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Design of A 12 KWp Grid Connected roof top Solar Photovoltaic Power Plant on school building in the Rohtak District of Haryana

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Abstract

The depletion of conventional resources on international groundwork has necessitated an pressing search for alternative energy sources to meet current day demands. Solar energy is a clean, inexhaustible and environment-friendly viable renewable option. A stand-alone photovoltaic can't grant a continuous supply of energy due to seasonal and periodic variations. Therefore, in order to fulfill load demand, grid connected power structures are now being implemented that mix photovoltaic and conventional electric source. The objective of this work is to estimate the workable of grid connected photovoltaic power plant in the Rohtak district of Haryana and potential strength estimated for an available roof location of 120 m2.

Keywords: Day time variations; Daily Energy Output; Monthly Energy Output; Grid Connected roof top PV System; MPPT Inverters; Solar Rays; Yearly Energy Output.

INTRODUCTION

Electricity is obtained from the PV array most efficiently during sunny daytime hours. At night or during cloudy periods, independent power systems use storage batteries to supply electricity. With grid interactive systems the grid acts as the battery, supplying electricity when the PV array cannot able to supply electricity[1-4]. Energy storage devices (e.g. batteries) have been avoided in this work, to reduce capital, operation, and maintenance costs. The grid connected PV system is well known in various parts of world, and several technologies are available[2-6]. This research work focuses on the development of a grid connected PV rooftop system of 12Kkw on a school roof. Additionally, there have been efforts to develop the power electronics circuitry involved and inverters with protecting devices have been designed. Overall, the goal is to measure the potential of a grid connected PV system in the Rohtak district of Haryana using a solar net meter and to establish a demonstration of this type of system using existing methodologies and available equipment.

MATERIALS AND METHODS

To locate the solar PV technology viable in the Rohtak district of Haryana, solar radiation over 12 months (may2016-April 2017,) was once measured the use of a solar meter. The day time variations, common monthly output and year output have been calculated and the related graphs were plotted to show the seasonal variation. The measured radiation records sheet of Rohtak district for the month of April 2017 has been given as an example. Day time variations for specific months have been plotted then monthly and each year outputs had been calculated.

Observing the peak values, the month-to-month common peak was once calculated, variation of the month-to-month peak for a 12 months used to be plotted and the average annual peak was calculated. For calculating output, the efficiency of the PV module was taken as 16.3%. Finally, a grid connected PV system was once designed with accessible technologies for estimated plant ability on 120 m2 of school roof top. The total plant ability was estimated the use of the photo voltaic workable assessment statistics beforehand determined.

RESULTS AND DISCUSSIONS

Estimation of Solar Potential & Possible Plant Capacity

With the help of solar meter, Solar rays was recorded from may 2016 to April 2017 for the present study.

Table 1: Average Output recorded from April 2017 (Time: 10 AM)

Date	PV Module Efficiency	Solar Radiation (Watt/m2)	Output (Watt/m2)	Monthly Output (Watt/m2)	Average Output (Watt/m2)
07/04/2017	16.27	760	123.65		
15/04/2017	16.27	830	134.46		
28/04/2017	16.27	870	141.54		
04/2017	16.27			399.65	1333.21

Table 2: Daytime calculations for Variations (April 2017)

TIME	Average Output (Watt/m2)	Average Output (Watt/m2-hr)	Daily Energy Output (Watt/m2-hr)	Monthly Energy Output (Watt/m2-hr)
10 AM	132.60	132.60		
11 AM	148.92	148.92		
12 NOON	141.62	141.62		
1 PM	127.26	127.26		
2PM	102.12	102.12		
3PM	96.06	96.06		
4 PM	72.09	72.09		
04/2017			82067	24626.8

