Performance Analysis of 3.3 kW Photo Voltaic Solar System for Domestic Applications

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Abstract: In this paper we analyse the feasibility of installing a grid-connected photovoltaic (PV) system of 3.3 kW capacity for a fuel station situated at Dhar (Indore). Photovoltaic is the technology that converts solar radiation into useful form of electrical energy. The study is based on design of solar system using a PVsyst software tool to estimate cost and evaluate performance. The study includes all aspects of solar system such as technical, economic and environmental.

Keywords: Photo voltaic, PVsyst, grid-connected, Simulation

I. INTRODUCTION

Carbon based fossil fuel emits Green House Gases (GHG). These emissions are the major cause for pollutions and global warming. To counter this problem all around the world almost all the countries are framing new energy policies based on renewable energy sources. Among all available renewable energy resources solar energy gained more attention because of its abundant availability. In photovoltaic technology each smallest unit of solar panel known as module and combination of these module is called array. Every module has a number of solar cells. Solar cells are fabricated by means of some semiconductors-based materials such as silicon. Photovoltaic system generates green and clean electricity that is most prime requirement for today's environment. There are several geographical and metrological factors which affect the performance of photovoltaic system such as latitude and longitude of site, ambient temperature, wind velocity, relative humidity, rain fall etc (Parlak,2014).

In this paper 3.3 kW PV system is designed for a fuel station under a pilot project. This small-scale roof top solar PV system is designed and its performance is evaluated by using PVsyst 6.6.6 software tool. This software tool uses all relative information of solar system from it's database based on geographical site selection to calculate generated power, used power, performance ratio, efficiency, losses etc. Study includes costing of system and performance of system for the period of one year.

II. PV SYSTEM DESIGN

Designing of PV system mainly consists of PV modules are connected in parallel and series forming array. The size pf PV array depends on power rating of solar system. Here 3.3 kW solar system is designed by using 240 W 21V Si- mono (PV Si-monocrystalline module). The maximum voltage and current rating by each module is 80-400 V and 28.2 A respectively at ideal conditions.

Among fifteen PV modules five are connected in series having such three strings, so maximum voltage is 450 V and maximum current is 28.2 A. Complete system is shown in figure 1 and table number 1 shows all components of PV solar system. Information related to required load and daily power consumption is given in table number 2.

