

The Design of 1 MW Solar Power Plant

Jitendra Sunte

Assistant Professor, Department of Mechanical Engineering, Lingaraj Appa Engineering College Bidar,
Karnataka, India

Article Info

Volume 6, Issue 4

Page Number : 27-35

Publication Issue :

July-August-2022

Article History

Accepted : 05 July 2022

Published : 15 July 2022

ABSTRACT

An area of 6acre land required for installation of solar power plant to generate 1 Mega watt electricity for industrial or domestic purpose. This paper is dealing with design materials for plant building, layout of power plant , components spare parts accessories for plant main parts. further plant enhances eco friendly pollution free electricity generation. This will be renewable energy source available in plenty amount for account consideration.

Keywords : Plant Accessories, Layout, Panel

I. INTRODUCTION

A solar power plant with a 1MW capacity or greater may be taken into consideration as a “Ground Mounted Solar Power Plant, Solar Power Station or Energy Generating Station”. These solar energy structures produce a big amount of power that is more than enough to strength any corporation independently or can eventually be bought to the government. Today, each person can installation a solar electricity plant with a ability of 1KW to 1MW on their land or rooftops. Ministry of New and Renewable Energy (MNRE) and state nodal groups are also presenting 20%-70% subsidy on solar for residential, institutional, and non-profit groups to promote such green energy resources. State energy boards and distribution businesses will assist you for the duration of the complete manner. These incentives/schemes will boost the strength technology in India and encourage human beings to put in sun power structures. In a developing united states like India, the intake of power is increasing constantly and

its production is restricted. Also, we don't have enough assets to store so much strength. Therefore, because of the upcoming energy intake, it'd be a sensible thing to install a sun power plant

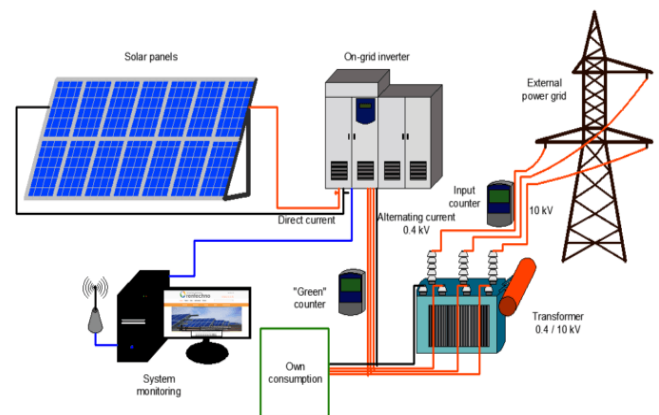
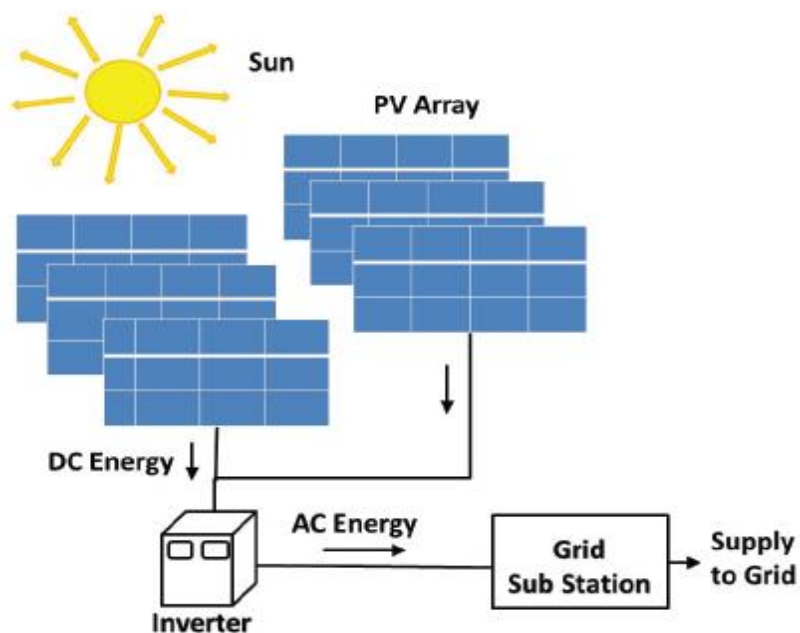


