DESIGNING OF ON-GRID SOLAR PV SYSTEM IN AN INSTITUTIONAL CAMPUS AT HYDERABAD

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Abstract - *The demand for electricity is peaking. At the same time the conventional energy sources are depleting. To bridge the gap between the increasing demand and production some energy resources need to be exploited. Renewable energy resources seem to be the best solution. Solar energy has its importance in such a scenario because it is a clean, environmental-friendly, and infinite source of energy. The solar photovoltaic systems are often classified into off-grid and on-grid systems. The yield of a solar photovoltaic system depends on various factors like irradiation, temperature etc. Evaluation of the system is very important for the characterization of the existing problems and future improvements. This paper involves the design of ON-GRID solar power generation in NAWAB SHAH ALAM KHAN COLLEGE OF ENGINEERING AND TECHNOLOGY for working with various institutional machines, appliances etc. The completion of this process depends on various factors like geographical location of institution, weather condition etc. This paper gives a complete procedure for specifying each component of the ON-Grid solar power generation system for the institution. Furthermore, installation cost and return on investment (ROI) also carried out. Promotion of ON-Grid solar PV plants in the educational institutes would help in reducing their energy consumption bills and ensure a continuous supply of electricity.*

Key Words: **ON-Grid solar PV system, electricity, solar panels, NSAKCET, solar power, Hyderabad**

1. INTRODUCTION

Now a day's production of electricity Is highly in demand. Because conventional energy sources such as coal, fossil fuel, nuclear are on the verge of exhausting. So, it becomes necessary to install Non-conventional energy sources such as solar energy, biomass energy, hydro-power, geothermal energy. But solar energy is most appropriate for the schools, colleges, institutes, and as well as the agricultural areas. The advantage of Non-conventional energy over conventional energy is it does not release greenhouse gases which are harmful for humans and the environment as it damages the ozone layer. This paper involves the design of the ON-Grid solar power plant in an institute (NSAKCET) located in Hyderabad city, Telangana, India. Where India is blessed with enough sunshine which can meet our requirement of demand for electricity.

In India Solar power generation is a fast-developing industry. At the ending of September 2019 India installed around 35% of total electricity generation capacity in-country, but the country is aiming for an even more pioneering target of 57% of total electricity generation capacity by the end of 2027 with renewable energy sources. According to the blueprint, India is aiming to install around 275 GW from renewable energy sources by the end of 2027.

Electricity generation

In December 2019 solar energy generation was 3.93 TWh out of 98.76 TWh of total generation capacity in India

YEAR	SOLAR POWER GENERATION (TWh)
2013-14	3.35
2014-15	4.60
2015-16	7.45
2016-17	12.09
2017-18	25.87
2018-19	39.27
2019-20	49.45

Table -1: Annual Solar Power Generation in India

Before presenting the results and analysis of this case study, we have given introduction of different components of a ON-Grid solar PV system and their functions are given below.
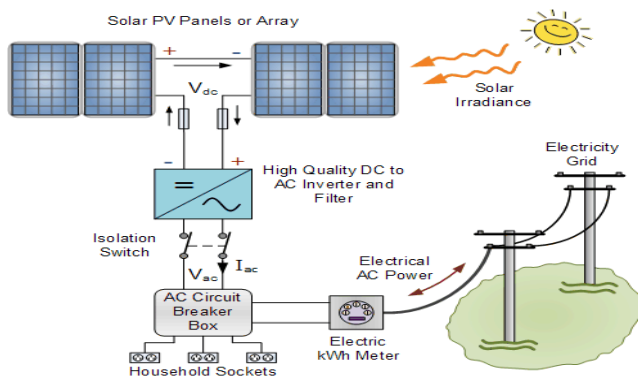
2. ON-Grid solar photovoltaic system

This ON-Grid solar PV system is connected to the utility grid. In this if excess power is generated it is fed to the grid when the power isn't sufficient, the load capacity is served by drawing the power from the grid. It is comparatively cheaper than the OFF-Grid solar system because the battery is not included in it. The major components in a standard grid-connected PV system are

1) PV Module / Panel
2) Module Mounting Structure
3) Cables
4) Array Junction Box
5) Solar Grid connect Inverter

6) AC Distribution Box
7) Earthing Kit & Lightning Arrestor

Fig -1: Interconnection of Components of a Typical ON-Grid Solar PV Power System

We have given a brief review of the functioning of the components

2.1 PV module

A solar panel is also called a solar module, photovoltaic module or photovoltaic panel. A stack of PV cells forms a solar panel or PV module. These cells use sunlight as a source of energy and produce direct current electricity. In this solar panel array are connected in series to are made in series to achieve desired output voltage and/or parallel to achieve desired current. These solar panels range from 30 to 400 watts. The efficiency of a solar panel ranges between 15% to 20%, only a high-quality solar panel can exceed up to 22%. A single solar cell only produces about 0.5 volts.

