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Cost Analysis OF 100 KW GRID Connected Solar Plant AT YIT – A Case Study

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ABSTRACT
Whole of the world is facing the problem of energy crisis due to the increasing in load demand and limited amount of fossil fuels available on the earth. To overcome this problem, alternative energy resources are being used now days. These alternative energy sources are also know as non conventional energy sources such as wind energy, geothermal energy, solar energy, tidal energy, bio mass energy etc. to generate the electricity. Among all these alternative energy sources, generation of electricity using solar power (sunlight) is the best option as it is most abundantly available and cleanest source. Solar radiation is converted into electrical power using solar cell which works on Photo-Voltaic effect. The objective of this paper is to analyze the cost of a 100 KW grid connected solar plant installed at YIT, Sitapura, Jaipur (India). This solar plant cuts the electricity bill amount of the organization by consuming less energy from the grid and results in the revenue profit to the organization.

***Keywords*:** solar radiation, solar cell, on grid solar cell, grid connected solar cell, roof top solar system, PV cell.

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I. INTRODUCTION

Energy generation resources like coal, liquid fuels, gaseous fuels, nuclear fuels etc. are in a limited position. These resources are decreasing with time where as demand is increasing continuously so renewable energy resources are the best option to adopt [1]. Among all renewable energy sources, sun is the best alternative for energy production. Sun produces clean and eco-friendly energy. The energy reaches on earth is called solar irradiance (W/m^2). Solar radiations are converted into electrical power using solar cell which works on Photo-Voltaic effect. Various solar cells or PV cells construct a solar panel by combining themselves. A single solar or PV cell gives an output in a small fraction of power. So to increase the output power, large amount of PV cell are connected on a plate. That plate is called PV module. In order to increase output power i.e. to increase output voltage and output current these PV modules are connected in series or parallel depending on the demand of power [2]. Solar plants may be OFF grid or ON grid. In OFF grid plant, batteries are used which make this system very costly [3]. But in ON grid plant, there is no need of any batteries or any storage devices. ON Grid Solar plant is cheaper and useful for passive Income. Generally, two meters are connected in solar system. One is called import meter and other is called export meter. The power fed to the grid from solar photo-voltaic power plant is the difference between two meter readings [4]. Irradiation and temperature are two important factors which affect the performance of solar plant. Power generation increases with increasing of solar irradiation but it has inverse relation with temperature [5-6]. A solar mission program is launched by Government of India that is "Jawahar Lal Nehru National Solar Mission (JNNSM)". This program has launched in two phases. First phase is launched in 2010 and second phase in launched in 2012.The purpose of this program is to increase the use of renewable energy resources. A target of 20,000 MW solar power generation is set up in this mission with the reduced cost. State Government offers subsidy on the installing solar plants (ON grid) [7]. In this paper, it can be observed that the investment cost of the solar plant is very high but adequate profit will be earned by the organization after pay back period of the plant till the plant's useful life.

II. COMPONENTS USED IN 100 KW GRID CONNECTED SOLAR ROOF TOP PLANT AT YIT

i) Solar Panel: A solar panel consists of group of PV cell which is used to generate DC electricity. Multiple solar panel connected together to form solar array. Total 318 solar panels of each capacity of 315 Watt are used in grid connected roof top plant at YIT, Jaipur. The net module covers the area of 636 m^2 of the roof of YIT.

ii) Power Conditioning Unit (PCU): PCU consists of an inverter and DC-DC convertor. Inverter acts as an interface between solar array and grid [8]. Due to change in solar irradiation, temperature etc. variable DC output is obtained in terms of power and voltage. DC output voltage of solar panel is changed to desire level corresponds to the local grid using a DC- DC convertor [9]. To obtain maximum power output from solar panels, MPPT technique is used in DC-DC convertor [10]. The output of DC-DC convertor is fed in to an invertor.Two invertors of 50 KW each are used in solar plant. The output of inverter is three phase sinusoidal output voltage having magnitude, phase sequence and frequency same as that of grid to which it is connected. Inverter is inbuilt with a filter circuit to remove harmonics present in three phase output of inverter. Inverter is provide with protecting schemes against over voltage, power fluctuations, frequency fluctuations, inrush current and various severe faults to protect the grid as well as solar plant.

iii) Other accessories: Other accessories include Junction box to connect the solar modules in series or in parallel, protection switches to protect the system against faults, pyranometer to measure solar irradiance, energy monitoring system include GRPS for remote monitoring and solar meter to measure import and export of generated units.

