

Solar for Colleges

Rooftop Solar Power for Institutions of Higher Learning

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Rooftop solar power is a revolution that is sweeping across the country and the world. India is particularly well suited to solar power due to its high solar radiation and generation potential. Backed by favourable policies and generous incentives, India is all set to be one of the largest generators of solar power in the world.

The recent boom in this sector has significant socio-economic implications for India, from job creation to empowerment of people in energy-starved regions of the country. Distributed generation – primarily **rooftop solar PV power plants** – will play a prominent role in bringing solar power both to regions that have little to no grid power, and to developed urban centres that have grid power but not enough to support their rapid expansion.

Colleges and other educational institutions will play a vital role in this transformation, not only in creating awareness about solar energy amongst their students, but also by utilising rooftop solar power to demonstrate that they are already part of the future. The benefits to the institution, its faculty, students, and to society at large are enormous which is why many of India's most famous educational institutions have already deployed large rooftop solar power plants on their rooftops.

As a leader in your college, you will certainly want to have a solar plant on your rooftop, but also have several questions on what you can realistically expect from your solar plant, and how to go about getting a high quality, reliable rooftop solar solution. This whitepaper from Solar Mango answers these and other questions based on our work with educational institutions.

We hope you find this guide useful in deciding on your rooftop solar plant and generating power from your own rooftop.



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1. How does rooftop solar power benefit my college

Educational institutions, especially colleges and similar institutes of higher learning, are ideal candidates for rooftop solar power

- a) They have a large proportion of rooftop space in proportion to their energy consumption
- b) Their peak loads are often in the daytime, coinciding with peak solar generation
- c) Most of their electrical loads can be easily supported by solar
- d) Depending on their tariff, solar power may be even cheaper than grid power
- e) Solar power is clean energy, and offers an ideal opportunity for their students to learn the practical aspects of solar power

As institutions that prepare students (and through them society) for a changing world, colleges can use solar power to demonstrate their superior understanding of the imminent solar revolution. With only about **1 in 200** colleges having rooftop solar power, your institution can be seen as a **pioneer and trendsetter** that better prepares your students for the future.

Rooftop solar power does come with its constraints, and colleges will have to decide which kind of solar plant configuration will best suit their needs. The following questions address many of the common concerns expressed by management of various educational institutions, based on our interaction with them.



2. What percentage of my college's power needs can be satisfied by rooftop solar?

The extent of power needs that can be met by solar depends on the extent of rooftop space available for the plant, but we typically expect

Power consumption timings	Air conditioning	% of power needs that can be met
Primarily during the day	None-Low	45%
Primarily during the day	Medium	30%
Mostly daytime, with medium consumption at night	None-Low	25%
Mostly daytime, with medium consumption at night	Medium	15-20%

Table 1: Estimate of electricity needs met by rooftop solar

These estimates are for grid connected plants without batteries. We recommend a site analysis with load study to provide more accurate estimations for your institution.

3. How much power can solar panels generate?

In India, a 1 kW solar plant will generate about 4 kWh (units) of electricity per day, on average over a year. The plant will generate more on some days than others, but 4 kWh/day is the typical expected generation for most places in India. A 1 kW plant will generate about 1,460 kWh (4 X 365) of AC power in the first year.

The solar panels will degrade, and generation will reduce by approximately 1% every year. Therefore, a 1 kW plant will generate

	Year 1	Year 2	Year 3	Year 4	•••	Year 25
Generation (kWh)	1,460	1,445	1,431	1,417		1,147
Table 2: Power generation from a 1 kW rooftop solar plant						



3.1 Does efficiency of solar panels impact amount of electricity generated?

Efficiency of panels only affects the area occupied by the panel, and not the electricity generation. A 250 W panel of 15% efficiency will generate the same amount of electricity as a 250 W panel of 18% efficiency, but will require more rooftop area for installation.

4. What is the cost of a good quality rooftop solar power system?

A good quality grid-tied rooftop solar system will cost about Rs. 1 lakh per kW. The cost breakup is approximately

Component	Rs.	% of total cost
PV modules (Crystalline)	52,000	52%
Inverter	23,000	23%
Balance of system (mounting structures, etc.)	17,000	17%
Installation	8,000	8%
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Table 3: Component level cost breakup of a 1 kW rooftop solar plant

Larger capacity solar plants (greater than 25 kW) may cost only about Rs. 80,000 per kW, depending on components used.

This is the complete cost required to commission the plant. If batteries are required, they can add 30% or more to the cost or the plant, depending on the duration of battery backup required.

