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Case Study

Estimation of Cost Analysis for 500kW Grid Connected Solar Photovoltaic Plant: A Case Study

Vinay Janardhan Shetty[Å*] and Keerti Kulkarni[Å]

[Å]Electrical & Electronics, Shri Dharmasthala Manjunateshwar College of Engineering and Technology,Dharwad-India-580002

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Abstract

The depletion of conventional resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present load demands. Solar energy is a clean, inexhaustible and environment-friendly potential resource among all renewable energy sources. But in the present scenario, there is a need of continuous supply of energy, which cannot be full filled alone by the grid. Therefore, in order to meet the load demand and increase the power generation, solar and other conventional conversion units are now being implemented as a Grid connected energy systems. The objective of this work is to estimate the cost analysis for 500kW grid connected solar photovoltaic plant and thereby have developed a system based on the potential estimations made for a chosen area of 10,1533m^2(present Built-up area). The specifications of the equipment are provided based on the availability of the component in India. Annual energy generation by proposed Grid connected SPV power plant is calculated.

Keywords: *Solar Photovoltaic (SPV) Energy, Energy Audit, Grid-Connected SPV system.*

1. Introduction

Photovoltaic offer the consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that converted light energy directly into electricity. It is anticipated that photovoltaic systems will experience an enormous increase in the decades to come. However, a successful integration of solar energy technologies into the existing energy structure depends also on a detailed knowledge of the solar resource. But to note it is essential to state the amount of literature on solar energy, the solar energy system and PV grid connected system is enormous. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid (A.S. Elhodeiby et al, 2011). For this survey we have gone through different books, journals and papers to get its keen knowledge.

2. Methodology

To find out the cost analysis for 500 KW grid connected solar PV plant in India, the solar radiation over different months were measured for Dharwad area in Karnataka-India. Then the average monthly outputs are found out and related graphs are plot for showing the variation. We started our project work from January month. So we measured value of solar radiation from January to December month after that we calculated the diurnal variations, average monthly output for twelve months (Jan 2013 to Dec 2013) also took help of NASA website to cross verify the readings. Thus from these data, we can estimate the rating of solar PV power plant for SDM college of Medical Sciences & Hospital, Dharwad, INDIA. For estimation of solar potential we need reading of solar radiation for our site. For the better understanding of the methodology, the measured radiation data sheet of Dharwad district for the month of January 2013 has been given as a sample. The variation for twelve months is plotted. From that the monthly output are calculated. Input solar radiation means how much amount of solar radiation is coming from sun and Output solar radiation means how much amount of solar radiation we can utilize to generate electricity which is depends upon the efficiency of the PV module. For calculating the output the efficiency of the PV module is taken as 13.2% (Phil Bolduc et al, 1993).. Chosen area for the estimated plant capacity is considered as 10,1533 m².

3. Energy Audit, Observation & Calculation of Pay-Back period

The energy audit of SDM College of Medical Science & Hospital, Dharwad was carried out using an ENERGY AUDIT Kit (MECO make) and the following details were noted down.

a. The rating of transformer is 1000 kVA, step-down of 11kV/0.430kV , 50Hertz , 3 phase , 52.48/ 1337

*Corresponding author: **Vinay Janardhan Shetty**

b. The estimated load for the above transformer rating was 800kW (approximately) and the present load on the system is nearly 1200kW, which requires 1700Amps of current to run the system at full load.

But from the observations made we can see that the installed transformer has a capability to serve only 1300 Amps of load on 100% loading which is dangerous during system transients and due to overloading, the CLR (i.e Current Limiting Resistor) connected at HV side of transformer used to fuse out. So to overcome this, engineering staff followed load shedding method which is not advisable especially for hospitals. Then after studying the irradiation level of Dharwad region using NASA metrological website we found that the SPV- Generation as a best method to overcome this overloading problem as well this will help in peak load cutting of the system and decreasing the monthly electricity bill of the hospital.