III. WORKING OF GRID CONNECTED ROOF TOP SOLAR PLANT SITUATED AT YIT

Solar plant installed at the roof of YIT building is an ON Grid type solar plant. The working of this plant is as follows:

When there is no any solar radiation (say at 5:00 am), solar plant will not able to generate electrical energy. Hence, YIT takes electric supply from the local grid.

When there is lesser solar radiation (say at 9:00 am in summer), YIT is supplied by both solar plant and local grid to meet the desired load of the college.

At Noon, there is a good amount of solar radiation. So, solar plant generates sufficient electricity to meet the load demand of YIT. Sometimes, the load demand of YIT is low especially during Sundays and holidays then the excess amount of generation by solar plant is fed to the local grid which results in passive income to YIT.

In night, solar plant does not generate electricity and therefore, YIT again consumes the electric supply from the local grid to meet required load.

IV. ADVANTAGES OF ROOF TOP SOLAR PLANT

(i) By using of this ON Grid solar system, organization can minimize its electricity bills provided by local electricity board.

(ii) In day time, scheduled and unscheduled power cut may be avoided.

(iii) The power quality which is given by solar plant is better than local grid power.

(iv) At the Institute, many students can get the training program and also can complete their research related to solar system. Thus students can increase their capabilities.

V. COST ESTIMATION

Table I shows the components specifications of 100 KW roof top solar plant. In this plant, 318 solar panels are installed with the rating 315 watt each. The useful life of the plant is 25 years. Table II shows that the net solar plant cost is 48,32,500/- rupees after deducting the subsidy @ 30% .

Table I Components specification of 100 KW roof top solar plant installed at YIT

No. of solar panels	318
Capacity of solar panels	315 W per panel
System size	100 kW
Net Module area	636 square meter
Net metering	RSEB
Annual Expected electricity generation	1,20,000 -1,50,000 units / year
Expected Monthly generation	120 - 150 unit / kWh
Expected Average per day generation	4 - 5 unit / kWh
Plant life	25 years

Table II Solar Plant Cost after subsidy

Cost of 1W Roof Top solar power plant	Rs 68.35 per watt
System cost 100 KW Roof Top solar power plant	Rs 68,35,000
Subsidy by the Govt. @30%	Rs 20,50,500
Net cost after subsidy	Rs 48,32,500

VI. UNITS GENRATED BY SOALR PLANT AT YIT

In this case study, the data of April 2017 is considered. Table III shows units generated per day in April 2017 [11]. Total generation in April month was calculated to be as 13976 units. From fig. 4, it can be seen that the lowest generation of 327.30 units was on 25-April-2017 and maximum generation of 535.10 units was on 09-april-2017. Including all barriers like unfavorable climatic conditions, maintenance of solar plant, shading etc., the annual plant generation is assumed to be 1,20,000 units in this case study.

Table III Power Generation in month of April 2017 by of 100 kW Solar Power Plant at YIT

S. No.	Date	Generation
1.	01-Apr-2017	508.70
2.	02-Apr-2017	481.70
3.	03-Apr-2017	485.50
4.	04-Apr-2017	467.00
5.	05-Apr-2017	482.20
6.	06-Apr-2017	506.70
7.	07-Apr-2017	452.00
8.	08-Apr-2017	519.00
9.	09-Apr-2017	535.10
10.	10-Apr-2017	344.80
11.	11-Apr-2017	516.20
12.	12-Apr-2017	499.50
13.	13-Apr-2017	482.90
14.	14-Apr-2017	472.40
15.	15-Apr-2017	481.30
16.	16-Apr-2017	482.30
17.	17-Apr-2017	480.20
18.	18-Apr-2017	486.90
19.	19-Apr-2017	483.00
20.	20-Apr-2017	462.10
21.	21-Apr-2017	479.90
22.	22-Apr-2017	479.70
23.	23-Apr-2017	469.00
24.	24-Apr-2017	404.20
25.	25-Apr-2017	327.30
26.	26-Apr-2017	410.70
27.	27-Apr-2017	487.90
28.	28-Apr-2017	478.90
29.	29-Apr-2017	381.20
30.	30-Apr-2017	427.70

