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Grid Interactive Rooftop Solar Photo Voltaic (PV) System & its Cost Analysis for Pantnagar University

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ABSTRACT: The fast depletion of fossil fuel resources on a worldwide basis has nesseciated urgent need of alternative energy resources to meet out present day demand. Solar energy is clean and environment friendly. There is a large potential available for generating solar power using unutilized space on rooftops and wastelands around buildings. Small quantities of power generated by each individual household, industrial building, commercial buildings or any other type of building can be used to partly fulfil the requirement of the building occupants and surplus, if any, can be fed into the grid. In order to utilize the existing roof space of buildings, the roof-top SPV systems on buildings can be installed to replace DG genets installed for minimum load requirement for operation during load shedding.
Pantnagar University has large unused area/roof from residential as well as office buildings. Therefore it has huge potential to generate solar power by installing grid connected rooftop solar system. We can cut the large amount of bill by implementing solar power generating unit. Government has also launched various schemes to encourage solar power in 12 Th year plan.
In this paper brief idea of Rooftop PV and Small Scale Solar Generation system is given and various government schemes has also been discussed. Since Pantnagar university has great scope for this scheme so estimated power calculation has been done for college of technology and one residential household.

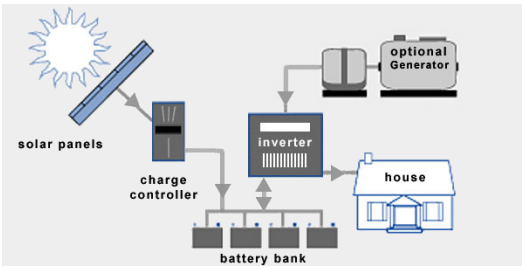
I. INTRODUCTION

Electrical energy is the basic necessity of any country for its overall development. Fossil fuels (Coal, Oil, and Diesel) are the main sources of electrical energy (about 60% in our country). Fast depletion of fossil fuels results insecurity of availability of fossil fuels, subsequent increase in energy cost, the environmental pollution and above all the global warming. This has brought the worldwide attention in reducing the pollution and conservation of the limited conventional fuels by encouraging more and more use of the energy available from the non-conventional/renewable sources such as solar ,wind, biogas, tidal waves and the small hydro etc. Solar photovoltaic (PV) technology, in particular, is emerging as an extremely attractive option, particularly with abundantly available solar resources, modular technology and zero fuel costs over 25-30 years of the project life. Considering this, the Government of India has recently expressed its intent to achieve 100 GW of solar capacity in the country by 2020, of which 40 GW is expected to be achieved through decentralized and rooftop-scale solar projects. The solar mission, which is part of the National Action Plan on Climate Change has been set up to promote the development and use of solar energy in for power generation and other uses with the ultimate objective of making solar energy competitive with the fossil based energy options. The solar photovoltaic device systems for power generation had been deployed in the various parts in the country for electrification where the grid connectivity is either not feasible or not cost effective as also some times in conjunction with diesel based generating stations in isolated places and communication transmitters at remote locations. With the downward trend in the cost of solar energy and appreciation for the need for development of solar power, solar power projects have recently been implemented. A significant part of the large potential of solar energy in the country could be developed by promoting grid connected solar photovoltaic power systems of varying sizes as per the need and affordability coupled with ensuring adequate return on investment . Since Pantnagar university has great scope for this scheme so estimated power calculation has been done for college of technology and one residential household.

Description of Solar energy Generation: Solar energy can be generated by two means (1) by Solar thermal generation (2) by solar PV cell. Now solar PV cell can be installed either in isolated mode or grid connected mode.

Off-Grid or isolated Solar Systems. An off-grid solar system (off-the-grid, standalone) is very useful specially to that places where grid is not available. To ensure access to electricity at all times, off-grid solar systems require battery storage and a backup generator (if you live off-the-grid). On top of this, a battery bank typically needs to be replaced after 05 years. Batteries

are complicated, expensive and decrease overall system efficiency.



Advantages of Off-Grid Solar Systems

1. Off-grid solar systems can be cheaper than extending power lines in certain remote areas where grid is not available.
2. If we use isolated system where grid available then reliability of power supply increased.