Fig 1. Ground Mounted 3d layout of solar power plant



Estimated Capital Cost for 1 MW Solar PV power plant (Crystalline Cell)

| Sr. No | Particulars | Capital Cost Norms for Solar PV Project (INR Lakh / MW) | Capital Cost Norms for Solar PV Project (USD Lakh / MW) | Land Requirement for Installation of the Solar cell for 1 MW |
|--------|--|--|--|--|
| 1 | PV Modules | 325.92 | 6.04 | 6 Acres |
| 2 | Additional module cost as against degradation | 9.79 | 0.18 | |
| 3 | Land Cost | 16.8 | 0.31 | |
| 4 | Civil and General Works | 94.5 | 1.75 | |
| 5 | Mounting Structure | 105 | 1.94 | |
| 6 | Power Conditioning Unit | 60 | 1.11 | |
| 7 | Evacuation cost up to inter connection point (Cables and Transformers) | 105 | 1.94 | |
| 8 | Preliminary and Pre-operative Expenses including IDC and Contingency | 80 | 1.48 | |
| | Total Capital Cost | 797.01 | 14.76 | |

Designing Steps

Know your requirement (Load)

Select the excellent-acceptable PV panel (sizing)

Preparing the format of the device

Inverter to be used

Battery to be used

Designing in Detail

1. Know Your Requirement

The solar electricity plant that you design could be the maximum efficient one best if it's miles in conformation with your requirement. You can calculate your requirement in approaches:

Either you could take a look at and analyze your three to four preceding month's electricity payments and recollect the biggest of them as your requirement. It is recommended to estimate your requirement a chunk larger than the most important of the above estimation.

Or you may analyze your load. This can be completed via calculating the entire quantity of electrical system working in your house, in conjunction with their power rankings and number of an hour every paintings in a day.

2. Selection of PV Panel

The maximum fundamental but the most important attention in designing a solar energy plant is the choice of the PV panel for use. Due to the supply of numerous sorts and capacities of solar panels, it will become even more complicated to pick one. But in case you become well aware of your load, then it is easy to select the panel.

The panel can either be a monocrystalline, polycrystalline, or thin movie. But Polycrystalline is more normally used because of is fair performance and fairer fee truth. From your load, you may decide the range of solar panels you'll require. E.G., if your

requirement is two kW, and your panel is of 250 W capacity, then you'll need eight panels.

Along with the range, the size of the panel is also an crucial issue. The available vicinity for installation should be known. The general size of a panel is 65 inches with the aid of 39 inches for residual installation.

Three. Preparing a Layout of your Design

The format is the real design of your sun plant. A layout has issues of each: the capability of solar panels and their length as nicely. A layout deals with the location available as properly. The panels, in line with the requirements, can be organized in:

Series: Here, panels might be linked in collection, the voltage generated by every of them. But cutting-edge via every remains the identical.

Parallel: Here, the panels are linked in parallel; the currents add up, retaining the voltage the identical.

Mixed: A layout may also encompass a mixture of collection and parallel linked panels. But then, positive matters ought to be kept in mind.

4. Selecting an Inverter

The number one function of an inverter is to transform the DC output of the solar panel into AC for making it appropriate for gadget. Various types of solar inverters are:

Microinverters: These are easy in design and set up. It is a plug and play device. They electrically isolate the panels from each other so that shading and different elements do no longer have an effect on the output. But its cost in line with top Watt is high.

Off-grid inverters: These have bidirectional conversion ability, i.E., DC to AC and vice versa. Hence it may preserve the PV voltage as well as the battery voltage.

String inverters: These are reliable, without problems handy, and fantastically efficient.

Central inverters: These are normally ground-set up.

Five. Battery

Batteries are used for constant electricity supply and garage of electricity. The batteries have to have a huge lifetime, reliability, and of direction, performance. Care need to be taken while choosing a battery due to the fact a battery of higher energy than required would boom the overall value of the machine.



Megawatt scale solar system

Power Generation

4000 kWh Units/Day

Average Cost

INR 4 to 5 Crore

(Inclusive of all taxes)

Annual Saving

1 Crore (Approx)

Area Required

4 to 5 Acres

#1. Types of Solar Power Plant

There are three types of solar power plants, which work on the same principle of the “Photovoltaic Effect”. These solar system consist of solar panels, a solar inverter, and solar batteries. The types of solar power systems are:

On-Grid Solar System – Saving + Grid Export

Off-Grid Solar System – Saving + Backup

Hybrid Solar System – On-grid + Off-grid



On grid solar power plants are best suitable for large institutes, commercial and industrial sectors because there is no load limit.