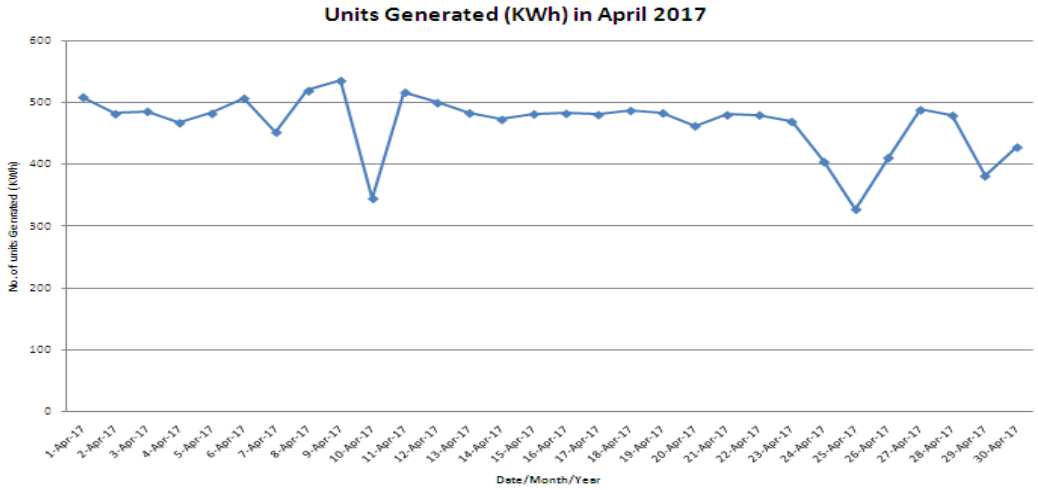

Fig.4. Units generation (KWh) by solar plant V/S No. of Days of April Month

VII. COST ANALYSIS

Cost analysis of this solar pant can be done in two aspects; first is reduction in monthly electricity bill and second one is profit after pay back period till useful life of solar generating system.

1) *Reduction in monthly electricity bill:*
From table III, it can be observed that total generation by solar plant for the one month is 13946 units. These generated units are used by YIT instead of units consumed by RSEB and hence, reduction in electricity bill corresponds to 13946 units can be calculated. The cost per unit electricity charges by RSEB in previous bill of YIT is Rs. 8.35. Therefore, monthly reduction in the bill corresponds to 13946 units is estimated to be Rs 1,16,449 (13946*8.35= Rs 1,16,449). Hence, a saving of Rs 1,16,449 is done by the organization.

2) *Profit after pay back till useful life of solar system:*
Total capital investment of this project is Rs 48,00,000. Annual units expected to be generated by 100 KW solar plant is 1, 20, 000 units (which results in annual saving of Rs 10 lakhs (approximately) to the organization. Therefore, number of years in which return on capital investment can be calculated as:

Pay back period (no of Years) = Capital investment/ Annual savings
= 48 lakh/10 lakh
≈ 5 years

Hence, approximately pay back period is calculated to be 5 years.

Since, the useful life of solar plant is 25 years and pay back period is 5 years, therefore profit earned can be calculated as:

Profit to YIT = (Useful life – pay back period) * annual saving by solar plant

Therefore, profit to YIT from rest of 20 years will be approximately 2 Crores rupees.

VIII. CONCLUSION

A clean energy is generated by solar power plant without affecting the environment. Solar plant has less maintenance with useful life of 25 years. The grid connected roof top solar power plant works on net metering system in which the beneficially YIT pays to the utility RSEB on net meter reading bases. The output of solar plant is connected to the distribution board of the building through the inverter to utilize the power. This roof top plant has a pay back period of 5 years. Total generation of 1, 20,000 units per annum by solar plant results in annual saving of Rs 10 lakhs (approximately) to the organization. Also, total profit to the organization after pay back period till useful life of plant is estimated to be approximately Rs 2,00,00000 (Rs Two Crores).

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