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Economic Analysis of Roof Top Solar Plant Using PvSyst

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ABSTRACT

In the present era, we are facing a large number of problems and crisis and one of the major problems is the energy crisis and carbon dioxide emission. These both are interrelated because of the emission from thermal plants or oil-fired plants the main emission is of carbon dioxide. In order to remove the energy crisis, we are gaining carbon emission which in turn is harmful. So non-conventional energy resources seem to be the most optimum option to tackle the above-said problem. It can be said be with one arrow we will be targeting 2 targets mountainously. But the major problem which we are facing is the economics of installing the solar plant. This paper will deal with the economic analysis of installing a solar power plant at a specific location and will talk about solar rooftop return of investment.

Keywords – Emissions, the return of investment.

1. Introduction

We all have been talking about the shifting to renewable energy as it will be the most viable and most optimum option but before that, we have to learn something about the economics of the plant. Like how much investment needs to be made, is it economical, any subsidies for common people and middle and low salaried group, what will be the ROI of the Solar plant. Humankind cannot move forward in the direction which is not economical. At the present time, we have seen that Mega solar plants are producing electricity at □ 2.5 which is nor somewhat equivalent to the power generated by coal power plants. But the main problem arises during the installation as the initial investment is very large for a solar plant. For 1 KW it takes approximately 60k to 80k depending on the location. For middle class and low salaried class, it's impossible to install such plants. To tackle this problem the Government of India have introduced subsidies at different levels and according to the location to help people install solar plants. In northeastern stated and J&K 70% subsidy is being provided whereas 30% is provided to the rest of India on rooftop on-grid solar plants[1]. Government of India is also giving a boost to solar energy so as to achieve the target set by India of achieving 100GW of solar energy by 2022 under Jawahar Lal Nehru Solar Mission[1].

India has a very high potential of capturing solar radiation and convert into electricity via solar thermal technology or solar photovoltaic technology. India receives around 4 to 5 KWh radiation per meter square[2]. Many researchers have done performance analysis using PvSyst[3-5]

This paper is carrying out a detailed study for economic analysis of 50 KWp solar rooftop with the following objective:

1. To get the Net Investment of solar plant according to the site.

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2. To get the Return of Investment Details.

2. PV plant Description

2.1 Geographic Position Of Site

The 50 KWp on-grid Solar rooftop power plant is situated at Baddi International School Baddi District Baddi Solan, Himachal Pradesh at coordinates 30.5730 N,76.4853 E. The location of this solar power plant is suited because there were no high rise building nearby to obstruct the radiation and was facing due south.

2.2 Plant Outline

The total capacity of the installed Rooftop on grid solar plant is 50 KWp which is spread over an area of 400m^2 area. The plant is installed on a single roof and consist of 158 modules with 6 strings of 20 modules each and 2 strings of 19 modules each. The support structure is galvanized iron and roof penetration structure. The plant is set in a way to get maximum energy output keeping in mind the economic value of the plant. The plant installed is On- Grid system and at night utilizes energy from the main grid system. The system evacuation is directly fed to the main line bus bar from the customer Lt panel at the 440v output. No transformer is installed in this system. 6 earthing pits are installed, 2 for each D.C, A.C and lightning arrestor.

2.3 Tilt and azimuth Angle

In most of the cases, the tilt angle is kept according to the latitude of the site location. But in this case, we are keeping it at 25^0 because if we keep it at 30^0 the pitch distance becomes large and the capacity if the plant is reduced by 10KW. The azimuth is set to -3 degrees as we needed to keep the plant align with the building else the capacity of the installed plant was coming to be very less if azimuth was set to 0 degrees.

2.4 Solar Panel Specifications

The solar panel which has been mounted at this location are of 320Wp with a module efficiency of 16.49%. Its V_{oc} is 45.80 and V_{mpp} is 37.2. Whereas its I_{sc} is 9.15 A and I_{mpp} is 8.60 A. the pitch has been set to 3.6m. The clearance difference between the bottom edge of the module and the ground is 0.5 m.