5. Is it more economical to use rooftop solar power instead of grid power?

The cost effectiveness of rooftop solar power vs. grid power depends primarily on

- Your current EB tariff
- Claiming accelerated depreciation



5.1 Without accelerated depreciation

If your organisation is unable to benefit from accelerated depreciation, solar is likely to be more economical than grid power if your effective EB tariff (inclusive of all charges) is between **Rs. 8-9/kWh** (or greater). If your EB tariff is less than Rs. 8/kWh, solar may still be cheaper than grid power on a case-to-case basis.

5.2 With accelerated depreciation

If your organisation can benefit from accelerated depreciation, solar is likely to be more economical than grid power if your effective EB tariff (inclusive of all charges) is **Rs. 7/kWh** (or greater). If your EB tariff is less than Rs. 7/kWh, solar may still be cheaper than grid power on a case-to-case basis.

The above calculations are based on a number of assumptions. We recommend analysing all costs with your own assumptions and estimates specific to your project before deciding on your solar investments.

6. Can I use the entire roof area of my college for solar panels?

A rooftop solar plant typically requires about 100 sq.ft of shade free rooftop space for every 1 kW of solar panel capacity. The size of your roof can limit the size of the solar plant you can install, making it necessary to ascertain the extent of roof space that can be used to install solar panels.

The entire roof may not be available for your solar plant. The available space may be limited by

- Space that is free of shadows throughout the year water tanks, chimneys, antennas, nearby trees, etc. can all cast shadows on the roof
- Other uses for the roof e.g. temporary storage
- Access space for any equipment or installations on the roof

We have often found that only 80% of roof area is available for installing solar panels.



7. What power loads in my college can solar power support?

The kind of loads that can be supported by a solar plant may vary depending on availability of grid power.

7.1 When grid power is available

All loads can be supported along with grid power. Here, the solar plant helps reduce grid power consumption.

7.2 When grid power is not available

If a hybrid inverter is used, the solar plant can sync with either a diesel generator, or a battery bank, or both

- **Diesel generator** The solar plant helps support all the loads powered by the diesel generator. Here, the solar plant abates diesel consumption (within some limits)
- **Battery bank** The solar plant supports electrical loads through its inverter and battery bank. Loads with heavy starting current, such as air conditioners or pumps, may not be supported by the plant. Loads that can be supported by this configuration include
 - o Lighting and fans
 - o Computer labs
 - College office equipment

It should be noted that a rooftop solar plant will usually need to sync with another source of power (grid/diesel/battery) to function. Solar inverters are designed to <u>shutdown the solar</u> <u>plant</u> in the absence of another source of power, even if the sun is shining brightly.

If you need to heat water, a solar water heater is a more cost-effective choice than heating water from electricity generated from a rooftop solar PV plant. Therefore we do not recommend rooftop solar PV to power water heating loads.



8. What are the technology alternatives I have in rooftop solar?

There are primarily three different types of rooftop solar plants.

Grid tied

- Uses a grid-tied inverter
- Syncs only with grid power
- Will not generate electricity in the absence of grid power
- Not recommended for locations with frequent load shedding. Recommended only for users with reliable grid supply

Off-grid

- Uses an off-grid inverter
- Can sync with diesel power and battery power
- Will generate power only if diesel or battery power is available
- Does not sync with grid power
- Only recommended for locations that are completely off-grid. Not recommended for locations that have intermittent grid power

Hybrid

- Uses a hybrid inverter
- Can sync with grid, diesel, and battery power
- Will not generate electricity if all three other sources of power are absent
- Recommended for locations that have frequent load shedding

9. Will I need to use batteries for the rooftop solar system?

As previously discussed, a solar plant will need to sync with another source of power. Therefore, a diesel generator or a battery bank will be required for a rooftop solar plant to provide electricity during power interruptions.

When evaluating battery banks, the following factors should be considered

• Infirm power – Rooftop solar plants do not provide constant power. Their generation varies with meteorological conditions. Battery banks can step in to support the plant whenever generation is low



- **Continuous power** A battery bank can step in to support the load immediately in the event of low generation, unlike a diesel generator which needs to be started
- Dedicated loads As battery banks can usually only provide a limited amount of power, they are used to provide electricity only to specific loads, fed through a dedicated electrical circuit
- Load restrictions Again due to the limited amount of power provided by batteries, the battery bank may not be able to support loads with heavy starting currents, such as air conditioning of heavy machinery
- **Cost** Not only do batteries add 30% or more to the cost of the solar plant, they also need to be replaced every few years. The lifetime cost of the batteries should be evaluated rather than just the initial outlay
- Weight/space The space and ventilation requirements of the battery bank, along with its weight, should be considered when identifying a place for the batteries

10.What happens to excess solar energy generated?

