International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

Feasibility Analysis for Installing Grid Connected Rooftop PV System in Village Gokul Pura, District Sikar, Rajasthan, India

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Abstract - *India is located in the sun belt of the earth, thereby receiving abundant radiant energy from the sun. The highest annual global radiation is received in Rajasthan and northern Gujarat. Jodhpur is called Sun City. In this work, the detailed analysis of 10 KWp Grid Connected PV System at the rooftop is carried out including the state/central Govt. Solar Policies. The detailed cost-benefit analysis is performed using the guidelines issued by Rajasthan Renewable Energy Corporation Ltd. RRECL, Rajasthan*

The proposed work presents the cost-benefit analysis before installing the solar rooftop systems and motivates the people towards the installation of solar rooftop systems.

The analysis done in the proposed work will give the people an idea about whether they should go for a solar system after considering their present monthly consumption of electrical energy. A detailed analysis of the site were done with the help of Meteonorm data set and PVGIS software

Key Words: **Solar, PV, Rooftop Solar System, Grid connected Solar PV System, Feasibility analysis, Solar Energy.**

1. INTRODUCTION

To prevent global warming, it is necessary to look renewable energy for the electricity generation.

This section presents an overview of various techniques by which the feasibility analysis is performed before the installation of solar PV system, based on the literature available. The idea of performing the feasibility analysis came from a broad array of literature mostly within energy and environmental economics. The state/central Govt. Solar Policies have attracted the people's attention towards the installation of solar rooftop systems. The literature considers the economics in Solar PV market and various incentives provided by the state/central Govt. Solar Policies. In the proposed work literature is prepared on feasibility analysis of solar rooftop system using cost benefit analysis without considering the social benefits.

Haas [1] has presented the comparison of installation cost for the production of electricity by solar photovoltaic system and other form of electricity production for decision makers. He has suggested the de-centralization of solar PV systems and subsidizing of small solar rooftop systems.

Krewitt [2] has suggested the difficulties in collecting the data required for estimating the cost of climate change in his study of social feasibility.

Muneer, Asif, Kubie [3] have addressed the increasing demand for electricity in the United Kingdom, depletion of conventional sources of energy and increasing environmental problems. In their feasibility analysis, they suggested solar energy as an alternative source of energy for UK.

The National Renewable Energy Lab (NREL) released a report in 1998 that presents the various technologies and substances used in the energy sector which are potentially hazardous: silicon, and cadmium telluride.

In his study, Herig [4] has calculated the turn-key cost of solar PV System. He has summarized the various incentives available for the installation of commercial PV System. Herig has pointed the solar policies for increasing the economic feasibility of solar in the last decade in US.

Sorensen [5] has presented the economic and social feasibility analysis of renewable energy technologies in his study.

Priya Ranjan Mishra, Rakesh Babu Panguloori, Narendranath Udupa, Deepak Mitra [6] have presented the economic evaluation of solar system for the petrol pump stations. They have compared the cost associated in electricity generation using solar PV system with the cost associated in electricity generation using existing DG set.

Anith Krishnan, Jijo Balakrishnan, Aravind Unni S., Nidhin Mohan Divya Krishnan, Jojy George Koduvath [7] have presented the feasibility analysis of distributed generation using solar PV System for the domestic consumer in Kerela state. In their study they have determined the financial

viability of 2KWp and 3KWp grid connected solar PV system for the domestic consumer.

Anil K. Berwal, Sanjay Kumar, Nisha Kumari, Virender Kumar, Abid Haleem [8] have analyzed the viability of a 50 KWp capacity solar plant installed at the roof of Saraswati library building of Deenbandhu Chhotu Ram University of Science & Technology. In their analysis, they have considered the Govt. while calculating payback period. They found payback period of 5.7 years with subsidy and 10.3 years without subsidy.