An on-grid sun gadget is a grid (Government electricity supply) linked system. This sun device will run your house appliances or linked load (without any restriction) by means of using solar electricity. If your related load will exceed the capability of the set up sun power plant, the machine will robotically use the electricity from the main grid. In case, your connected load is much less than the generating ability, it will deliver surplus energy to the grid. This sort of gadget is recommended to lessen power bills most effective

Off-Grid Solar Power Plant

Off grid solar power plants are by and large used for homes and residential areas wherein backup is required because of ordinary and long energy cuts.

An off-grid sun strength plant is a battery-based solar electricity gadget. In this type of solar gadget, there

are sun panels, solar inverter, and sun battery. This device will run your private home appliances or related load (as according to sun inverter potential) by way of using solar power. The unconsumed or surplus energy could be saved within the solar battery financial institution. An off-grid sun energy device is usually recommended in which electricity cuts are the important trouble.

Hybrid Solar Power Plant



Hybrid solar strength flora are suitable for each residential and industrial locations. Just its additives and capability trade in keeping with its installation motive.

A hybrid solar electricity plant is a mixture of an on-grid solar gadget and an off-grid sun system. This sun gadget will integrate the functionality of each sun strength structures. One side, a hybrid sun system connects with the primary power grid and on the other side, it concurrently may be connected with solar batteries to provide backup to practice.

#2. 1MW Solar Power Plant Design

A 1MW solar photovoltaic system can be design and customize as per your requirement. You can change this design after concerning a team of solar experts. Here we have a rough design of 1 megawatt solar power system below.

Components Required for 1MW Solar Power Plant

Quality solar components are a key to a successful and efficient solar power system. To set up a 1 megawatt solar power plant at any place, you need the following components. You can customize the solar system by increasing or decreasing the quantity of these components according to their power ratings.

| Components | Specification | Quantity |
|--------------------------------|--|------------------------------|
| Solar PV Module | Mono or Mono PERC (400 Watt) | 2,500 Nos. |
| Solar Inverters | With MPPT Technology (1MW) | 1 |
| SCADA/Monitoring System | Integrated with Remote Monitoring system web based | 1 |
| Protection Devices | SPD, MCB, DC Fuse, etc. | As per design or requirement |
| Cables | DC Side= 10 mm ² , AC Side=LT: 16mm ² & HT: 185mm ² | As per Distance & Gap |
| Solar Structure | Ground Mounted | 1 MW Standard |

We have used 400 watt solar panel and 1MW solar inverter for the calculation.

#3. 1MW Solar Plant Cost

The cost of solar power systems has changed recently and the government is promoting green energy in many ways. You can now install 1MW solar power plant by investing INR 4-5 crore. Thereafter, you can supply the electricity to the government for more than 25 years.

Installation Cost of 1MW Power Plant

For better understanding of investment in 1 megawatt solar power system, we have break down the overall cost in fragments. You can now compare and analyse the cost of solar panels, solar inverters and other accessories individually.

| Particulars | Estimated Cost |
|------------------------------|--------------------|
| Solar Panels | 3 Cr. |
| Solar Inverter | 1 Cr. |
| Combiners + Junction Boxes | 20 Lakh |
| Protective Gears Arrangement | 10 Lakh |
| SCADA & Data Logger System | 7 Lakh |
| Land Bank | *5 Acre |
| Erection of Project | 50 Lakh |
| Total Project Cost | 4.87 Cr. (Approx.) |

Land value of 5 acre is not included in this table.

All the figures in above table are just to provide a rough idea. Don't consider it as an exact and final cost of 1MW solar power plant.

Prices may subject to increase and decrease time to time.

Since a 1kW solar system generates = 4 units/day

Accordingly, 1MW will generate,
 4 units x 1000kW = 4,000 units/day (1MW = 1000kW),
 & 4,000 units x 30 days = 1,20,000 units/month.
 1,20,000 units x 12 months = 14,40,000 units/year.

But the exact generation can be varied according to the types of solar panel you installed, installation location, solar brands, etc.

Income from 1 MW Solar PV Plant

| Particulars | Description |
|-----------------------------------|---|
| Daily units generated | 4000 Units |
| Yearly units generated | 4000×365=14,60,000 units |
| Govt. pays per unit | 3.85 ₹/unit |
| | [According to Central Electricity Regulatory Commission (CERC)] |
| Total income over the year | ₹56,21,000 |
| Net income over the year | ₹43,51,000 (Total income – Annual Maintenance Cost) |

• All the figures shown above are just to provide a rough idea of income from 1MW solar power plant. Don't consider it as exact income from 1MW solar power plant.