Fig -2: Solar Panels

2.2 Structure

The intensity of sunlight will be maximum utilized when incident irradiation is perpendicular to solar panels, hence tilt of the panels is an important design parameter, the panels are tilted at an angle according to the site location. This structure will be made of galvanized mild steel/aluminum-based on-site soil and wind load parameters. The number of Array frames will be provided based on the

design and site requirements. These array frames are corrosion-free

Fig -3: Structure for the Solar Panel

2.2 Inverter

Inverter is an essential component in the PV solar system. It is used to convert direct current (DC) current to alternating current (AC). This output current from the inverter will be fed to the AC distribution Board.

Fig -4: String Inverter

2.3 Balance of the System Components

Components such as Cables, Array Junction Box, AC Distribution Box, Earthing Kit, and Lightning Arrestor are known as balance of the system components, these components play a vital role in the protection of solar PV system. And an appropriate cable size should be chosen such that to minimize voltage drop.

3. Methodology of PV system design

The designing of ON-Grid solar PV system is done with following steps: -
Step-1: selection of site
Step-2: study of building load requirement
Step-3: choose of system components
Step-3: determine the capacity of inverter
Step-4: select the size of the cable
Step-5: design of solar panel array
Step-6: cost analysis of the system
Step-7: calculation of return of investment (ROI)

➤ **Site Selection**

Before installing solar rooftop system, the following factors need to be considered such as: -

- ✓ Availability of sufficient rooftop space
- ✓ No obstacles should be present at the rooftop
- ✓ Rooftop should withstand the load of solar panels and the structure
- ✓ Should be transportation feasible

➤ **About Hyderabad District**

Hyderabad is located on the southern side of the Telangana state. The latitude and longitude coordinates of Hyderabad are 17.35 and 78.45. The highest temperature in the district reaches about 45.5°C and the lowest temperature decreases by about 7°C

➤ **Annual average solar irradiance in Hyderabad**

- ✓ Average direct normal irradiance 5.27 kWh/m2/day
- ✓ Average global horizontal irradiance 5.77 kWh/m2/day

➤ **Direct Normal Irradiance**

Monthly Average	
JAN	6.18
FEB	6.71
MAR	5.85
ARP	5.70
MAY	6.21
JUN	3.99
JUL	2.98
AUG	3.18
SEP	4.46
OCT	5.34
NOV	6.37
DEC	6.42

Table -2: Monthly Average of Direct Normal Irradiance [4]

➤ **Global Horizontal Irradiance**

Monthly Average	
JAN	5.28
FEB	6.10
MAR	6.59
ARP	6.90
MAY	6.97
JUN	5.73
JUL	5.19
AUG	5.13
SEP	5.51
OCT	5.46

NOV	5.31
DEC	5.11

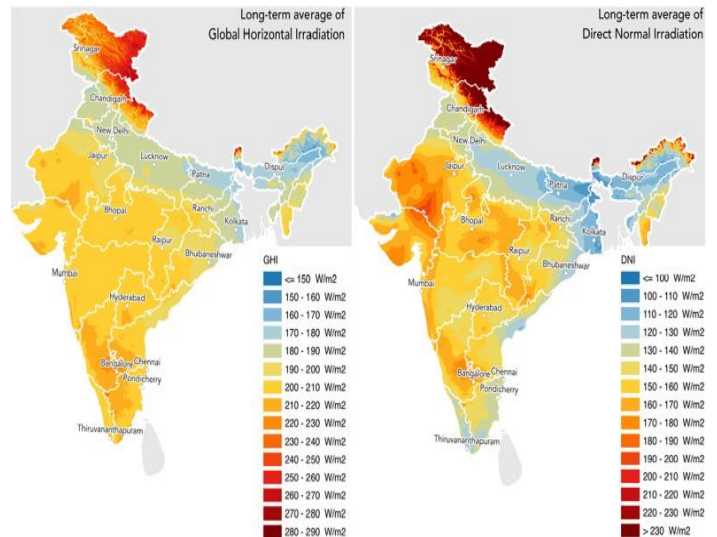**Table -3:** Monthly Average of Global Horizontal Irradiance [4]

Fig -5: Long-term Average of Global Horizontal and Direct Normal Irradiance [5]

4. Proposed Calculations

According to average total electric load (Watt hour per day) of the campus; -

- Total Load of Fans = No. x Hours x Wattage

Total Load of Fans = 440 x 6 x 50 = 132000 Wh/Day

- Total Load of Tube Lights=No. x Hours x Wattage

Total Load of Tube Lights = 640 x 1 x 18 = 11520 Wh/Day

- Total Load of AC = No. x Hours x Wattage

Total Load of AC=2 x 1 x 1732 = 3464 Wh/Day

- Total Load of Computers = No. x Hours x Wattage

Total Load of Computers = 500 x 2 x 100 = 100000 Wh/Day

- Total Load of Machines in The Campus = 1000 Wh/Day

Average Total Electric Load

= 132000+11520+3464+100000+1000

= 247984-Watt Hour Per Day = 248 Kwh/Day (Approx.)