Sometimes the solar energy generated by the rooftop plant is greater than the loads' requirements – this can happen on holidays, lunch breaks, etc. The implications of this excess generation are

- Wastage Excess solar power generated is wasted. If the solar plant is synced with the grid, the excess generation will flow back into the grid
- Metering If your facility has a unidirectional (conventional) EB meter, the power that flows into the grid will be added to your electricity consumption and you will be billed for it

Net metering, or bidirectional metering, is the solution to both the above issues. If your state permits net metering, the excess generation from your solar plant that flows into the grid will deduct from your EB bill, saving energy costs. This can be critical for educational institutions that see significant load reduction during vacations.

11.What are the disadvantages and limitations of rooftop solar?

While rooftop solar power has many advantages, some constraints and disadvantages should also be considered when evaluating a solar investment.

• No power at night – Unless expensive batteries are used, a rooftop solar plant does not provide electricity at night. Most solar power is generated between 10 AM and 4 PM



- Large space requirement At a 100 sq.ft for every kW of solar panels, solar plants need a lot of roof space that might not be available in some buildings
- No generation during power failure Unless another source of power (such as grid/diesel/batteries) is available, rooftop solar plants will not generate power even if there is bright sunshine
- Holiday wastage Unless net metering is available, power generated on holidays is wasted
- Diesel is still used In most cases, a rooftop solar plant can help reduce, but will not eliminate, diesel consumption

12.Does rooftop solar really require little maintenance?

Rooftop solar PV plants do not have moving parts (unless they use trackers, which very few do) and therefore require little by way of maintenance. Maintenance activities are predominantly

- **Panel cleaning** Dust accumulation on the solar panels blocks sunlight from reaching the solar cells in the panels, reducing electricity generation. Solar panels need to be washed and cleaned periodically, typically once in 2-3 months
- General maintenance Checking cables to see if they are fastened properly, replacing any blown fuses, etc.
- **Battery checking** If batteries are used, they usually require the most maintenance for electrolyte levels, signs of overcharging, etc.

We recommend having an AMC (Annual Maintenance Contract) as rooftop solar PV plants do require some maintenance for optimal functioning.

Inverters are the only major component likely to need replacement during the lifetime of the solar plant. Typical lifetime of rooftop solar inverters in Indian conditions is around 10 years.

Batteries are also likely to need replacing every few years. Frequency of replacement depends on how often batteries are used.



13.How do I go about choosing a high quality rooftop solar vendor?

We recommend the following steps when choosing a rooftop solar vendor:

Decide on purchase model	 Energy consumers can either buy the solar plant itself, or only pay for the power generated by the plant, on a per kWh basis – Build Own Operate (Transfer) model Solar vendor may have specific criteria for eligibility for the BOO(T) model, such as credit rating
Contact solar vendors	 Identify qualified solar vendors - based on expertise, execution capabilities, team size, proximity to site location Invite vendors for site visit and load analysis
Decide solar plant features	 Based on interaction with vendors, decide plant size; plant architecture; components to be used
Negotiate with vendors	 Invite quotations from vendors, negotiate on price, timelines, AMC, warranty, responsibilities, etc.
Finalise vendor	 Choose the best combination of vendor credentials and terms Sign contract with finalised vendor

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14.Takeaways

- Rooftop solar PV plants can position your college as a trendsetter and an example for other institutions and society to follow
- Students get introduced to, and gain practical insights into a form of distributed energy generation that is taking over the world
- Colleges are ideally suited to rooftop solar PV as their electrical loads and solar power generation usually match in timing
- Price/generation/space 1 kW solar plant will cost Rs. 1 lakh, generate 4 kWh/day (on average over a year) and occupy 100 sq.ft of shade-free rooftop space
- Rooftop solar power may be more economical than grid power depending on your grid tariff and eligibility for accelerated depreciation
- Loads
 - Rooftop solar power can support most electrical loads when synced with grid power or diesel power
 - When synced with battery power, rooftop solar may be able to supply only limited loads (depending on battery capacity)
- Types of rooftop solar PV plants
 - Grid-tied Will sync only with the grid, will not provide electricity in the absence of grid
 - Off-grid Does not sync with grid, needs to sync with diesel or batter power to provide electricity
 - Hybrid Can sync with grid, diesel, or battery power; requires at least 1 of the 3 other power sources to generate electricity
 - Rooftop solar PV plants always require another source of power to provide electricity
- Maintenance of rooftop solar PV plants is predominantly cleaning of panels. Batteries, if any, can add to the maintenance requirement
- Inverters and batteries will both need replacing during the 25-year lifetime of the solar plant

Talk to Solar Mango for a High Quality Rooftop Solar Solution

Are you an energy intensive energy consuming educational institution looking for rooftop solar power? <u>Solar Mango</u> can help you gain reliable, cost-effective rooftop solar power.

Write in with your requirements to <u>enquiry@solarmango.com</u>, call us on **09840436048**, or visit <u>www.solarmango.com/in</u> for more information.