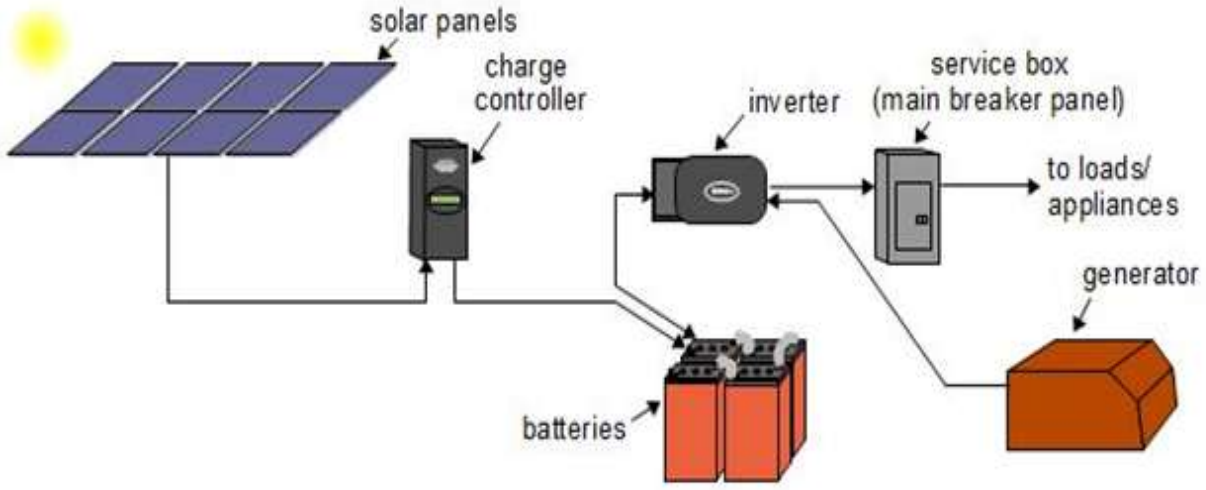

Figure 1: Working of simple photovoltaic system

Table 1

Components	Company	Quantity	Investment (In Rs)
PV module	BP Solar Aleo_S_75	15	153600
Batteries	Exide	7	44800
Inverters	AEG Industrial Solar	3	21600
Wiring and others	___		4500
			Rs 224500

Table 2

Equipment	Quantity	Power consumption	Uses	Energy (Wh/day)
Pump 1	1	736 w (1 HP)	2 h/ day	1472Wh/day
Pump 2	1	552W (0.75 HP)	2 h/ day	1104Wh/day
LED lamp	4	15W	10 h/ day	600Wh/day
Fans	2	60W	4 h/ day	480Wh/day

III. SIMULATION RESULTS

The performance of 3.3 kW PV system has evaluated using PVsyst 6.6.6 software tool. The cost of solar PV system is approximately Rs 224500. This investment includes cost of PV modules, batteries, inverters and other charges such as connection.

Monthly power generation by the PV system is calculated using PVsyst 6.6.6 software tool. According to simulated data maximum global irradiation were found in the month of May (224.1 kWh/m^2) but effective global irradiation is low (210.4 kWh/m^2) due to temperature effect on PV modules. The available solar energy is maximum (230.5 kWh) in the month of march. Annual solar energy produced by the system is 6.20 MWh/year.

Grid-Connected System: Main results

PVsyst Evaluation mode
Project: New Project
Simulation variant: New simulation variant
Main system parameters System type Grid-Connected
PV Field Orientation tilt 15° azimuth 0°
PV modules Model Aleo_S_75 / 240 Pnom 240 Wp PV
Array Nb. of modules 15 Pnom total 3600 Wp
Inverter Model AS-IR01-1000 (1kw) Pnom 1000 W ac
Inverter pack Nb. of units 3.0 Pnom total 3000 W ac
User's needs Unlimited load (grid)
Main simulation results System Production Produced Energy 6.20 MWh/year
Specific prod. 1723 kWh/kWp/year
Performance ratio PR 79.68%