M. Shravanth Vasisht, G.A. Vashista, J. Srinivasan, Sheela K. Ramasesha [9] have reported the performance of solar photovoltaic modules mounted on the rooftop of a rail coach of the Indian railways. The focus of their experiment was to quantify the reduction in diesel consumption of the end-on generation system that powers the electrical load in the new generation coaches. In their work, they have estimated the generation of 18 kWh of electricity in a day by one solar coach, leading to a saving of 1700 liters diesel annually.

Akash Kumar Shukla, K. Sudhakar, Prashant Baredar [10] have presented the economic analysis of a 110 KWp standalone rooftop PV system for Hostel-1 building in MANIT Bhopal, M.P., India. They have carried out the detailed cost analysis of this solar PV project including installation and maintenance cost. They have suggested two inverters each of 55 KVA capacity.

R. S. Shivalkar, H. T. Jadhav, P. Deo [11] have presented the feasibility examination of net metering implementation in commercial buildings of Reliance Energy Consumers in Mumbai. In their work, they have studied the economic viability of 15 KWp solar plant. They found a payback period of 4.63 years corresponding to tariff of Rs. 12.

Omid Nematollahi, Kyung Chun Kim [12] have investigates the feasibility of using solar energy in different regions of South Korea. They have calculated the minimum, maximum and average value of horizontal radiation for the 24 stations for a period of 5 years. In their study they found that central and southern regions of South Korea receive higher quantities of radiation as compared to northern areas.

A. Nicholls, R. Sharma, T. K. Saha [13] have presented the financial and environmental analysis of installing solar PV system in Australia. In their study they have also considered the environmental benefits for performing feasibility analysis.

Shelly Hagerman, Paulina Jaramillo, M. Granger Morgan [14] have analyzed the economic viability of solar PV system for the different states of U.S. They have carried their feasibility study by collecting insolation data for more than 1000 locations, installation cost by regions and the subsidy applicable to that location. In their study, they found that only Hawaii has achieved socket parity without use of subsidy.

1.1 Site Details

Site is located at NH-52 in Village Gokulpura, Sikar. Gokulpura is a Village in Sikar District of Rajasthan State, India. Gokulpura Pin code is 332001. As per constitution of India and Panchyati Raaj Act, Gokulpura village is administrated by Sarpanch who is elected representative of village. The detail of the site is given in Table 1.

1.2 Solar Radiation at Proposed Site

Rajasthan is favorably placed to become the largest provider of solar power among all sources of energy in India at a competitive cost and achieve the scale on solar power generation, which can change face of the State and transform the complete economic situation for betterment of the masses. Rajasthan has more than 325 sunny days in a year with solar radiation of about 6-7 kWh/m2/day. Mostly the western part of Rajasthan is blessed with abundant solar energy. Jodhpur in Rajasthan is receiving very good solar radiation which is known as Sun City of India.

Table -1: Site Details

A	Site Name	Gokulpura, Sikar
B	Co-ordinates	27.5°N, 75.1°E
C	Site Elevation	427 Meters
D	Slope	27°
E	Installed capacity	10 KWp
F	Type of Module	Crystalline Silicon
G	Mounting System	Fixed tilt
H	Inverter Capacity	10 KW
I	Type of roof	RCC

The radiation analysis is carried out for different tilt angles of PV modules. The generation of the proposed 10 KWp grid connected PV system is estimated corresponding to 27^0 fixed tilt using PVGIS as shown in fig 1.

