	: 17.69 N
Longitude	: 83.21 E
Building Elevation	: 39 m
Annual Solar radiation	: 5.12 kWh/ Sq.m/day

Mean Global Solar Radiant Exposure

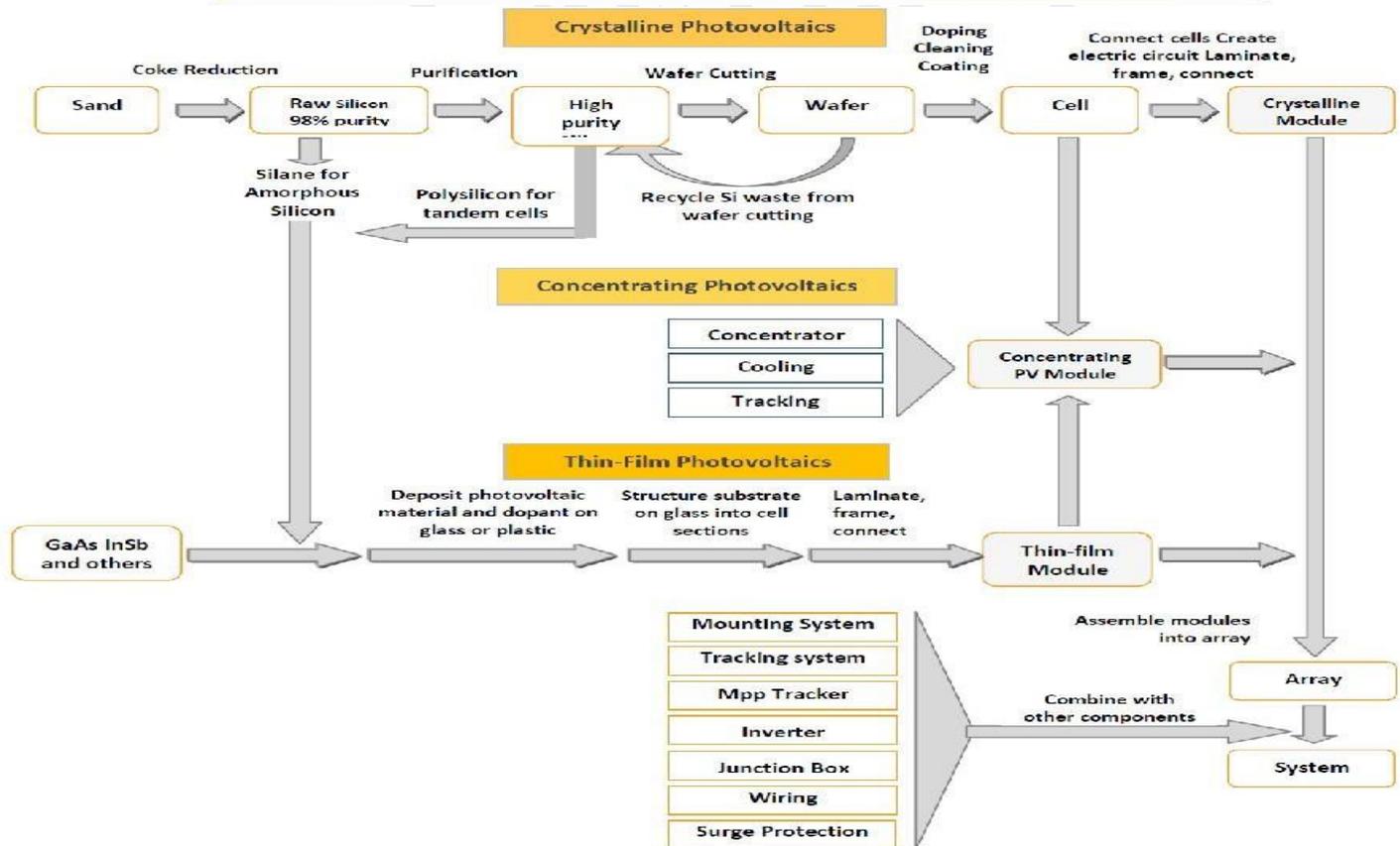
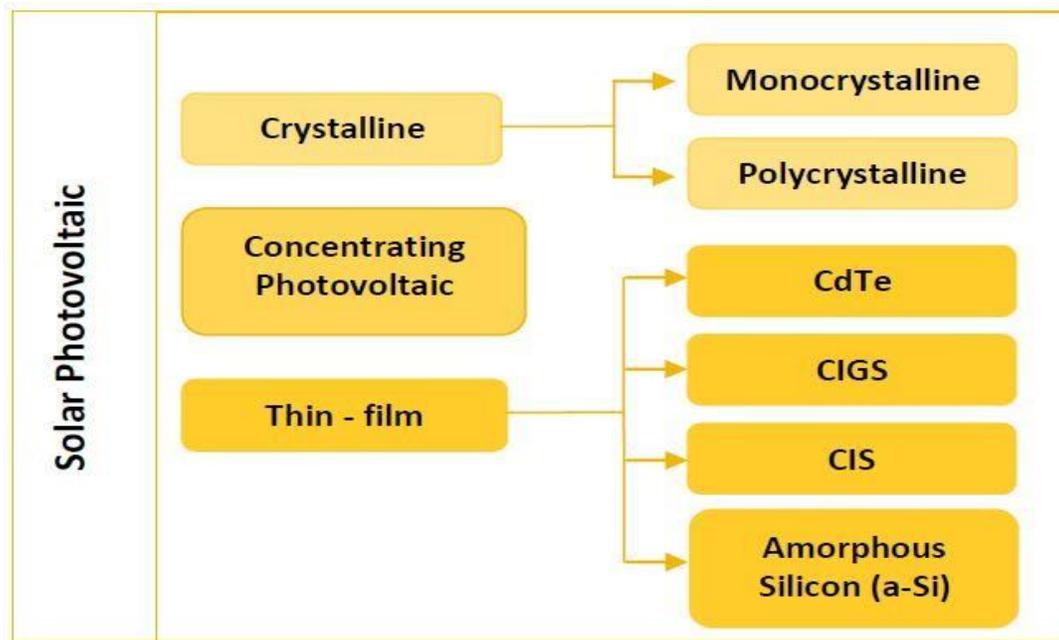
Gajuwaka @ Visakhapatnam.

