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DESIGN OF ROOF-TOP SOLAR PANEL SYSTEM FOR RIT CAMPUS

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***Abstract*— Application of solar photovoltaic (PV) system has increased on a large scale & is becoming interesting to researchers, investors and policymakers. Main objective of this study is to present Design of roof-top solar panel system of 300 KW for RIT campus. For this project fixed mounted PV panels are used. At present institute is using utility power and diesel generator to backup power. In this paper, net metering system is studied for design the capacity of solar panel system. Shadow analysis is performed to utilize maximum available solar energy, fixing location of building roof and spacing between the two rows of solar panel for installing rooftop solar panel system. Orientation of building is considered to fix the horizontal angle of solar panel with roof. Also the study of electricity requirement of institute and generation of proposed electricity through solar power of capacity 300 KW in terms of Kwh per year is done in this paper. It is found by project feasibility analysis that RIT campus will save up to 40 % electricity cost per year.**

Keywords- PVmodules,Netmetering,Shadow analysis,Orientation of building.

I. Introduction

In today's condition, we see vice versa phenomenon about use of conventional energy i.e. available natural resources of conventional energy are reducing very fast and consumption is increasing rapidly. Generation of conventional energy requires use of coal, fossil fuel etc. As we know availability of such resources is limited, so fulfillment of energy required for nation, we have to think about renewable energy sources. Solar energy is a source available as renewable energy which is free of cost and available in large extent. It also helps to reduce pollution and global warming effect [2].

In India compound annual growth rate of electricity charges is about 8.6 % [7]. As we move from developing country to developed country, the consumption of electricity also increases. Considering the increase in consumption of electricity and cost of electricity per unit per year, we need to focus on renewable energy.

Nowadays government is focusing on renewable energy, providing required help to renewable energy sector for generation of electricity. The government is giving incentives and relaxation in taxes under the schemes of renewable energy sector. Use of solar energy in educational institutions also increases awareness of renewable energy in students as well as society.

II. Functional Description of key component of solar panel system

Following figure shows key component of solar panel system

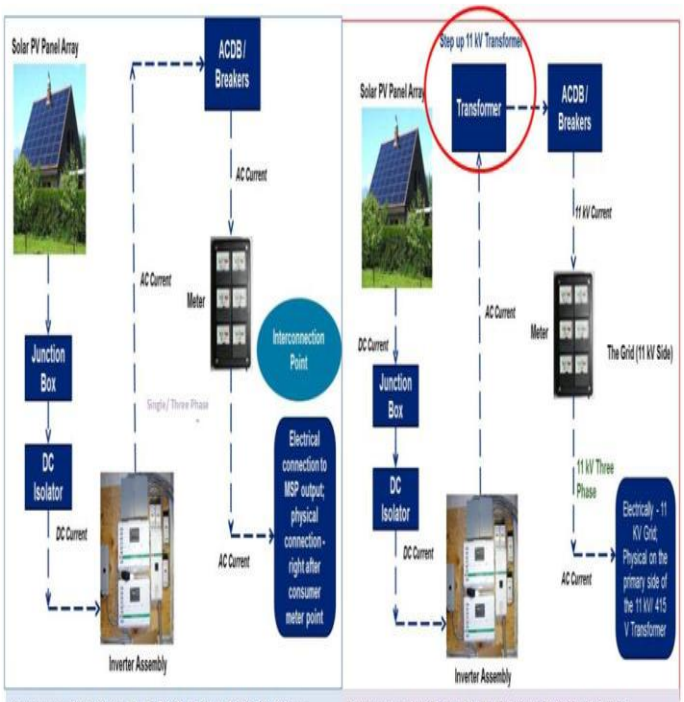

Figure: Interconnection Schemes

Key component of solar panel system

Solar Panel – A solar panel (photovoltaic module) is photovoltaic cell, it uses solar photovoltaic as component of a rooftop panel system to generate Direct Current electricity. Solar panels are connected together. Solar panel is graded by its DC output power and ranges between 100 - 350 watts. We have selected 320 watts panels for our system.

Junction box - An electrical junction box is a connecting box for solar Photovoltaic modules for electrical connections. With consideration of environmental safety rule it should be IP65.

Inverter (Power Conditioning Unit) - The Power Conditioning Units (PCU) used in grid connects PV system to Normal meter system consists of an Inverter and other electronics devices such as remote monitoring. The inverter is the most important part of the PV system. It works as the interface between the PV panels and Grid system. PV panels output varies with the solar radiation. The maximum variation done by the PCU is as follows:

- *Change the incoming Direct current received from PV modules into Alernate current with available power quality.*
- The inverter work as a protective device for the system. It should trip in the case voltage, current or frequencies is increases more than acceptable range.
- Our solar power system capacity is 300 kw & capacity of inverters available in market are 33 kw & 60 kw. So we selected 5 No. of 60 kw each inveter.