Grid Connected Solar Systems

Solar PV rooftop system is basically a small pow plant at your rooftop. The Grid interactive Roof T Solar Photo Voltaic (PV) mainly consists of thr major components. These are the solar PV modul mounting structure for the modules and the inverter power conditioning units. Solar PV modules form array and it requires a mounting structure to hold I modules at the required angle for maximiz generation. The solar panels convert solar energy in the form of light into electricity in DC form (Direct Current). The DC electrical energy is converted to AC (Alternate Current) power by the inverter/power conditioning unit which is connected to the power grid through AC distribution board. The AC power output can be measured through metering panel connected to it. The 415 V AC output of the system can be synchronized with the grid and the electricity can be exported to the grid depending upon solar power generation and local consumption.

Grid synchronization

Electrical inverters convert direct current generated from solar PV modules to alternating current. Therefore, solar modules need to be connected to inverters. Nowadays we have smart Grid-interactive inverters. These inverters can produce AC power that matches voltage and frequency of the grid and the power line it connects to. There is another requirement of adding an isolation transformer. For safety purposes, isolation transformer is used to transfer electrical power from inverter to the connected load while isolating the load from the power source. In addition, the injection of DC power into the grid can be avoided by using an isolation transformer at the output of the inverter. Power generated from the rooftop solar system during the daytime can be utilized fully by powering the building loads and feeding excess power to the grid as long as grid is available. Whenever, solar power is not available due to shadow or a cloudy day, the building loads can be served by drawing power from the grid or DG sets. Smart inverters automatically understand the power situation and always give preference to power generated from solar modules.

Metering

If the project location has feed-in-tariff applicable, the separate feed-in-meter (export meter) is suitable. Feed-in-tariff meter records gross generation from the rooftop solar system. However, conventional energy meter (Import meter) record electricity consumption of the building. Currently, the state of Gujarat have feed-in-tariff scheme and hence feed-in-tariff meters are applicable in Gujarat. However, where feed-in-tariff provision is not applicable, project developer can have net metering system (bi-directional meter).

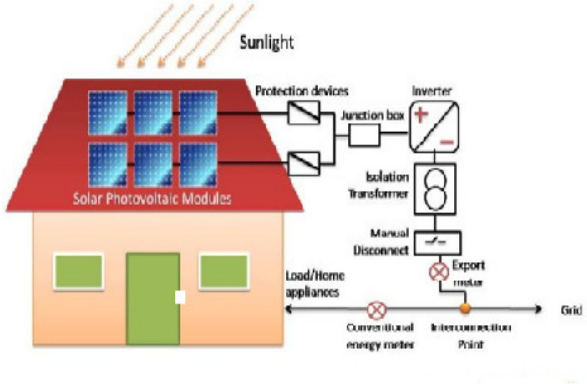


Fig. 1. Feed in metering schematic.

Advantages of Rooftop Solar PV systems

1- Ideally, grid interactive systems do not require battery back-up as grid acts as the back-up for feeding excess solar power and vice-versa. So cost of grid connected system is less approximately 40% to 50 % initial cost is reduced and maintenance of battery cost is also reduced
2- Energy generated is fully utilised
3- Few batteries may be installed for continuity of power during grid failure.
4- Large amount of cut in bill will be there if we use net meetring.
5- Maintenance cost is negligible

Various Options for Installation of Solar Power Projects:-

For the success and smooth operation of rooftop and small solar power plants, various situations and conditions needs to be worked out to make it a workable business model. There can be many possible business models, some of which can be considered by MNRE are as follows:

(a) **Solar installations owned by consumer**

i) Solar Rooftop facility owned, operated and maintained by the consumer(s).

ii) Solar Rooftop facility owned by consumer but operated and maintained by the 3rd party.

(b) **Solar installations owned, operated and maintained by 3rd Party**

The 3rd party implements the solar facility and provides services to the consumers. The surplus electricity may be injected to the electricity grid. The combinations could be:

i) Arrangement as a captive generating plant for the roof owners:

The 3rd party implements the facility at the roof or within the premise of the consumers; the consumer may or may not invest as equity in the facility as mutually agreed between them. The 3rd party may also make arrangement of undertaking operation and of maintenance of the facility. The power is then sold to the roof owner.

ii) Solar Lease Model, Sale to Grid :

The 3rd party implementing the solar facility shall enter into a lease agreement with the consumer for medium to long term basis on rent. The facility is entirely owned by the 3rd party and consumer is not required to make any investment in facility. The power generated is fed into the grid and the roof top owner gets a rent.