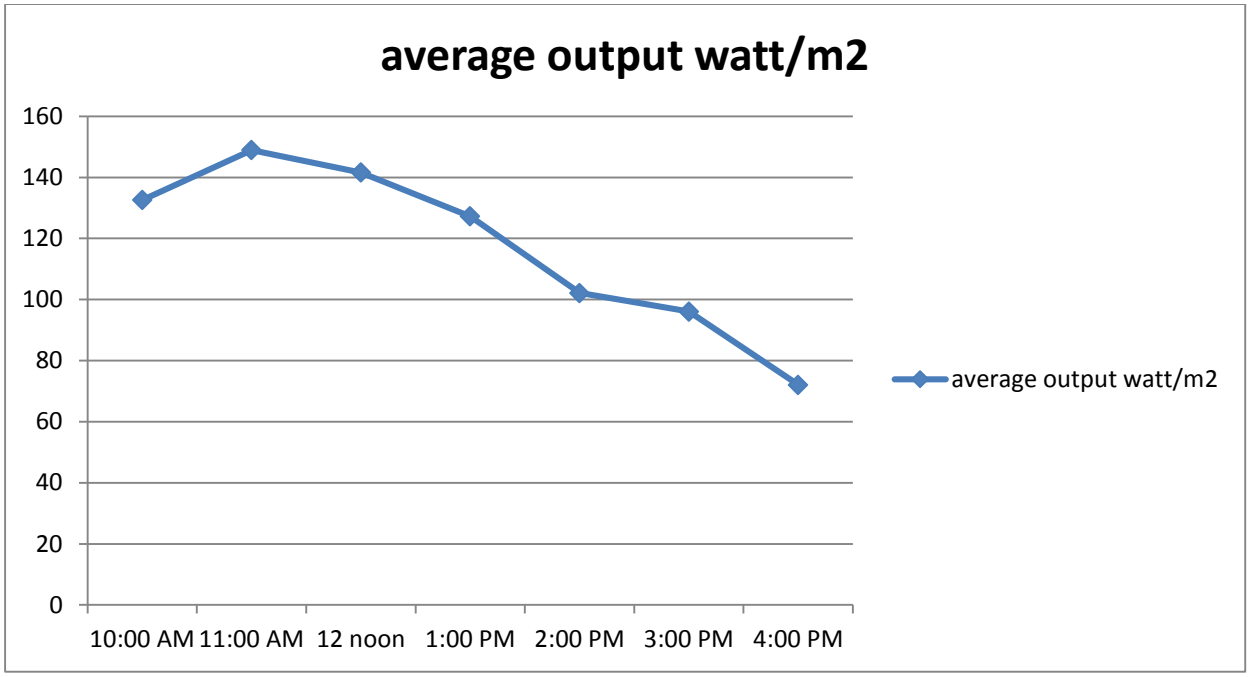

Figure 1: average output

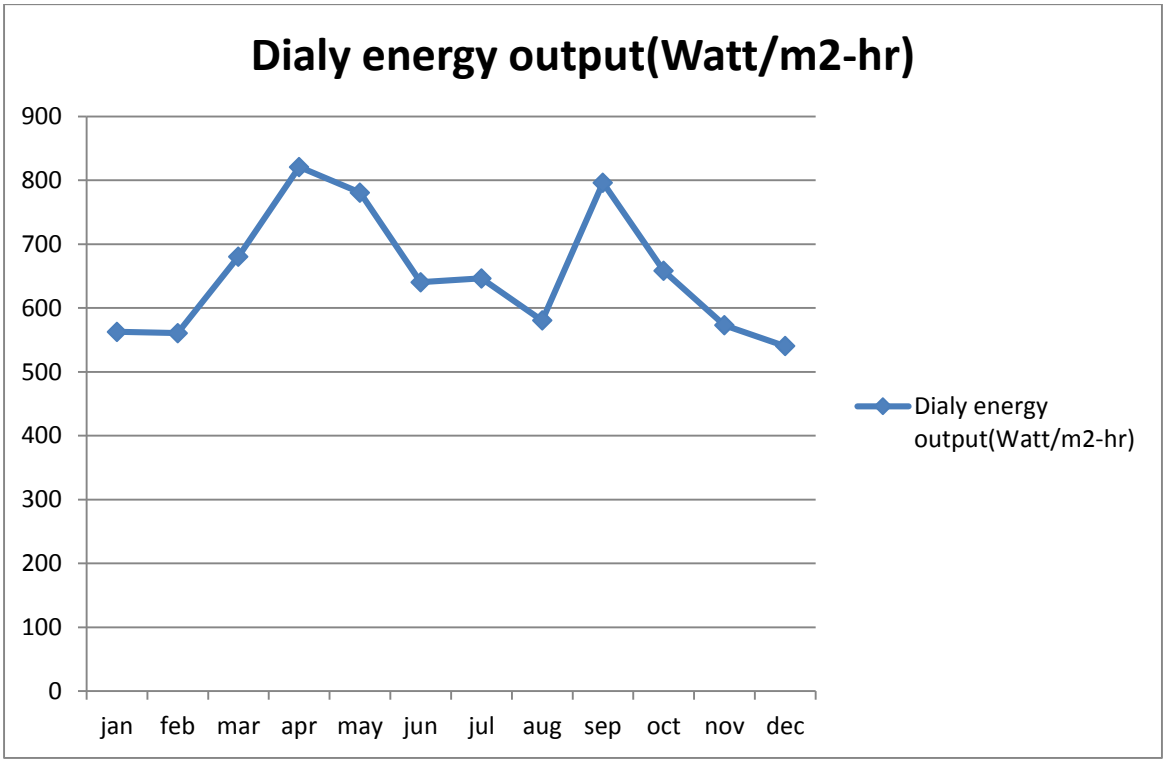

Figure-2: Daily energy output

The results for the month of April 2017 have been shown as a sample (Table 1). Only the average output calculation at 10 AM is shown in this table. Similar results were obtained at 11 AM, 12 NOON, 1 PM, 2 PM, 3 PM and 4 PM. The day time variation for the month of April 2017 is also shown (Table 2).

Table 3: Total Energy Output

Months	Daily Energy Output (Watt/m2-hr)	Monthly Energy Output (Watt/m2-hr)	Average Monthly Energy Output (Watt/m2-hr)	Average Yearly Energy Output (Watt/m2-hr)
january	562.56	16876.8		
february	560.67	15698.76		
march	680.26	20407.8		
april	820.67	25440.77		