Month	Monthly solar radiation-Horizontal
	Kwh/m ²
January	149.5
February	153.6
March	185.6
April	192.2
May	188.2
June	146.7
July	141.6
August	140.2
September	142.9
October	152.1
November	139.1
December	138.3
Annual	1870.1

Monthly Parameters at site

6. SELECTION OF PV TECHNOLOGY

According to the crystalline structure amorphous, poly-crystalline and mono-crystalline solar cells are known. According to technological procedures used by production solar cells can be divided into silicon solar cells, produced from Si wafers, and thin-film solar cells produced with vacuum technologies. Basic features from different solar cell types can be found below.

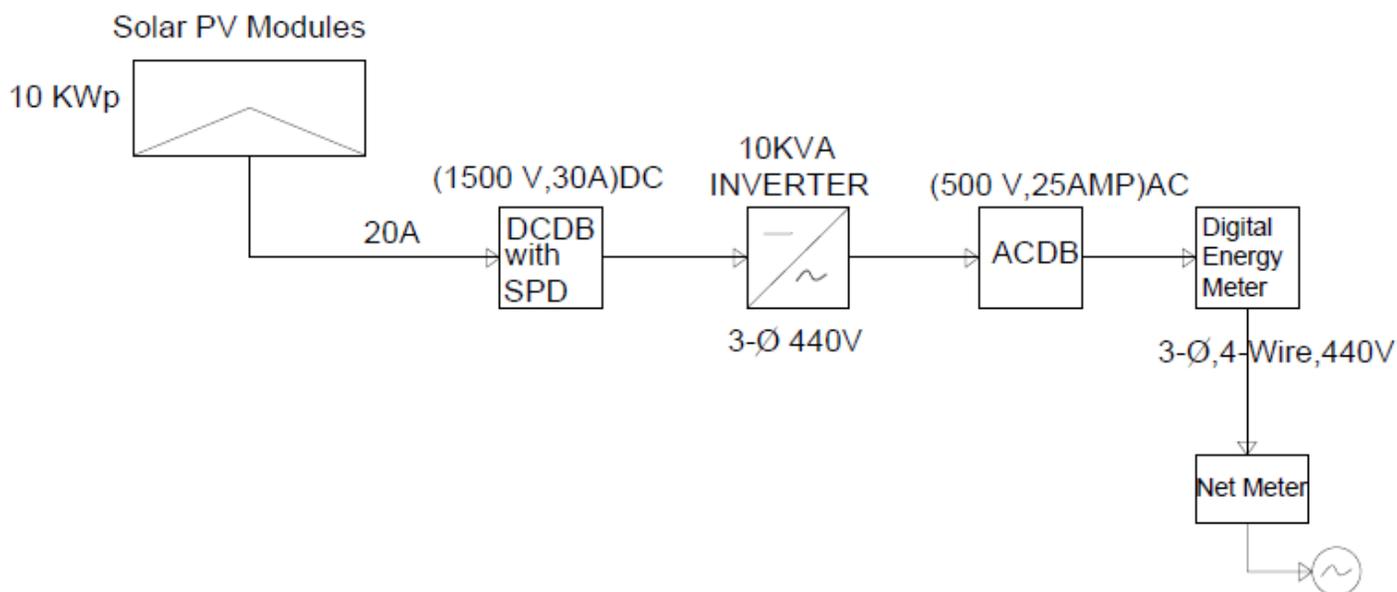


Short circuit current	11.68 A
Module Efficiency(%)	20.93%
Maximum system voltage (Volts)	IEC: DC 1500V
Type of solar PV cell	Mono PERC Crystalline silicon
Solar cells	72 nos. of 163.75mm silicon cells
Module output	MC 4 terminations
Certification	IEC61215 & EN IEC 61730 Class A, Safety Class II
Power warranty	<ul style="list-style-type: none"> • 25-year limited warranty on power output & 5-year product warranty • 25-year performance warranty - 10 years: 90% minimum performance - 25 years: 80% minimum performance

Technical Specification – Module Mounting Structures

Material	GI / Aluminium
Overall dimension	As per design
Wind rating	100 km/hr
Tilt angle	5° -Fixed angle
Foundation	RCC/ PCC As per design
Fixing type	SS 304 fasteners

Single Line Diagram for 10KWp Solar PV System



District Name	Visakhapatnam
State	Andhra Pradesh
Installed Power Plant capacity	10KW
Technology	Solar Photovoltaic
Location of place on Earth	(i) Latitude : 17.69N (ii) Longitude : 83.21E
Altitude	39m
Average annual solar isolation	4.0 kWh/m ² /day
Nearest Town	Visakhapatnam
Nearest airport	Visakhapatnam Airport
Nearest Railway station	Visakhapatnam
Type of Module proposed	Mono PERC Crystalline

Type of Inverter proposed	String
Total Inverter capacity	10kW
Projected Gross Energy Production per year	14.4MWh @100% grid availability

Material for Crystalline Modules

Sl.No.	Description	Qty	Unit
1	470Wp Solar Module Mono	22	Nos.