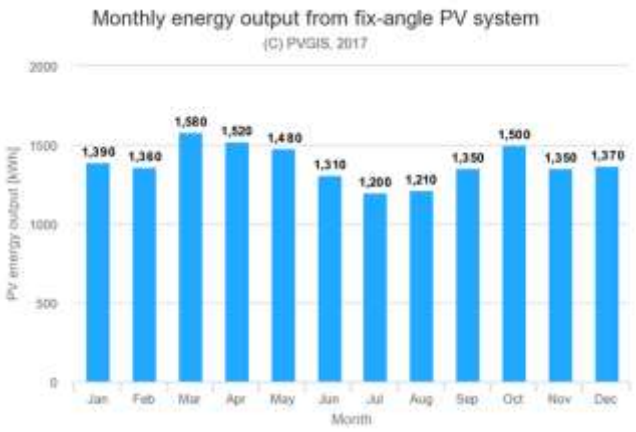

Fig -1: Monthly generation for fixed tilt of 27^0

2. INSTALLATION LAYOUT

Fig. 2 shows the schematic diagrams of proposed system.

Fig -2 (a): Installation Layout

It is clear from the fig. 2(a) that 40 modules are used for the proposed PV system having fixed tilt angle of 27°. The galvanized module mounting structure is used to protect it from corrosion.

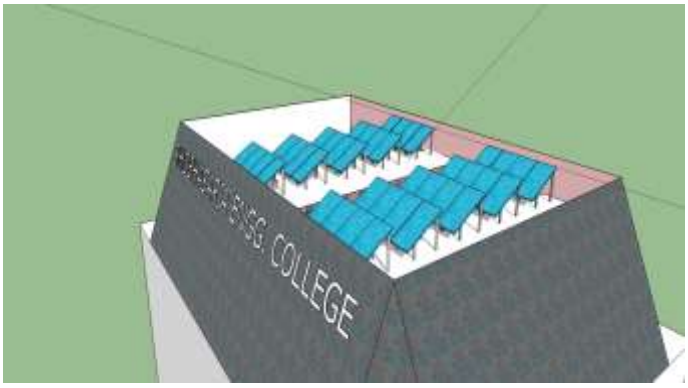

Fig -2 (b): Installation Layout

The top view of the proposed PV system is shown in fig. 3.

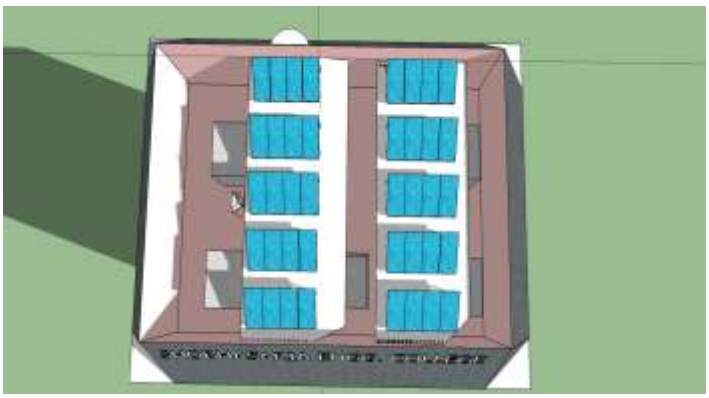

Fig -3: Top View of the proposed PV system

2.1 Specifications of modules and inverter

Table 2 presents the specifications of modules and inverter with their manufactures. 40 modules of Renesola each of capacity 250 Wp is used for the proposed 10 KWp grid connected PV system.

3. RESULTS AND DISCUSSION

The generation of the proposed 10 KWp grid connected PV system is calculated using the PVGIS software. The generation calculations are performed for the fixed tilt 10 KWp grid connected solar PV system. PVGIS is used for the sizing of PV system and calculation of its generation. A simulation studies for 27 degree tilt angle has been made with help of most reliable software PVGIS. The PVGIS report indicates that setting up a solar PV plant at the said location will generate sufficient electrical energy i.e. 16600 units/year.