May	780.52	23415.6		
june	640.24	19847.44		
july	646.36	19390.8		
august	580.28	17988.68		
september	796.26	23887.8		
october	658.11	20401.41		
november	572.76	17182.8		
december	540.21	16746.51		
			19773.01	237276

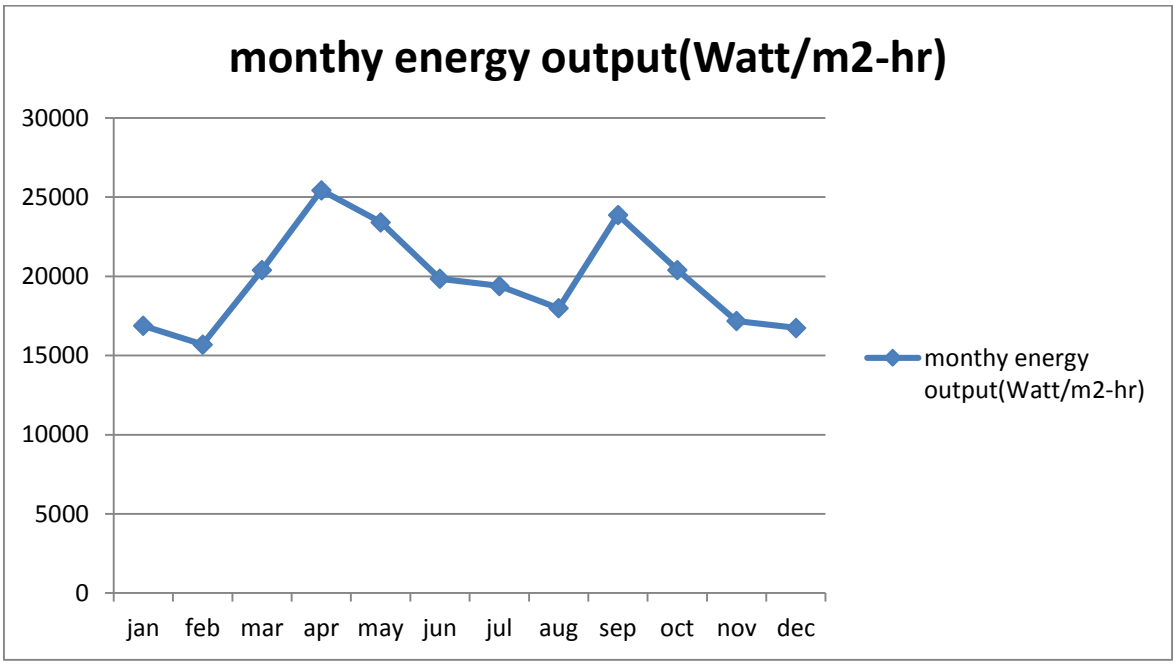

Figure-2: monthly energy output

Table 4: Peak Variation & Possible Plant Rating

month	**Peak Output (Watt/m2)**	**Average Peak Output (Watt/m2)**	**Average Peak Output for 150 m2 Area(Watt)**	**Possible Plant Capacity (KW)**
january	104.16			
february	112.51			
march	131.62			
april	148.92			
May	140.22			
june	129.12			
july	138.18			
august	130.18			
september	139.32			
october	120.21			
november	119.16			
december	108.22			
		126.81	12680	12.81