Manual/Automatic disconnect switch - It is an automatically operated electrical switch designed to protect an electrical circuit from overload & short circuit.Step-up transformers – The output from the inverters require a step-up in voltage to reach the AC voltage level. This is used in the case with PV power plant installation, where the Low Tension (LT) infrastructure cannot handle the amount of power which get generated by the rooftop plant. The step up transformer receive the output from the inverter to the required 11 kV grid voltage. Substation in the RIT campus is used for grid connection.

III. Research Methodology

Design the Roof top solar panel system with a capacity of 300 kw for RIT campus.

The parameters considered are,

a. area of roof top required to generate 300 kwp
b. Shadow analysis for calculation of effective area to install solar panel along spacing between solar panel.
c. Building orientation to fix the position of solar panel in order to utilize maximum solar energy.
d. Calculate the electricity generated per solar panel per year and cumulative electricity generated by total number of solar panels.
e. Total electricity per year through solar panel system.
f. Total electricity consumed by RIT per year as per previous
electricity bill.
g. Calculate % saving per year in electricity bill.

IV. Feasibility analysis of solar panel system

Before going to install & design capacity of solar panel system, we have to analyze the site. Two types of analysis are carried out to fix position of solar panel along with its orientation.

Following are types of analysis

1. Shadow analysis
2. Building Orientation analysis

1. Shadow analysis

Shadow analysis is most essential step in phase of analysis of solar panel system. It plays an important role for design of solar panel system as well as maximizes the solar rays on the solar panels. Formula given below which help to calculate shadow length made by surrounding obstacle.

[Equ 1] L= h /tan (α)

L = horizontal shadow distance
h = height of object
α = sun elevation angle
α = 90º + latitude of site- declination angle

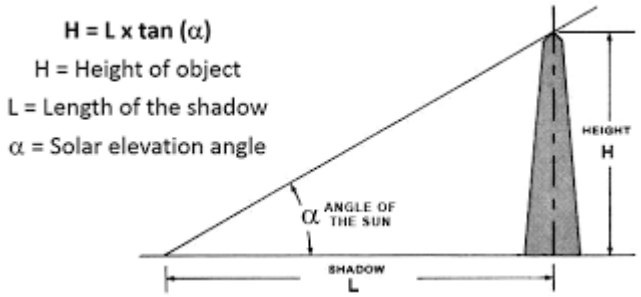

Fig No.1 Shadow analysis

For RIT campus,
Calculate Shadow Length (L)
Data =
Location of site = 17.06°N, 74.28°E
Height of object = 1 m
Sun elevation angle = 49.44 º
L= 1 / tan (49.44º)
L = 0.85 m

For RIT campus, if height of object is 1m then horizontal distance of solar panel should be 0.85 m from the object to null the shading effect.

2. Building Orientation

Building orientation plays important role in the capacity of solar system. Building orientation helps to fix the position of solar panel system. If Building orientation is perpendicular to true N-S direction then capacity of solar system is maximum. With increase in angle of building with true meridian, decreases in the capacity of solar panel system.

For RIT campus,
Case I Building Orientation = 30º with true meridian

Dept. of Mechanical Engg.

Department	**Capacity of Roof top solar system (No. of module)**
Mechanical	53.44 kw (167)

Case II Building orientation = 0º with true meridian (Ideal consideration)

Dept. of Mechanical Engg.

Department	**Capacity of Roof top solar system (No. of module)**
Mechanical	98.56 kw (308)

V. Net metering system & Capacity of solar PV System

Net metering system is scheme regulated by the MSEDCL to enhance the solar panel system in state of Maharashtra. Under this scheme consumer has right to install solar panel system of specified limit for net metering system. These schemes mention the criteria for eligible consumer and their permitted capacity. Capacity of solar system is depend up to the permissible load (Kw) of

individual consumer or institute. Maximum permissible capacity of solar panel system is 40% DTC of consumer.

Net Meter means electricity supply code which is capable of recording the import and export of electricity. The meter installed by the MSEDCL to measure the electricity generated by solar panel system as well as consumed by the consumer.

Capacity of solar PV System

1. Capacity of solar panel system for net metering system depends on sanction load for eligible consumer.
2. For RIT campus Sanction load = 685 KW
3. Capacity of solar panel system = 40% of sanction load or 40% of DTC transformer (**Net Metering system)**
   10% variation is allowed in capacity by MSEDCL
4. Capacity of solar panel system = 300 KW

Area required for solar panel system

- For 1 kw generation of electricity through solar panel system = 10 sq.m
- Total capacity of solar panel system = 300 KW
- Total area required for solar panel system
  = 300X 10
  = 3000 Sq.M

Area Available at RIT campus

Table No.1: Roof top area available at RIT campus

Department	Rooftop area (Sq.M)
Mechanical building	700
Electrical Dept.	700
ETC Dept.	140
MBA	930
Doncharya Hostel	356
Guest House	400
Ladies Hostel	372
Total Available Area	3598