3.1. PV Panel cost with subsidy

Cost of 1kWp roof top Solar Photo-Voltaic	1	1,00,000
Cost of 350kWp roof top Solar Photo-Voltaic	400kW	4,00,00,000
Subsidy @30%	0.3	12000000
Net Cost after Subsidy		2,80,00,000
Accelerated Depreciation @80%	0.8	2,24,00,000
Tax Rate @35%	0.35	7,8,40,000
Tax Saved through Accelerated Depreciation		2,01,60,000

3.2. Cost of 3 Phase Inverter in (Rs/Watt)

Cost of 3 Phase Inverter in (Rs/Watt)	25
Size of Inverter	500kVA
Total Cost for 3 Phase Inverter	1,25,00,000

3.3. Cost of 3 Phase Transformer (Rs/Watt)

Cost Of 3 Phase Step-up Transformer(Rs/Watt)	20
Size of Transformer	500kVA
Total Cost for 3 Phase Inverter	1,00,00,000

3.4. Cost of system without On-line battery

Cost of System Without On-line Battery	
Net cost after subsidy(SPV-PANELS)	2,80,00,000
Total Cost for 3 Phase Inverter	1,25,00,000
Total Cost for 3 Phase Transformer	1,00,00,000
Net Cost for whole set up	5,05,00,000

3.5. Cost of the system with all auxiliary and misc cost

Subtotal above by 0.2 (20%) to cover balance of system costs (wire, fuses, switches)	0.2
Cost Estimate for Balance of System: (Net Cost for whole set up × 0.2)	5,05,00,000
Total Estimated PV System Cost is Rs	1,01,00,000

Carrying out all the calculations we find that the system cost comes around **Rs. 6,06,00,000** (i.e six crore six lakhs).

3.6. Difference in Power Consumption Bill

The difference in bill amount annually after connection of SPV generation was found to be **Rs. 75,89,307** (seventy five lakh eighty nine thousand three hundred seven rupees).

3.7. Pay-Back Period calculation

As we know, $Pay - Back\ Period = \frac{X}{Y}$

Where: X= Total cost of PV system with all auxiliary equipments. Y= Total annual cost saving after installation of PV System.

Pay-Back Period=8 years

3.8. Profit after pay-back period till useful life of SPV

As we know that useful life of PV is 25 years and we calculated the pay-back period of SPV is 8 years so by subtracting useful life to Pay-back period and then multiplying the difference in bill amount we can get the profit of Rs 13 Crore's.

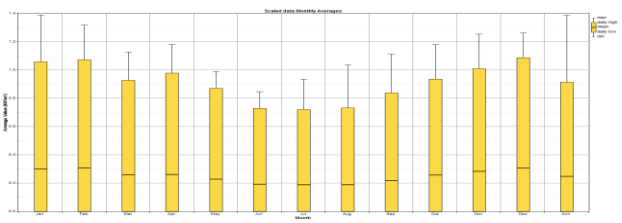
PROFIT=(Useful life-Pay-Back Period)*Difference amount in bill after connection of PV

3.9. Calculation of required Roof-Area required for 500kW SPV installation

Calculation of roof area required for installation of pv-generation		
	length(mm)	breadth(mm)
Module size for 240Wp	1690	990
Area covered by one panel	16,73,100	mm²
Applying Trigonometry for effective area calculation		
Number of Panels required for 400kWp (500kW approx)		1666.666667
		1667
Extra area added for clearance		25 mm²
Area covered by 1667 panel's (mm²)		69,71,25,00,000
Area covered by 1667 panel's (m²)		69,712

Present built up area in SDM College of Medical Sciences & Hospital	**1,01,533 m²**