To Calculate the Size of the Solar System

- Average Peak Sunshine Hours=Daily Sunshine Hours in Summer + Winter + Monsoon/3
- Daily Kwh/Peak Sunshine Hours = Size of The Solar Panel

  284/4=62 Kw

- Therefore, Size of The System Is 62 Kw That Is 62000 Watts

Area Required to Install 62 Kw Solar Plant

- As per the guideline of solar energy 1kw solar plant required 10 sq. meter area

- So, for 62kw power plant we required = 62 x 10
  =620 sq. meters
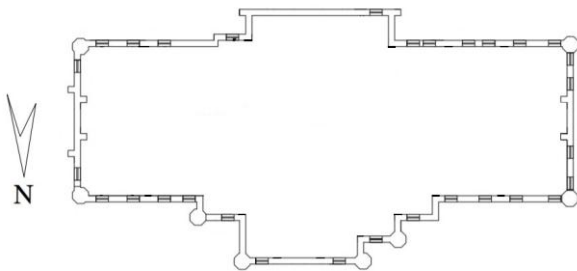
Existing Rooftop Plan
Block-A 937.98 Sq. Mts.

Fig -6: Design of Admin Block

- We have the rooftop area of 937.98 Sq. mts in Admin block with no obstacles around so, it would be appropriate to install 62 KW solar power plant in Admin block.

To Calculate Solar Panels Needed / Array of Solar Panel

- If we use 330 watts, 24volt in series-parallel type connection.
- In series-parallel connection both current and voltage increases.
- No. of String of Solar Panel (Watt) = Size of Solar Panel/Capacity of Each Panel
- No. of Solar Panel in Each String = Solar System Volt/Each Solar Panel Volt
- Total No. of Solar Panel = No. of String of Solar Panel x No. of Solar Panels in Each String

Calculation Electrical Load to Find Size of the Inverter

- Load of Fan = No. x Watt

Load of Fan = 445 x 50 = 22250 Watt

- Load of Tube Light = No. x Watt

Load of Tube Light = 640 x 18 = 11520 Watt

- Load of AC = No. x Watt

Load of AC = 2 x 1732 = 3464 Watt

- Load of Computer = No. x Watt

Load of Computer=500 x 100 = 50000 Watt

- Load of Machines in Campus = 1000Watt

Total Electrical Load

= 22250+11520+3464+50000+1000=88234 Watt

To calculate size of the inverter

- Total Electrical Load in VA = Watts/P. F
- Size of Inverter = Total Load x Correction Factor/Efficiency
  Therefore, Correction Factor=1.2

5. Cost of Plant

Equipment's	Quantity	Price (Rs.)
Polycrystalline Solar Panel (330 W)	188 X 7260	13,64,880/-
String Inverter (60 KW)	1	2,30,000/-
Structure Mounting, System Accessories and Service Charges		10,09,120/-
Transportation and Handling	1	20,000/-
TSSPDCL Net Metering Application	1	30,000/-
GST Charges on Equipment And services		2,31,756/-
Total		28,85,756/-

Table -3: Cost Analysis of the Solar Power Plant

- Total cost of the plant = 28,85,756 Rs. (Including 3 years annual maintenance)

Payback Period of the System

- ✓ Total Cost of the Plant = 28,85,756 Rs.
- ✓ Plant Capacity = 62 Kw

Generation Per Day = 62 x 4(average peak sunshine hours)
= 248Kwh/day (Units per day)

Monthly Generation = 248 x 30
= 7440Kwh/month (Units per Month)

- ✓ So, Average Monthly Bill Can Be Saving Every Month is Rs. 74,400
- ✓ Annual saving = 74,400 x 12
  = 8,92,800 Rs.
- ✓ Subsidy for Plant Installation = 0 Rs.

Because, No Subsidy for Commercial Projects in Telangana.
So,

- ✓ Payback Period= (Total Cost- Subsidy)/Annual Saving
  = (28,85,756- 0)/8,92,800
  =3.23 Years

6. CONCLUSIONS

The main purpose of this paper was to design an ON-Grid solar power system with the help of solar irradiance data of Hyderabad. In this paper, calculations are done to determine the size of the solar plant required (62 kW), the area required to install the solar system (620 sq. meters) and cost of installation of the solar plant for Nawab Shah Alam Khan College Of Engineering And Technology (NSAKCET), Hyderabad to meet the electricity requirement of the college

and to ensure the continuous supply of electricity in the campus.

From the work presented we may conclude that a total of 188 solar panels of 330 W are needed in a 62-kW capacity solar power plant, to generate about 248 units/Day (Kw/Day), monthly 7440 units are generated, so total money saved from the electricity bill is 74,400 Rs. Per month. The total cost of the plant is 28,85,756 Rs. The payback period of the plant is about 3.23 years with this it is clear that the initial cost is more but the payback period is less. The life span of the solar system is about 25 years as claimed by the manufacturing company. By installing a solar system in NSAKCET the college can meet their requirement of electricity demand with low maintenance and high benefits.

ACKNOWLEDGEMENT

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