VI. Design of rooftop solar panel system

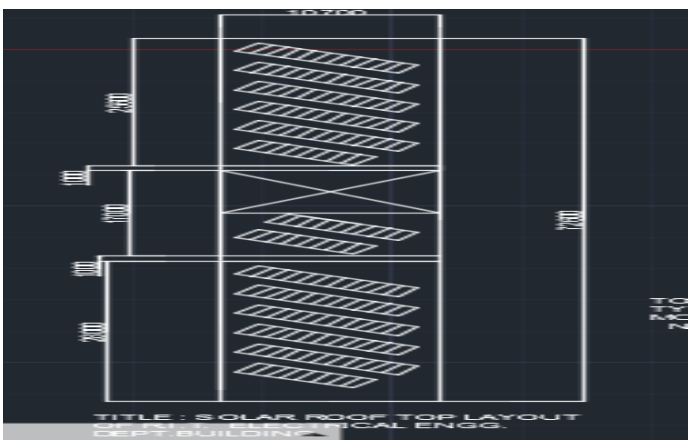

Fig No1.Solar panel rooftop Layout of electrical Engg.Dept

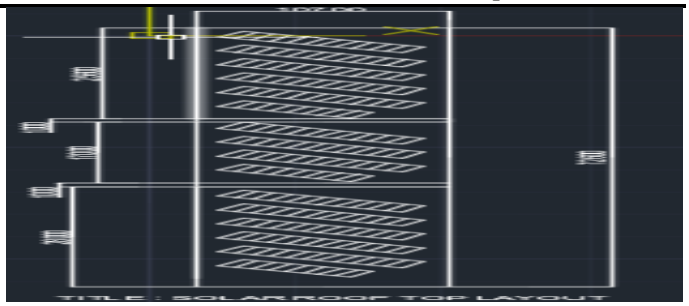

Fig No 2.Solar panel rooftop Layout of Mechanical Engg.Dept

VII. Calculation of electricity generation of 300 KW roof top solar panel system

Data-

- Location of site = 17.06°N,74.28°E
- Annual solar radiation[1]= 1,879 KWh/sq.m
- Solar panel size = 1.99 X0.995 M
- Capacity of solar panel system = 300 KW

1. Number of solar panel = capacity of solar panel/
   Peak watt efficiency of solar panel
   = 300 X1000/320
   No. of solar panel = 938

2. Total solar panel area= No.of solar panel X solar panel area
   = 938 X 1.98
   = 1,857 Sq.m

3. Total radiation falling on solar plant = Total solar area
   X Solar radiation
   = 1857 X 1879
   = 34,89,303 Kwh

4. D.C. calculation = 15 % of total radiation on solar plant
   = 15% X 34,89,303
   = 5, 23,395Kwh/per year

5. A.C. calculation = 80% of D.C.
   = 80% X 5, 23,395

Total generation of electricity per year = 4,18,326 Kwh/per year

1. (National renewable energy of India)

Table No.2: 5 year saving statement for RIT

Description	Unit	Year 1	Year 2	Year 3	Year 4	Year 5
Solar capacity	Kwp	300	297	294	291	288
Effective CUF	%	15	15	15	15	15
RIT Annual consumption	Kwh (Lakh)	7.46	7.46	7.46	7.46	7.46
Annual Generation	Kwh Lakh	4.18	4.14	4.10	4.05	4.01
Import of electricity	Kwh (Lakh)	3.28	3.32	3.36	3.40	3.44
Saving per unit	Kwh	6.07	6.07	6.07	6.07	6.07
Annual saving	In Rs (Lakh)	25.22	25.19	24.9	24.80	24.60

VIII. Total cost of solar project For RIT campus

Table No.3: Total cost of 300 KW roof Top panel system

Sr. No.	Description	Quantity	Cost
1	Solar panels 320	937	85,02,760
2	Mounting structure	15 tons	40,00,000
3	Inverter	5	22,25,0000
4	AC distribution box	5	80,000
5	Cables	3300 M	3,93,800
6	Lighting arrester	5	1,20,000
7	Electrification charges	Lumsum	2,42,500
8	Labour charges with R.C.C. block	Lumsum	10,00,000
9	**Total cost of solar panel system**	**=**	**1,65,64,060**

SECI (solar Energy Corporation of India) Scheme Subsidy for rooftop solar panel system

Solar Energy Corporation of India, a company form by ministry of new and renewable energy government of India to enhance solar energy in India, launched a scheme to provide subsidy to developers for installing rooftop on educational institutes and hospitals.

Total cost of solar panel system reducing subsidy= total cost of project – subsidy per kwp X capacity of solar panel system

Total cost of solar panel system for RIT campus

= 1,65,64,060-18300X300

= Rs.1,10,74,060

Conclusion

- Total investment for 300 KW solar panel system is Rs.1,10,74,060.
- Roof top Area required for rooftop panel system increases with increase in angle of building with true meridian.
- Solar panels facing are south and erected at an angle of 30° with building roof and spacing between the solar panel rows are 2.5 M.
- Rooftop panel system save the cost of electricity for RIT campus is 40% per year.

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