Table -2: Specifications of modules and inverter

MODULE		INVERTER	
Manufacturer	Renesola	Manufacturer	Zeversolar
Model	JC250M-24/Bz	Model	Zeverlution 1000S
STC Power	250 Wp	Vmax Array	500 V
Efficiency	15.4 %	Efficiency	92.8 %
Voc	37.4 V	Weight	7.30 Kg
Isc	8.83 A	Grid Voltage	220-230 V
Vmpp	30.1 V	Frequency	50 Hz
Impp	8.31 A	Pac	10 KW AC
Module Size (WxL)	0.992x1.640 m2	Phase	Three

3.1 Payback Period without considering the Subsidy provided by RRECL

As per electricity bill, the consumer (Shobhasaria Engineering College, Sikar) has consumed 25628 units from 04/03/2018 to 04/04/2018.

The bench mark price of Rs 75,000 for 1 KWp grid-connected system is used for feasibility analysis. Per unit cost of electricity is used as given in Electricity bill of the consumer issued by AVVNL (Ajmer Vidyut Vitran Nigam Limited) i.e. Rs 8.35/unit. In their calculation, the authors calculated payback period of 5.4 years without considering the subsidy/incentives provided by nodal agency of State Govt. i.e. RRECL (Rajasthan Renewable Energy Corporation Limited). The electricity units i.e. 16600 units/year generated by proposed system are considered for the feasibility analysis which are estimated using PVGIS.

3.2 Payback Period by considering the Subsidy provided by RRECL

The incentive provided by RRECL ((Rajasthan Renewable Energy Corporation Limited)) for the installation of solar rooftop system is 30% of the total project cost. In this case, the subsidy provided by RRECL is considered for the calculation of payback period of the proposed 10 KWp system. The remaining parameters (generation, project cost, per unit cost charged by AVVNL) are same as mentioned in article 3.1. In this case of performing cost-benefit analysis, the subsidy provided by the Govt. is considered and corresponding payback period of 3.7 years is calculated.

4. CONCLUSIONS

This paper has presented the detailed economic feasibility study of the grid connected solar PV system at village GOKULPURA, SIKAR. This paper has also presented the effect of subsidy provided by state Govt. on the payback period.
A detailed analysis of the site (Gokulpura) were done with the help of Meteonorm data set and PVGIS software.

In this work, the detailed analysis of 10 KWp Grid Connected PV System at the rooftop is carried out including the state/central Govt. Solar Policies. The detailed cost-benefit analysis is performed using the guidelines issued by RRECL. The proposed work presents the cost-benefit analysis before installing the solar rooftop systems and motivates the villagers towards the installation of solar rooftop systems. The analysis done in the proposed work will give the villagers an idea about whether they should go for a solar system after considering their present monthly consumption of electrical energy.

The solar radiation data at proposed site are calculated using PVGIS data. These calculated values of solar radiation are used for estimation of generation by the proposed system. In order to show the effect of seasonal tilting, the solar radiation data are obtained at different tilt angles. It was found that the generation from the proposed system will be more in case of seasonal tilting as compared to fixed tilt facility. The cost-benefit analysis is performed for the system having fixed tilt facility in two ways. In one way, the subsidy provided by the Govt. is not considered and corresponding payback period of 5.4 years is calculated. In other way of performing cost-benefit analysis, the subsidy provided by the Govt. is considered and corresponding payback period of 3.7 years is calculated. Thus the incentive provided by State Govt. has reduced the payback period by approximately 2 years. In this work the economic feasibility analysis of a solar PV system is carried out to satisfy the energy needs of a commercial consumer which can be extended for the domestic and industrial users.

In the present work, only economic study is performed without considering social impacts like ozone layer depletion, carbon emission etc. Therefore, this work can also be extended by taking into account the social impacts while performing feasibility study.

ACKNOWLEDGEMENT

The author is highly grateful to Director, Shobhasaria Engineering College, Sikar, Rajasthan, for providing this opportunity to carry out the present work.

The author expresses gratitude to faculty members of Electrical Engineering Department, Shobhasaria Engineering College, for their intellectual support throughout the course of this work.

Finally, the author is indebted to all whosoever have contributed in this dissertation work and friendly stay at Shobhasaria Engineering College, Sikar, Rajasthan

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