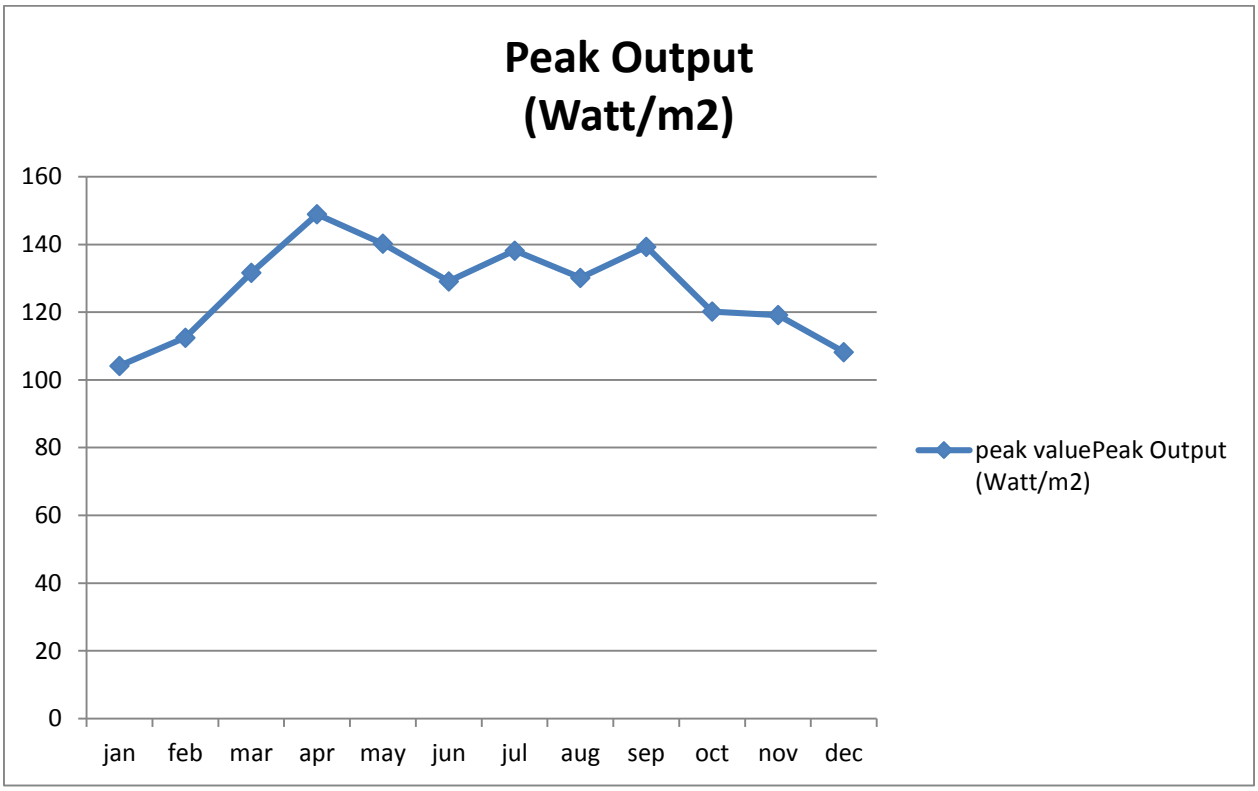

Figure 4: peak energy value output

Day time variations of different months (may2016-April 2017) were showing in the graph. For only representation purposes, day time variation for the month of April 2017 is shown (Figure 1).

Daily and monthly energy outputs graphs are also in (Figure 2). Energy outputs of day time, monthly base and yearly based were calculated (Table 3). Peak values are used for the different months and supposed plant capacity was shown in (Table 4). Monthly peak variations were also drawn in Figure 3.