• The electricity generation shown above has been taken on an average basis. The exact electricity generation depends on daily sun hours/availability.

• The government electricity price per unit varies state to state and may subject to increase and decrease as per government policy.

#5. Project Report for 1MW Solar Plant

We see a huge demand for information regarding the investment model for setting up a 1 MW solar system. We have decided to create a 1 MW estimate series. So here it is:

| Particulars | Description |
|--------------------------------|----------------|
| Capacity of Power Plant | 1 MW |
| Generation per Year | 14.60 Lakh (On |

| | | | | |
|-----------------------------------|-------------|--------------------------------------|------------|-------------|
| | Average) | (without AD) | | |
| Degradation 1 to 10 year | 0.05% | Taxation (without AD) | 7,230,000 | |
| Degradation 11 to 25 year | 0.67% | (Min Alternative Tax 19%) | | |
| Debt Percentage | 70% | Profit After Tax (Without AD) | 30,770,000 | |
| Equity Percentage | 30% | | | 113,300,000 |
| Rate of Interest (Indian) | 13.0% | Profit After Tax (Without AD) | | |
| Rate of Interest (Foreign) | 10% | Total amount in account | | |
| Repayment Period (Indian) | 11 years | Bank Debt Amount | | |
| Repayment Period (Foreign) | 15 Years | Balance cash in hand | | |
| Percentage of Indian Loan | 70% | | | |
| Sale of Electricity | Rs.6.49 | | | |
| Cost of Project per MW | 450 Lakh | | | |
| O&M Cost per MW | 8 Lakh/year | | | |
| Depreciation | 5.28% | | | |
| Corporate Tax | 30.28% | | | |
| Minimum Alternate Tax | 18.38% | | | |
| Project Cost | 450 Lakh | | | |
| Debt | 355 Lakh | | | |
| Equity | 95 Lakh | | | |

#6. 1MW Solar Plant Balance Sheet

Here is the balance sheet of 1MW solar power plant.

| EXPENDITURE | AMOUNT (Rs.) | AMOUNT (Rs.) |
|-----------------------------------|---------------------|---------------------|
| Operational Expenses | 8,000,000 | |
| Bank Interest Payment | 33,000,000 | |
| Depreciation | 34,300,000 | |
| Total Expense (without AD) | | 75,300,000 |
| Profit Before Tax | | 38,000,000 |

#7. Solar Power Plant in India

India's Top 10 States with Solar Installation

India is one of the biggest strength era portfolios. The call for for easy electricity in India is massive and is constantly growing. Therefore, the Indian government has released the Jawaharlal Nehru National Solar Mission (JNNSM) on 11 January 2010, which objectives to produce 227 GW (Gigawatt) of solar power via 2022. It is a 3-section undertaking that targets to put in 20,000 MW on-grid solar energy flora, 2000 MW off-grid sun power plant inclusive of 20 million solar lights, and to create favorable conditions for developing sun manufacturing capability in the u . S . A ..

#8. MW Power Plant Installations

Solar energy in India is one of the most hastily developing industries. This can be judged from the truth that many large-capability solar strength flowers had been already hooked up in India. Let's see some of those sun power flora.

Bhadla Solar Park, Rajasthan (2255 MW)

Bhadla Solar Park is a 2055 MW capacity solar power plant located in the Jodhpur district of Rajasthan and spread over a total area of 10,000 acres. It is one of the largest solar parks in India.

Shakti Sthala Pavagada Solar Park, Karnataka (2000 MW)

Shakti Sthala Pavagada Solar Park is situated in Karnataka. It is one of the world's biggest solar power plants that has spread over 13,000 acres with 2,000 MW of power generation capacity.

Charanka Solar Park, Gujrat (790 MW Approx.)

Charanka Solar Park is the world's third-largest photovoltaic solar power plant. The park is installed in the Patan district of Gujarat and has a 790 MW capacity. Kadaladi Power Station, Tamil Nadu (4000 MW)

Kadaladi solar park is a 500MW solar park planned for commissioning in 2019 in the region of Ramanathapuram district and proposed a 4,000 MW power station, built by Tangedco at Naripaiyur village. Dhirubhai Ambani Solar Park, Rajasthan

Dhirubhai Ambani Solar Park is located near Pokhran in the Jaisalmer district of Rajasthan. This solar power plant is developed by Reliance Industries. It is one of the largest in the state of Rajasthan.

