

Design And Installation Of Roof Top Solar Panel

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ABSTRACT

The project is about to design solar electricity system for our college. This project is the study or analysis of the benefits which would have got if the solar system was designed in the past. The primary objective is to determine the electrical power required for institute, and to designed the solar system of generating the same power as perthe requirement of the institute.

This study includes the collection of various things like electricity bills, measurement of shadow free area available in the institute.

The measurements of the roof top area available on the terrace of the college was measured by us. There was approximately 3000 sqm area. The average units consumed by institute 10000 kWh. The number of panels required for this purpose is 263 panels. The 84 Kw system is used.

From all this data, we have calculated the actual required area for this system i.e. equal to 573sqm. This much area is available at the roof top with satisfying all the preliminary conditions.

The secondary objective is to store the extra power generated and using it in unfavorable conditions. The extra generated power can be stored by various means.

The warranty for panels is of 25 years while the other accessories has warranty of 5 years. Thus, our overall cost will be covered after 3.82 years and we will be using the free electricity for further time period.

The System will be cost about Rs.3474000 and work will be established at the rate of Rs. 45.1 per watt.

1. INTRODUCTION

India is the densely populated country. The requirement of energy is thus high. In order to overcome the limited availability of non-renewable sources, we need to look into the generation of power by using renewable sources of energy. The generation of electricity from solar energy is one of them. The most convenient way to fulfill the need of electricity is to prepare it by using solar power. One can produce his own electric power easily with this method.

The project deals with the same thing. We have studied all the aspects regarding the generation of electricity using solar energy. It is very advantageous to use the solar power. Thus, we have designed the complete solar power plant for our institute.

The project is actually the design of solar power generation plant in order to produce electricity. The designed plant is according to the actual need of electricity. For this purpose we did collection of various data as per the progress of the work.

We simply studied the electricity related aspects. We collected electricity bills. It includes the consumption of power. From this data we calculated the actual power of the system. We also calculated the area required for this purpose. We finally calculated cost required for this project.

Overall this project is about design of solar power generation plant and how it is beneficial to our institute.

2. LITERATURE REVIEW

Solar power is arguably the cleanest, most reliable form of renewable energy available, and it can be used in several forms to help power your home or business. Solar-powered photovoltaic (PV) panels convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun. This electricity can then be used to supply renewable energy to your home or business.

To understand this process further, let's look at the solar energy components that make up a complete solar power system.

The roof system

In most solar systems, solar panels are placed on the roof. An ideal site will have no shade on the panels, especially during the prime sunlight hours of 9 a.m. to 3 p.m.; a south-facing installation will usually provide the optimum potential for your system, but other orientations may provide sufficient production. Trees or other factors that cause shading during the day will cause significant decreases to power production. The importance of shading and efficiency cannot be overstated. In a solar panel, if even just one of its 36 cells is shaded, power production will be reduced by more than half. Experienced installation contractors such as NW Wind & Solar use a device called a Solar Pathfinder to carefully identify potential areas of shading prior to installation.

Not every roof has the correct orientation or angle of inclination to take advantage of the sun's energy. Some systems are designed with pivoting panels that track the sun in its journey across the sky. Non-tracking PV systems should be inclined at an angle equal to the site's latitude to absorb the maximum amount of energy year-round. Alternate orientations and/or inclinations may be used to optimize energy production for particular times of day or for specific seasons of the year.

Solar panels

Solar panels, also known as modules, contain photovoltaic cells made from silicon that transform incoming sunlight into electricity rather than heat. ("Photovoltaic" means electricity from light — photo = light, voltaic = electricity.)

Solar photovoltaic cells consist of a positive and a negative film of silicon placed under a thin slice of glass. As the photons of the sunlight beat down upon these cells, they knock the electrons off the silicon. The negatively-charged free electrons are preferentially attracted to one side of the silicon cell, which creates an electric voltage that can be collected and channelled. This current is gathered by wiring the individual solar panels together in series to form a solar photovoltaic array. Depending on the size of the installation, multiple strings of solar photovoltaic array cables terminate in one electrical box, called a fused array combiner. Contained within the combiner box are fuses designed to protect the individual module cables, as well as the connections that deliver

power to the inverter. The electricity produced at this stage is DC (direct current) and must be converted to AC (alternating current) suitable for use in your home or business.

Inverter

The inverter is typically located in an accessible location, as close as practical to the modules. In a residential application, the inverter is often mounted to the exterior sidewall of the home near the electrical main or sub panels. Since inverters make a slight noise, this should be taken into consideration when selecting the location.

The inverter turns the DC electricity generated by the solar panels into 120-volt AC that can be put to immediate use by connecting the inverter directly to a dedicated circuit breaker in the electrical panel.

The inverter, electricity production meter, and electricity net meter are connected so that power produced by your solar electric system will first be consumed by the electrical loads currently in operation. The balance of power produced by your solar electric system passes through your electrical panel and out onto the electric grid. Whenever you are producing more electricity from your solar electric system than you are immediately consuming, your electric utility meter will turn backwards!