Solar photovoltaic generation potential during the period may 2016-April 2017 was recorded for Rohtak district of Haryana. In month of December lowest production is recorded. Month of July and August solar rays levels were also recorded variable due to rain and other factors. Above said outputs were calculated on the 120m2 roof top area. An estimate of the possible plant was made on the basic of monthly peak values and average peak values recorded.

System Design

Roof top grid connected solar PV systems can be designing based on the various routes i.e say it may be with battery storage or without battery storage, with electric generator synchronization o or without electric generator, etc[7-8]. Because of short life of batteries, heavy replacement cost and costly installation and commissioning process, batteries are not used in this system. However, a electric generator is used in the system. Net metering arrangement is done with the uttar Haryana bijli vitran nigam limited (state discom).

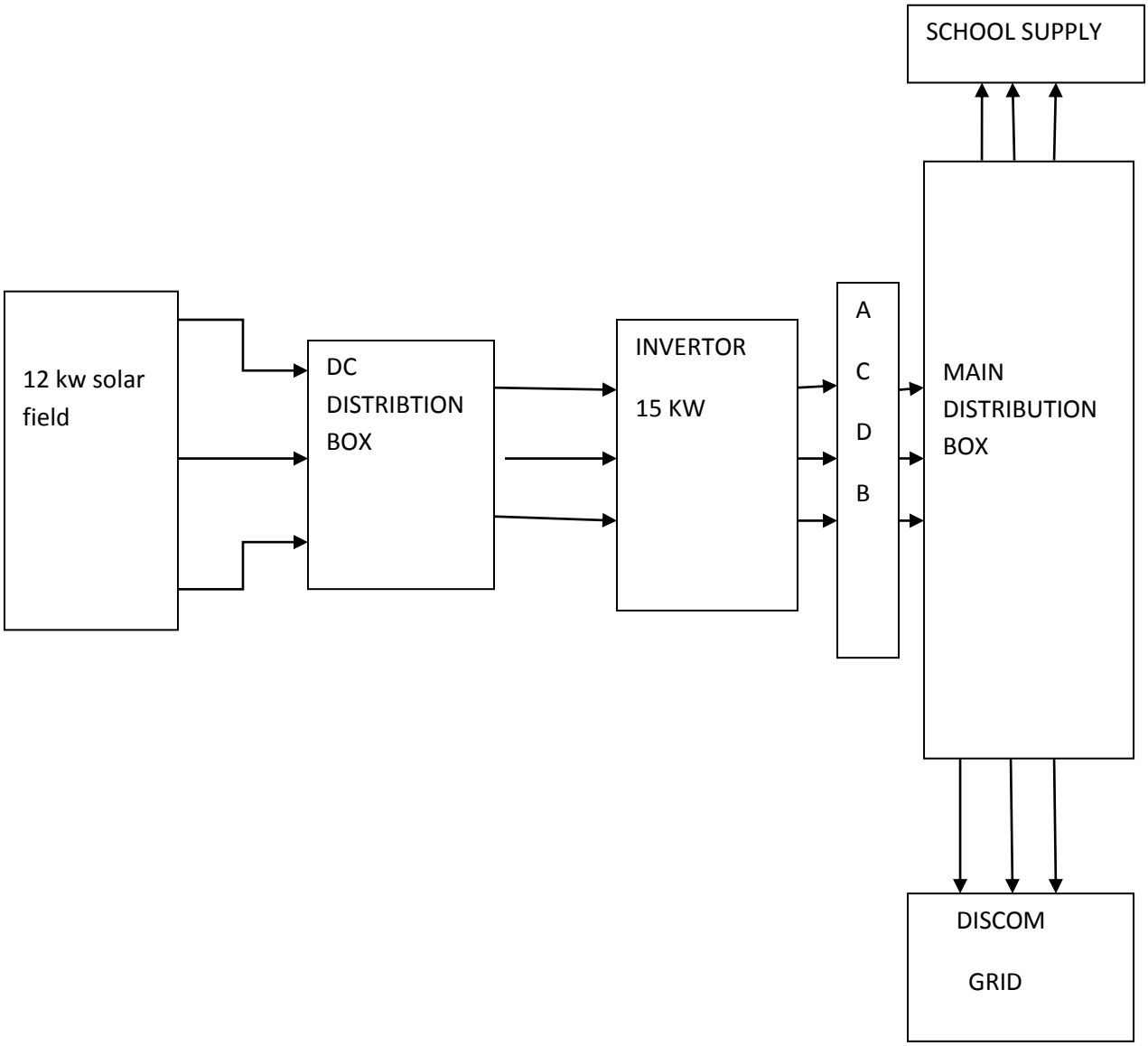

Figure 4: 12 KWp Grid Connected Solar Photovoltaic Power Plant

In the net metering system the incoming (from the discom grid) and outgoing electric power (from the solar grid) is recorded. From the solar rays results obtained, a 12 KWp solar photovoltaic roof top power plant can be Designed on a 120 m2 area. In the system we use tata solar power made pv modules of 315 watt[9-10],39 no. of pv modules are used(315*39=12285 watt) each pv module containing 72 cell with power rating from 315 to 316 watt. These 39 PV modules can be designed within a 120 m2 area. To ensure appropriate voltage output there are 3 parallel array are made. Each array is designed with 13 modules in sires and all three series are connected to dc distribution board with three surge protection devices and fuse safety. finally from DCDB three dc outputs are finally feed to mppt type delta make inverter of 15 kw capacity .Inverter which converts direct current to alternating current. After the inverter AC current is feeds into the ACDB (AC distribution box) with mccb safety switches with surge protection devices and RYB indicators. Next step is to feed the supply from ACDB to main electric distribution board of school with MCCB protection switch and further to the grid. All the above components together make the complete layout of the system.

System instrumentation

The system instrumentation and specifications for 12 KW power plant is divided into following

Grid Specification: The conventional electricity source i.e grid available to the school having the following rating:-

1) Number of phases- Three phase supply