Maharashtra Solar Power Plant (67.2 MW)

Maharashtra Solar Power Plant is situated in the Beed district of Maharashtra. This solar power plant was established in August 2017. This solar power plant has a capacity of 67 MW and is named after the state of Maharashtra.

Scope of Solar Power in India

India is a developing united states of america and its populace is increasing day by day. It is anticipated that India will become the sector's maximum populated country by 2022. India affords a high quality environment among buyers eager to faucet into India's ability. India has an extended manner to move within the region of solar energy.

In close to future, India will explore new capacity regions and make sure the maximum use of sun power get world management. The "National Institution of Solar Energy in India" has determined the united states's sun electricity ability at round 750 GW. India is slowly going to get its dominion in the field of solar

power generation because of the ambitious kingdom and center's solar policies and tasks.

Nowadays India begins switching to sun strength this is one of the satisfactory monetary decisions in nowadays's world. As we can see the charges of fossil and fuels are increasing daily so this is an ideal alternative to this trouble. Although, India has large scope inside the discipline of sun strength in close to destiny due to the fact solar strength for domestic and industries are a cheap source of easy electricity and secondly, it's miles available extensively across the country with none interruption.

I. REFERENCES

- [1]. Ministry of New and Renewable Energy. (2017, June 7). Physical Progress (Achievements). Online]. Available: <http://mnre.gov.in/mission-and-vision-2/achievements/>.
- [2]. Z. Song, Z. Zhang, and X. Chen, "The decision model of 3-dimensional wind farm layout design," *Renew. Energy*, vol. 85, pp. 248–258, 2016.
- [3]. M. Mayo and M. Daoud, "Informed mutation of wind farm layouts to maximise energy harvest," *Renew. Energy*, vol. 89, pp. 437–448, 2016.
- [4]. National Institute of Wind Energy. (2017, June 10). A Technical Note on Micro-siting of Wind Turbines. Online]. Available: http://niwe.res.in/assets/Docu/Micro-siting_Guidelines.pdf.
- [5]. K. Padmavathi and S. A. Daniel, "Performance analysis of a 3 MWp grid connected solar photovoltaic power plant," *Energy for Sustainable Development*, vol. 17, pp. 615–625, 2013.
- [6]. M. Bharathkumar and H. V. Byregowda, "Performance Evaluation of 5MW Grid Connected Solar Photovoltaic Power Plant Established in Karnataka," *International Journal of Innovative Research in Science, Engineering*

- and Technology, vol. 3, no. 6, pp. 13862–13868, 2014.
- [7]. D. D. Milosavljevi, T. M. Pavlovi, and D. S. Pir, “Performance analysis of A grid-connected solar PV plant in Niš, republic of Serbia,” *Renew. Sustain. Energy Rev.*, vol. 44, pp. 423–435, 2015.
- [8]. D. M. Manukumar, T. Ganesh, and M. C. Math, “Performance and Evolution of Grid Connected to 5MW Solar Photovoltaic Plant in Shivanasamudra,” *International Journal of Research in Advent Technology*, vol. 3, no. 1, pp. 123–128, 2015.
- [9]. M. Muralikrishna and V. Lakshminarayana, “Hybrid (Solar and Wind) Energy Systems for Rural Electrification,” *Journal of Engineering and Applied Sciences*, vol. 3, no. 5, pp. 50–58, 2008.
- [10]. Indian Wind Power Magazine. (2017, June 11). Indian Wind Power. Online]. Available: <http://www.indianwindpower.com/pdf/Indian-Wind-Power-Magazine-April-May-2017.pdf>.
- [11]. B. K. Saxena and K. V. S. Rao, “Comparison of Weibull parameters computation methods and analytical estimation of wind turbine capacity factor using polynomial power curve model: Case study of a wind farm,” *Renewables: Wind, Water, and Solar*, vol. 2, no. 3, pp. 1–11, 2015. DOI: <http://dx.doi.org/10.1186/s40807-014-0003-8>.

Cite this article as :

Jitendra Sunte, "The Design of 1 MW Solar Power Plant", *International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME)*, ISSN : 2457-0435, Volume 6 Issue 4, pp. 27-35, July-August 2022.

URL : <https://ijsrmme.com/IJSRMME22644>