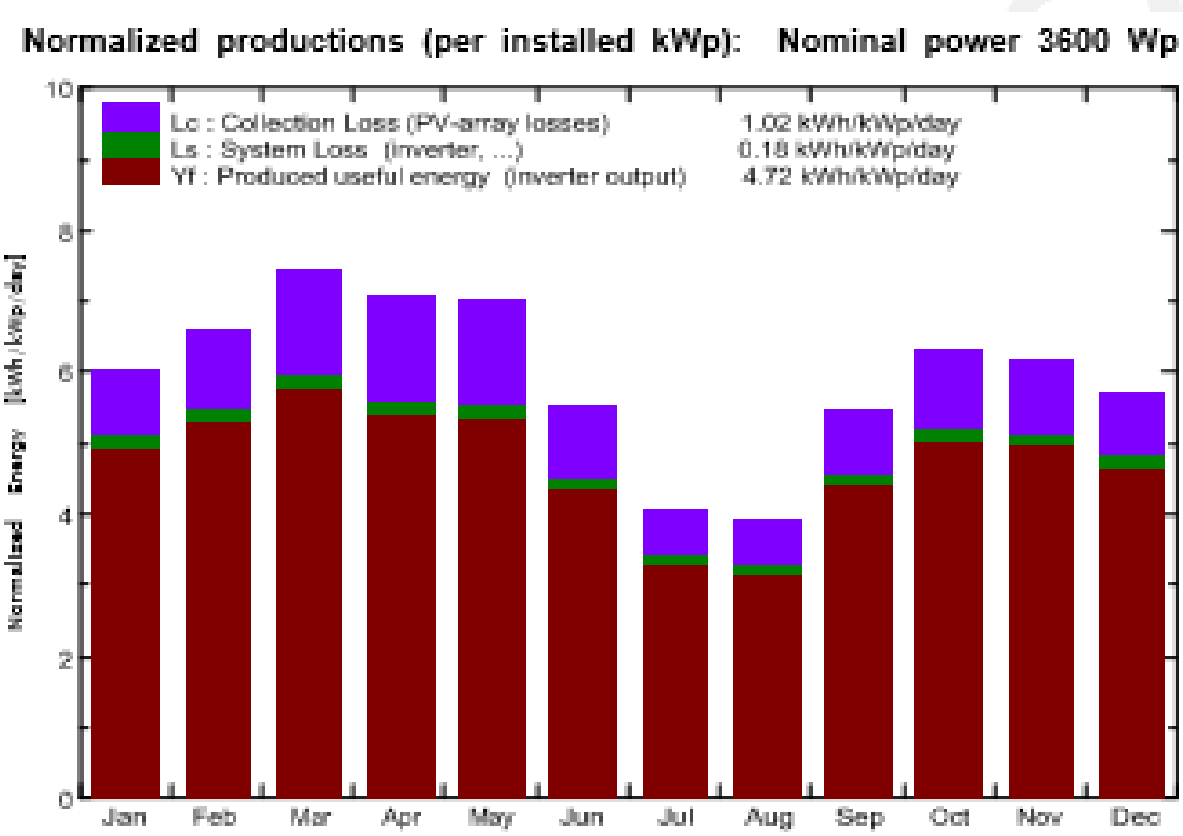

Figure 2 Solar energy production data

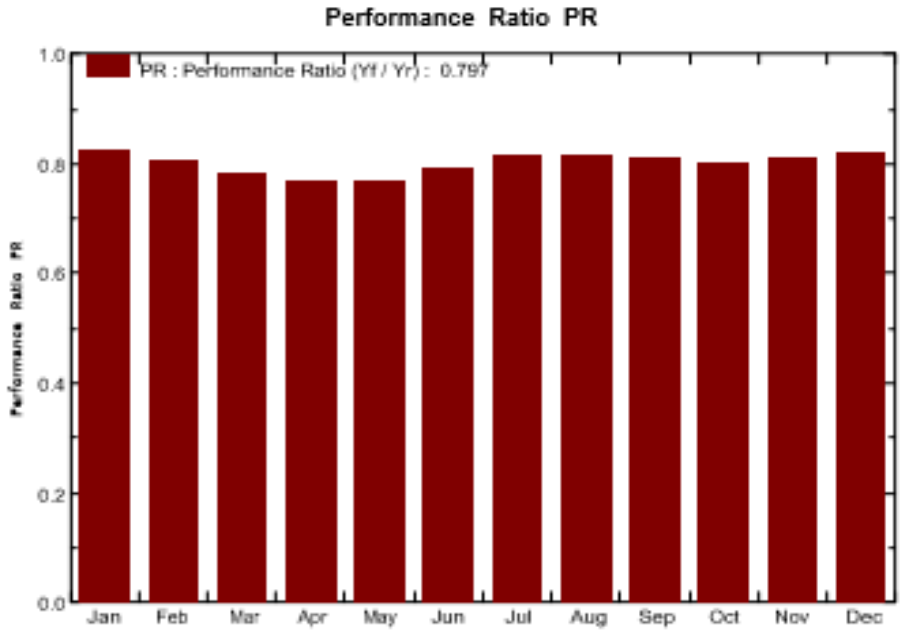

Figure 3 Performance ratio data

New simulation variant
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	151.2	31.31	18.60	186.2	181.4	0.571	0.551	0.822
February	158.6	35.61	21.40	184.7	180.1	0.555	0.536	0.806
March	211.6	41.49	26.46	230.5	224.9	0.668	0.647	0.779
April	207.7	64.87	30.54	211.9	206.3	0.607	0.585	0.767
May	224.1	75.48	32.30	216.9	210.4	0.620	0.597	0.765
June	174.2	83.99	29.01	165.5	159.8	0.490	0.471	0.791
July	130.0	88.18	26.03	125.1	120.3	0.383	0.366	0.812
August	122.6	75.49	24.74	121.1	116.9	0.370	0.354	0.812
September	157.0	71.88	25.05	164.1	159.1	0.495	0.477	0.807
October	173.4	55.50	25.26	195.3	189.9	0.580	0.561	0.797
November	151.9	32.95	22.25	184.3	179.4	0.556	0.537	0.809