2) Voltage rating -400 VOLT AC
3) Frequency-50Hz

Solar field: the solar field having the solar power modules, mounting structure wires layout, earthlings connections, lighting arrestors upvc pipes for wires covering etc. are shown in the actual site photographs and specifications in the given table:

Solar field	
Plant Capacity Voltage Output 240 Volts dc	12.81 KW
Current Output	26.24 A dc
No. of Modules	39 nos.
Area	120m2
Solar Panel Specification	
Watt	315 Watt
Voltage	40 Volts
Current	8.519A
Type	Polycrystalline
Efficiency	16.27-17.84%
Temperature	25 deg c
Voc	45.49 V
Isc	9.11 A
Rs	.0590 ohm
Rsh	86.27 ohm
P max	315.67
V pm	37.056 v
Ipm	8.519 A
FF	0.762

Inverter and protection devices: The inverter and protection devices are placed below the structure or inside the building or under shed for better practice as shown in photograph some specification[11] about the inverter and protection devices are given in the table below:

Inverter Specification

KVA rating	15 KVA
Input DC voltage	550-650v
Input current (DC)	26.58 A dc
Output voltage(AC)	15.50 kva
No. of Phases	Three
Power factor	0.9992
Type	MPPT type(2 mppt slot each having two dc input support)
Efficiency	Almost 97-98%
Total harmonic distortion	< 2%

Protection	
Protective device	400 Volts under voltage relay
DC Distribution box	
DCDB	3 in 3 out(with 3 surge protection device)
AC Distribution box	
ACDB	32mccb,surge protection device with RCB indicator.
Mounting structure	
Material	Hot dipped G.I structure
Nut bolt	Stainless steal
Air tolerance limit	Up to 130 km /h
Others –Dc wires(4 sq mm),UPVC piping, Copper lighting arrestors,17 mm diameter copper plated earthling rod	

CONCLUSIONS

Grid connected Solar PV power plant generation potential recorded during may 2016-April 2017 was assessed for the rohtak district of Haryana It was discovered that the month of December produced the lowest solar radiation. Monthly and each year outputs were calculated on the foundation of one hundred twenty m2 area. Considering the monthly peaks, the average height output was calculated and an estimate of the possible plant ranking used to be made. The methodology adopted looks high-quality for finding out the possible plant ability for an arbitrarily chosen area. The graph described is primarily based on the solar radiation measured. System sizing and specs are provided primarily based on the sketch made

FUTURE SCOPE

In future we study of the system with battery bank and cost analysis of the system will done. Also we will study about the modules performance before and after cleaning and its effects on overall power plant performance.

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