Net meter

In a solar electric system that is also tied to the utility grid, the DC power from the solar array is converted into 120/240 volt AC power and fed directly into the utility power distribution system of the building. The power is “net metered,” which means it reduces demand for power from the utility when the solar array is generating electricity – thus lowering the utility bill. These grid-tied systems automatically shut off if utility power goes offline, protecting workers from power being back fed into the grid during an outage. These types of solar-powered electric systems are known as “on grid” or “battery-less” and make up approximately 98% of the solar power systems being installed today.

Other benefits of solar

By lowering a building’s utility bills, these systems not only pay for themselves over time, they help reduce air pollution caused by utility companies. For example, solar power systems help increase something called “peak load generating capacity,” thereby saving the utility from turning on expensive and polluting supplemental systems during periods of peak demand. The more local-generating solar electric power systems that are installed in a given utility’s service area, the less capacity the utility needs to build, thus saving everyone from funding costly additional power generating sources. Contributing clean, green power from your own solar electric system helps create jobs and is a great way to mitigate the pollution and other problems produced by electricity derived from fossil fuel. Solar-powered electrical generating systems help you reduce your impact on the environment and save money at the same time!

3. METHODOLOGY

The method we used for this is the most efficient method of calculation of power of solar plant. The same method is used commercially as it is an economical method.

The very first step we did is data collection of various established projects and actual site visits. This is to get the preliminary information about how to execute the project in the right direction. The collection of preliminary data was done to have the idea about various components and their specifications.

The next thing we did is the secondary data collection regarding the power requirements of our institute. For this purpose, we collected the electricity bills of our institute. The electricity bills includes the data regarding the power consumed by our institute. The next step we did is to measure the area available at the roof top. Then we deduct the area affected by the obstruction and area covered by shadow. By this calculation we got the area available for establishing the solar power plant.

After area calculation we had to decide the kind of a panels to be used for this purpose. Then we decided the place where panels are to be set. It depends upon the surrounding climatic conditions.

The actual design is done by two methods.

1. Design by connected load by MSEB or respective authority.

In this method, the required power is taken as connected load. For our Institute the connected load is 145Kw. This method results in high cost as the power required is less than the power generated. This method also causes loss of area. The method is not preferred to design the solar power plant commonly.

2. Design by actual consumed electricity.

This method is the best method to design the solar power plant. We have used this method for the design of solar power plant for our institute. In this method, the power of the system is calculated by using actual consumed units of electricity.

3.1. DATA COLLECTION

Primary Data Collection

The preliminary data collection was done in order to know the procedure of design of solar electrical power system. It includes visits to various established sites and collecting information, study of various research papers etc.

Secondary Data Collection

The secondary data collection includes various materials and their specifications which are necessary in order to design the system. It also includes collection of electricity bills to know the actual energy consumption by the Institute.

Below Graph Shows the Use of Electricity and Amount of Bill of Year



2017.

4. CALCULATION

5.1 Calculation of Units Consumed Per Month

Units Consumed In Kwh Per Month

MONTH	UNITS CONSUMED PER MONTH
January	7589
February	9529
March	10021
April	14393
May	10782
June	8598
July	5317
August	10903
September	5782
October	11606
November	7686
December	8507
Total	110713



This data is obtained by using the monthly electricity bills of our institutes.

Now, from this data we can calculate average monthly consumption of electricity.

Average Monthly Consumption = Total Units Consumed / 12

$$= 110713 / 12$$

$$= 9226.08 \text{ Kwh/month}$$

Now,

$$\begin{aligned}\text{Average Daily Consumption} &= \text{Average Monthly Consumption} / 30 \\ &= 9226.08 / 30 \\ &= 307.58 = 308 \text{ Kwh / day}\end{aligned}$$

5.2 Field Area Calculations

Field Area Calculation

Our institute has 5 buildings. Among them C and D buildings are joint. A, B and E buildings are separate. We have actually calculated the area of the roof for this purpose.

We have divided the buildings in 2 to 3 sections for easy measurements.

Building C and D

Section A,

$$\text{Total Area} = 11.3 \times 27.3 = 308.49 \text{ sqm}$$

Deductions

$$D1 = 3.8 \times 4 = 15.2 \text{ sqm}$$

$$D2 = 6.9 \times 4 = 27.6 \text{ sqm}$$

$$\text{Total available area} = 265.69 \text{ sqm}$$

Section B

$$\text{Total Area} = 10.3 \times 37 = 381.1 \text{ sqm}$$

$$D1 = 7.2 \times 2.7 = 19.44 \text{ sqm}$$

Deductions

$$\text{Total available area} = 361.66 \text{ sqm}$$

Section C

$$\text{Total Area} = 10.3 \times 27.6 = 284.28 \text{ sqm}$$

Deductions

$$D1 = 6.9 \times 2.7 = 18.63 \text{ sqm}$$

$$\text{Total available area} = 265.65 \text{ sqm}$$

5.3 CALCULATION OF POWER OF SYSTEM AND AREA REQUIRED FOR PANELS

Average size of panel=2x1m(max)

The panel we are using =320 watts

Now, Average monthly consumption = 9226.08 units/month

Now,

Unit consumption per day = $9226.08/30=308.08$ units/day

Then, 1KW system generates averagely 4KWH/day

Hence,

$$\text{Power of system} = 308/4 = 77 \text{kw}$$

We are using 320watts panels.

$$\text{Number of panels} = 77000/320 = 240 \text{ panels}$$

(1kw=1000watts)

Average area of one panel is 2x1 sqm.