December	140.8	31.79	19.84	176.4	171.7	0.541	0.521	0.820
Year	2003.3	688.54	25.14	2162.0	2100.1	6.437	6.202	0.797

Grid-Connected System: Loss diagram
PVsyst Evaluation mode
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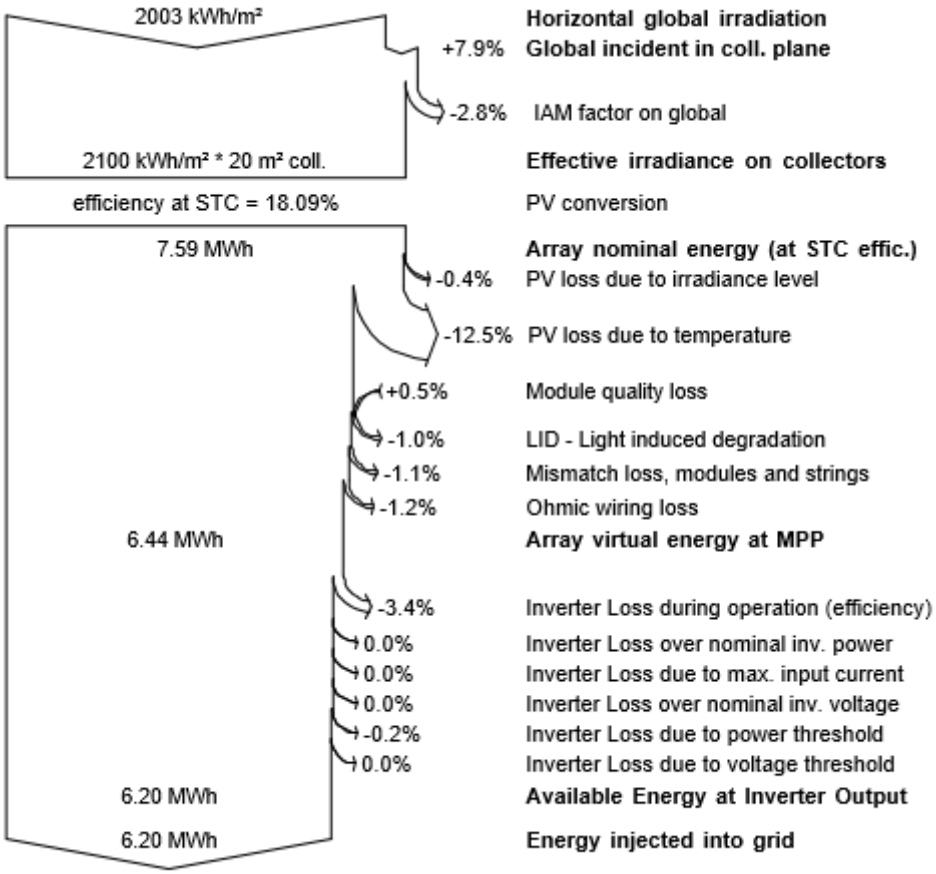

IV CONCLUSION

In this paper, a 3.3 kW capacity rooftop PV solar system is studied for a fuel station under a pilot project in Dhar(Indore). Cost analysis and performance of system has been evaluated using PVsyst 6.6.6 software tool. The designed PV system generates 6.20 MWh/year solar energy but due to batteries, inverters and other losses the useful energy is limited to 4.94 MWh/year only. The simulation result also represents detail of energy produced per month.

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