(c) **Solar Installations Owned by the Utility Ownership of**

i) Solar installations owned operated and maintained by the DISCOM

The DISCOM may own, operate and maintain the solar facility and also may opt to sub contract the operation and maintenance activity. The DISCOM may recover the cost in the form of suitable tariff. The electricity generation may also be utilized by DISCOM for fulfilling the solar renewable purchase obligation.

ii) Distribution licensee provides appropriate viability gap funds

The DISCOM may appoint a 3rd party to implement the solar facilities on its behalf and provide appropriate funds or viability gap funds for implementing such facility. It may also enter into an agreement with the 3rd party undertaking the operation and maintenance of the solar facilities.

Scope and Implementation:

Pantnagar University has a great potential of grid connected solar energy generation using **PV** cell because of the following base.

1- Grid is available almost 24 hrs. So grid connected is preferred.
2- Most of the domestic consumer has inverter and battery, so only panel cost has to borne by domestic user.
3- Most of the Official buildings have their own DG set, so no need of emergency battery backup on case of grid failure in sunny days.
4- Most of the residential houses are single story. So large unutilised roof area is available for energy generation.
5- Large unutilised roof area of Official buildings and plain area are also available.

Data and Facts:

1- Available roof area is 100 sq m to 150 sq meter in cat I and II and Energy requirement is 5000-6500 units per year and Aprox 500 houses are there.
2- Available roof area is 50-100 sq meter for cat III and IV and Energy requirement is 1000-2000 units per year and approximate 1500 houses are there.
3- Available roof area is 10,000 sq m to 15000 sq meters in College buildings approximate Energy requirement 50,000 units per year.
4- For 1kW capacity PV panel, Approx 10 sq m area is required and .8 to .9 lakh cost will be there.
5- Overall average university consumption per year is $25x10^6$ unit
6- One KW_p can generate 1500 units per year in Uttarakhand

Calculation and Analysis:

1- Domestic Cat I and II:

- From first point of the data average area available for the domestic Cat I and II is 130 sq meters
- If we utilise only 100 sq meter area for PV generation Then Maximum energy can be generated= 100/10=10 KW_p
- Average energy generated per year= 1500x10=15000 units whereas Energy requirement with one AC is aprox 6000 units.
- From the calculation it is clear double the energy can be generated then consumption.
- Minimum 4 KW_p is sufficient to meet out the demand of 6000 units
- Installation Cost = 0.8x10=8 lakh - subsidey of 30%=5.6 lakh.Bank loan is available at max 10 %.
- If we invest this money ,then for 20 years it can give approx 5000 per month plus 2000 saving on bill so total benefit of Rs 7000.00 per month (which is goodreturn).

2- Installation on the roof of College and Office Buildings:

- From first point of the data average area available 10000 sq meters
- If we utilize only 5000 sq meter area for PV generation Then Maximum energy can be generated= 5000/10=500 KW_p
- Average energy generated per year= 1500x5000=7500000 units whereas Energy requirement for an college is aprox 500000 units.
- From the calculation it is clear 1.5 times the energy can be generated with 50% roof space .
- Installation Cost = 0.8x500=40 lakh - subsidey of 90%=4 lakh

3- Overall University requirement and Potential:

- From the university bill the average unit consumption per month is 20lakh unit, so per year unit consumption is 24000000 units.
- Capacity requirement to meet out overall demand=24000000/1500=16 MW.

- Area required=1,60,000 sq m
- Where as Roof Area available in Pantnagar university is Approximate 200000 sq m.

II. CONCLUSIONS

From the above calculations it is clear that University has max 32MW solar PV generation capacity and requirement is 16MW so Approximate 2000000 Units per month can be fed to grid and overall benefit will be around 50 lakh per month. Since the life of solar panel is around 25 years and approximately nil maintenance cost of grid connected system, this scheme is very useful as to reduce the carbon consumption, and by using this schems, we can diminish the effect of global warming.

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