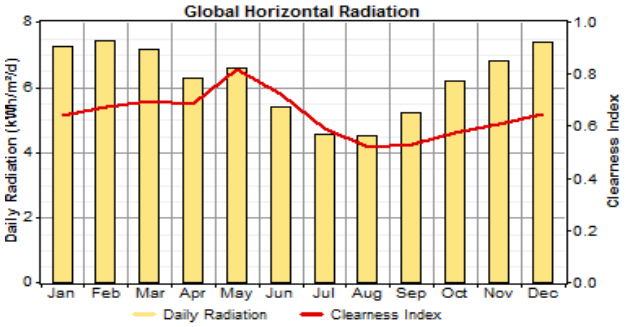
4. Graph for monthly energy potential



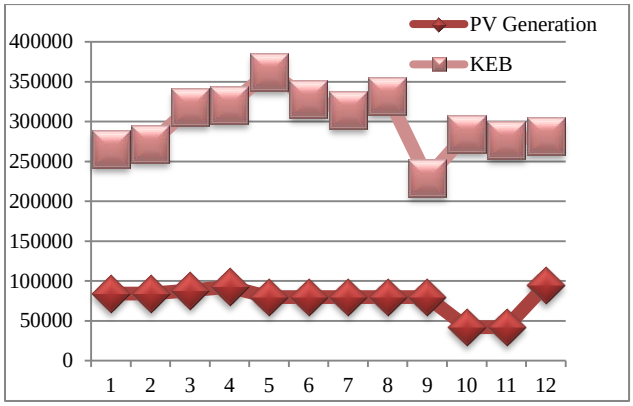
The above statics gives us information about varying sun irradiation level for 12 months in terms of kWh/m^2/day,

using which we can calculate the amount of electricity generation by SPV panels.

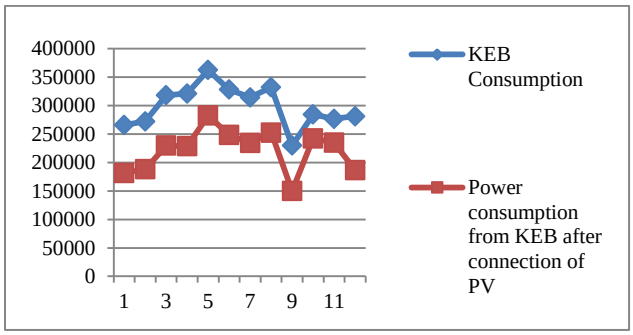
5. Graph for Global-Horizontal Radiation



6. Generation & Consumption Curve



7. Reduction in Power Consumption after connection of PV Source



From the above respective graph 6 and 7 we can get to know that how much amount of load can be taken care by SPV generation and the reduction in power consumption from KEB (i.e Karnataka Electricity Board) thereby reduction in the amount paid to KEB.

Conclusions

The design described is based on the potential measured & the system is capable of taking care of half of the medical load during day time thereby reducing the burden on utility transformer and the consumption cost of electricity. System sizing and specifications are provided based on the design made. Finally, cost analysis is carried out for the proposed design. Estimated PV System Cost is Rs. 6 Crore's as calculated. The methodology adopted seems satisfactory for determining the possible plant capacity for an calculated area of 69,712m^2 whereas the total built up area of all the hospital building is approx 101533m^2.

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References

Souvik Ganguli and Sunanda Sinha (29-30th Oct., 2009), A Study and Estimation of Grid Quality Solar Photovoltaic Power Generation Potential in some districts of West Bengal Patiala, Page(s): 522-528

A.S. Elhodeiby, H.M.B. Metwally and M.A. Farahat (11-14 March 2011), Performance analysis of 3.6KW Rooftop grid connected photovoltaic system Egypt. *International Conference on Energy Systems and Technologies*, (ICEST 2011), Cairo, Egypt.

D. Picault, B. Raison, and S. Bacha (2009.), Guidelines for evaluating grid connected PV system topologies. *IEEE International Conference on Industrial Technology*. Page(s): pp. 1-5

Phil Bolduc, David Lehmicke & Joseph Smith (1993), Performance of a grid connected PV system with energy storage. *IEEE Photovoltaic*. Page(s): 1159 – 1162

R. Ramkumar & J. E. Bigger (1993), Photovoltaic Systems. *Proceedings of IEEE*. Volume: 81, Page(s): 365 – 377

Eduardo Román, Ricardo Alonso & Pedro Ibañez (August 2006), Intelligent PV Module for Grid- Connected PV Systems, *IEEE Transactions on Industrial electronics*, Vol.53.No.4, Page(s): 1066 – 1073