3. Cost of Components

There are different components which are used in the solar power plant .in below table we will be showing the different components and there cost/ Wp

S.No.	Component	Cost/Wp
1	Pv Module(polycrystalline)	□ 19.50
2	Inverter	□ 6
3	Lightning arrestor	□ 0.50
4	Earthing	□ 1.50
5	Wires and Settings	□ 6
6	Installation structures	□ 4
7	Monitoring System	□ 2
8	ACDB and AJB	□ 0.40
9	Engineering and Labour	□ 3
10	Maintenance cost/ year	□ 1
	Total	□ 4390

Table 1- Cost/Wp of Components

4. Formula used

4.1 Gross investment

It can be defined as the product of investment made per watt peak and the total capacity of the plant. it can be shown by:-

Gross investment = Cost per Watt peak * Total plant capacity

4.2 Net investment

It can be defined as the total gross investment of the plant plus the total tax Applicable to the gross investment. Usually, for ease of calculation, we take 12% tax slab as almost 90% of the Solar rooftop components comes into 12% GST slab. It is given by

Net investment = Gross Investment + (12% of gross Investment)

4.3 Total yearly cost of plant

It can be defined as the sum of annuities and yearly maintenance cost. Yearly maintenance cost is taken as □ 1/Kw installed. Therefore it can be given as:

Total yearly cost = (Annuities/year) * {□ 1/Kw * installed capacity (kW)}

4.4 Yearly Balance

It can be defined as the total amount of profit margin of a consumer after one year of the working of solar rooftop plant. It can be given as:

Yearly Balance = (Energy Generated * tariff) – (Running cost/year) – (Annuities/Year)

4.5 Net Profit

It can be explained as the total amount of profit gained after the successful running of the plant for a pre-determined amount of time. It can be given by:

Net Profit = $\sum_{1}^{25} Yearly\ Balance$

4.6 Energy Cost

It can be explained as the total investment made including taxes and loan EMI divided by energy produces in that year. It is given by:-

Energy Cost = $\frac{Total\ Cost\ per\ year}{energy\ produced\ in\ that\ year}$

5. Graphs and tables

5.1 PvSyst Simulation

Below Provided Graphs Shows the Simulation of Economic Evaluation in PvSyst software. One graph shows Economic evaluation by cost/Wp and the other one shows Cost/ Whole plant.

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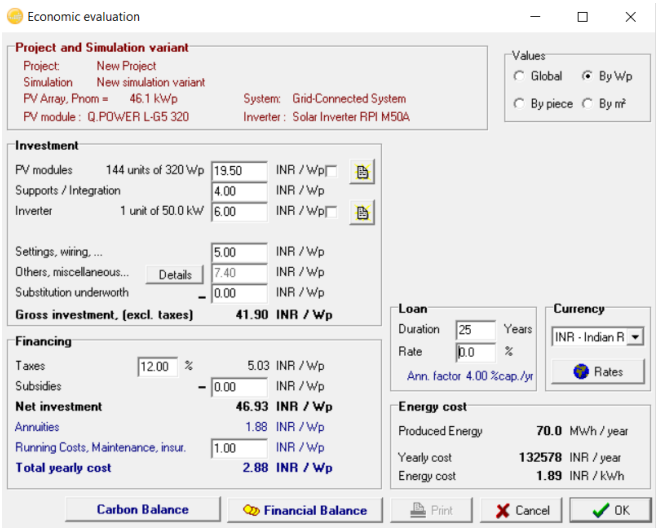

Figure 1- Cost/Wp[6]

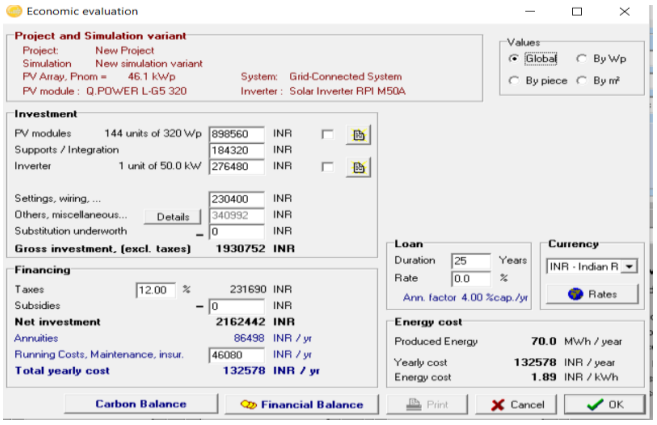

Figure 2 – Cost/Global[6]

5.2 PvSyst simulation Graphs

These graphs show the Yearly Financial balance in INR and Cumulative Financial balance or Net profit from the plant after the successful running of the plant for the desired time. The X-Axis shows Lifetime and the y-axis shows the total profit.