2	String Inverter 10KW	1	Nos.
3	PV Junction Box – 5KW	2	Nos.
4	Module Mounting Structure	For 22 Modules	Sets
5	DC Cable 1C x 4Sq.mm	100	Mtrs.
6	AC Cable 4 C of 10sqmm armour Cu cable	50	Mtrs.
7	DC Earthing kit	1	Set
8	Lightning Arrestor	1	Set
9	Digital Energy Meter	1	No.

CHAPTER 13: RESULTS

Complete Turnkey of the Engineering and construction of 10KW Solar PV Rooftop system was done on the premises of Simhagiri Hospital in Gajuwaka which can generate 14.4 MWh per year.

- 1401 KWh per KWp is the expected Energy Yield by the end of 1st year from installed 10KW Solar PV System
- DC overloading of the system can be done upto 40%
- Impact of losses specific to Ohmic and shading were captured
- Grid availability and plant availability on 440V is limited to 97.5%
- Expected Monthly Energy yield data was captured within the simulation report
- 5 Deg Tilt was considered with the installed system due to space constraint

- Aluminum profiles were used instead of Hot Dip Galvanised structures for Module Mounting Structures and can with stand 150KMPH
- Modules can hold 2400Pa specific to wind and 5400 Pa specific to hail storms

7. CONCLUSION

Engineering, Procurement and Construction of 10KW Solar PV System was installed on the Rooftop of Hospital, Gajuwaka, Visakhapatnam on a fixed tilt of 5 deg with Aluminium extruded frame. Due to the fact of space constraints, pitch between module rows was reduced with increased shading loss to accommodate higher installed capacity with compromised ground coverage ratio.

- Proposed rooftop is not a shade free zone and can accommodate only 2KWp for shade free access installation
- 10.3KWp was installed with customized design of frame footings with reduced pitch of 1.5 mtr and reduced tilt of 5 Deg
- The same can be increased to 10 Deg Tilt with same pitch and with the increased shading loss with in the existing space.
- Future expansion on the same system can be done by going with elevated roof structures such that the existing loss factors can be reduced to increase the energy density of existing location

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