Thus,

Total area required for panels = $240 \times 2 \times 1 = 480$ sqm

Now, we need to consider following conditions,

Provide 1m distance from boundaries

Provide 10cm distance between two panels

Direction of panels should be south facing.

For calculation purpose; we are considering sets.

Each set will include 6 panels with 10cm spacing.

As per the specifications of panel, the size is 2×1 sq.m

Now, each set will occupy 13.02 sq.m area.

Now, total number sets = total number of panels/number of panels in 1 set

Hence, total number of sets = $240/6=40$ sets

Total area required = $40 \times 13.02 = 520.8 = 521$ sqm

5.4 Actual Setting of Panel And Its Inclination

Site Selection

Considering all the aspects, we have decided to set the panels on 'E' building. Following are the reasons to set the panels on E building.

- It is the only building which has its own area more than the area required for this purpose.
- This building has negligible obstructions.
- This building is highly exposing to sunlight.
- It will be convenient for transportation of panels as it is close to the main road.

Inclination

The inclination of the solar panels is dependent on the latitude of the region. The latitude of the Pune is 18° . Considering other climate related factors let's add 5° to it. It will be 23° with respect to horizontal surface.

Orientation

The facing of panels must south facing. It needs more time to be exposed in sunlight.

5. COST ANALYSIS

6.1 COST OF THE WORK

Here we are using 320 watt panels for this purpose,

The nominal cost of the single panel is Rs.9600

Thus, we need 240 panels of 320 watts.

Thus overall cost of the panels = $9600 \times 240 = \text{Rs.}23,04,000$

Now,

We need inverters for conversion of current.

The inverters costs Rs. 12,000 for 1kw system,

Therefore for 77Kw system;

Cost of the inverters= $12000 \times 77 = \text{Rs.}9,24,000$

We also need fabricated structures for assembling the solar panels in right position.

The cost of this structures is about Rs.3000 per Kw.

Thus overall cost of fabricated structures = $3000 \times 77 = \text{Rs.}2,31,000$

Thus, Overall cost of this complete work will be,

$$\begin{aligned} \text{Total cost} &= \text{Cost of panels} + \text{Cost of inverters} + \text{Cost of fabricated structure} \\ &= 2304000 + 924000 + 231000 \\ &= \text{Rs. } 34,59,000 \end{aligned}$$

Considering prevention from lightening and high voltage. We need to provide LA rod and earth pits. They would cost Rs. 15,000 maximum.

Hence,

$$\text{Final cost of the work} = 3459000 + 15000 = \text{Rs.}3474000$$

Now, we need to find out the cost of project in terms of per watt cost.

$$\begin{aligned} \text{Hence, per watt cost of the project} &= 3474000 / 77000 \\ &= \text{Rs.}45.1 / \text{watt} \end{aligned}$$

6.2 BENEFITS IN TERMS OF COST

The electricity is supplied to us by MSEB.

There are different rates according to usage and type of areas i.e. industries, schools, colleges etc.

MSEB charges Rs. 8.21 per unit use of electricity for educational institutes.

Now,

As we calculated, our institute consumes averagely about 9226.08 units per month.

Hence,

$$\text{The average monthly electricity bill of our institute} = 9226.08 \times 8.21 = \text{Rs. } 75746.11$$

Now,

From this we can calculate the average annual electricity bill,

Hence,

$$\text{Average annual electricity bill} = 75746.11 \times 12 = \text{Rs.}908953.32$$

Now,

The overall cost of our project is Rs. 3474000

Now,

Considering this conditions, we will get back the amount invested after;

$$\begin{aligned} &= 3474000 / 908953.32 \\ &= 3.82 \text{ years} \end{aligned}$$

We get 25 years warranty for solar panels and 5 years warranty for other accessories.

Considering the financial damage after 25 years, we get extra benefit of 21.18 years.

This much time will save,

$$\begin{aligned} &= 21.18 \times 908953 \\ &= \text{Rs. } 1,92,51,624.54 \end{aligned}$$

Results

- ✓ Total Amount To Be Invested = Rs. 34,74,000
- ✓ Cost Of The Project Per Watt = Rs 45.1 / Watt
- ✓ Total Power Of The System = 77Kw
- ✓ The Invested Amount Recovery = 3.82 years

6. CONCLUSIONS

From this project, we concluded that solar power is the source from which we can generate electricity easily and economically.

It is 100% eco- friendly method. We can save our money with this method. After the invested money is recovered, we will be using the further electricity for free

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