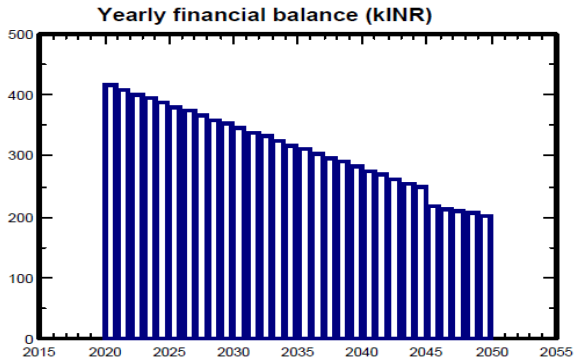

Figure 3 – Yearly Financial Balance[6]

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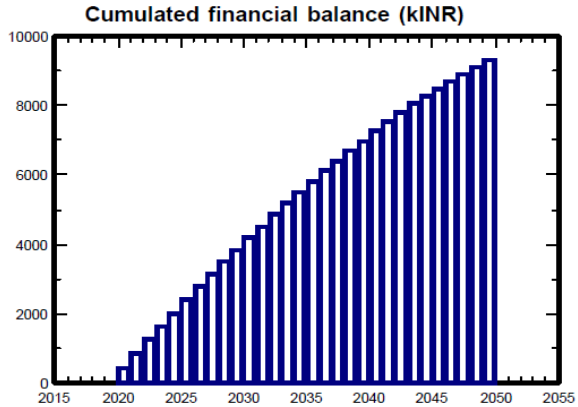

Figure 4 – Cumulated Financial balance[6]

Figure 3 has a declining graph due to the fact that there is annual depreciation in the energy produced by the solar power plant and is considered to be around 1-2% per year. And after the end of 25 years due to lower factor deviation the tariff at which energy is sold in depreciated by 50%.

We can see from figure 2 that net investment is □ 2162442 whereas after 25 years of running ofthe plant we can see from figure 5 that total amount saved by the consumer for 50 KWp plant is □ □ 8295500.

Long term economic balance

Year	Loan 10.0 %	Running costs	Sold energy	Yearly Balance	Cumul. Balance
2020	238.2	46.1	700.1	415.8	415.8
2021	238.2	46.1	693.1	408.8	824.7
2022	238.2	46.1	686.1	401.8	1226.5
2023	238.2	46.1	679.1	394.8	1621.3
2024	238.2	46.1	672.1	387.8	2009.2
2025	238.2	46.1	665.1	380.8	2390.0
2026	238.2	46.1	658.1	373.8	2763.8
2027	238.2	46.1	651.1	366.8	3130.7
2028	238.2	46.1	644.1	359.8	3490.5
2029	238.2	46.1	637.1	352.8	3843.3
2030	238.2	46.1	630.1	345.8	4189.1
2031	238.2	46.1	623.1	338.8	4527.9
2032	238.2	46.1	616.1	331.8	4859.8
2033	238.2	46.1	609.1	324.8	5184.6
2034	238.2	46.1	602.1	317.8	5502.4
2035	238.2	46.1	595.1	310.8	5813.2
2036	238.2	46.1	588.1	303.8	6117.0
2037	238.2	46.1	581.1	296.8	6413.8
2038	238.2	46.1	574.1	289.8	6703.6
2039	238.2	46.1	567.1	282.8	6986.5
2040	238.2	46.1	560.1	275.8	7262.3
2041	238.2	46.1	553.1	268.8	7531.1
2042	238.2	46.1	546.1	261.8	7792.9
2043	238.2	46.1	539.1	254.8	8047.7
2044	238.2	46.1	532.1	247.8	8295.5
2045	0.0	46.1	262.6	216.5	8511.9
2046	0.0	46.1	259.1	213.0	8724.9
2047	0.0	46.1	255.6	209.5	8934.4
2048	0.0	46.1	252.1	206.0	9140.4
2049	0.0	46.1	248.6	202.5	9342.8

Figure 5 – Long term Economical balance[6]

6. Conclusion

In the above paper, we ran a 50KWp solar plant simulation and saw that around 22 Lakhs INR was being invested for the solar installation in an institute and that institute after 25 years if successful running of solar plant gained a net profit of 8295500 which is a massive amount. The total Return of Investment which we got was 6 years. All the invested money was gained within 6 years of running of plant successfully. Therefore we can say that solar plants are the most viable future but for common people, it needs some plans and activities so that they can also install in the household without economic burdens

Acknowledgment

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