Investigation of Solar Energy Prospective in India using Photovoltaic Cells on Rooftops

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Abstract— **Solar energy is available abundantly over most part of India in abundance. It is available in many parts of the country for more than 250 days of the year. Solar energy is emission free and environment friendly. The present work is to estimate the potential of solar energy by installing photovoltaic cells on the rooftops of the residential houses. Rooftop photovoltaic cells will solve the problem of open land needed for solar thermal power plants. 90 TWh of energy can be generated from rooftop photovoltaic cells if installed on 60% of the residential houses. 61.61% of the domestic energy needs can be fulfilled from the energy generated by rooftop photovoltaic cells installed on 60% of the houses.**

Keywords- Solar Energy, Photovoltaic Cells, Renewable energy, Solar Thermal Power.

I. INTRODUCTION

Annually around 5,000 trillion kWh of solar energy is incident over India's land area with most parts receiving 4-7 kWh/m^2 per day [1]. Adequate solar radiation is available over many parts of the country for more than 250 days during the year [3]. Solar energy is environment friendly as it has zero emissions. It is the most secure source of energy as it is available abundantly throughout the year and is renewable. Theoretically, only a small fraction of the total incident solar energy can meet the entire country's power requirements. Capturing solar energy typically requires equipment with a relatively high initial capital cost. However, over the lifetime of the solar equipment, these systems can prove to be cost-competitive, as compared to conventional energy technologies. The payback period for the domestic consumer is from 2 to 3 years only and the payback period goes on decreasing for high capacity system used by commercial consumers [2]. India's energy demand is expected to increase by 9% annually. To meet this increasing demand of energy solar energy can be utilized. Potential of electric energy generation from solar radiations with respect to area is almost 20 MW/ sq.km [4]. The electricity consumption in India by various sectors is given in Fig. 1 [7]. The total consumption of electricity in India is 612.644 TWh; the domestic consumption of electricity is about 146.080 TWh annually. The major part of this electricity is generated from coal based thermal power plants which are not environment friendly. In the present work an effort has been made to estimate the potential of solar energy in India by installing photovoltaic cells on the rooftops. The main focus of the present analysis is on domestic sector.

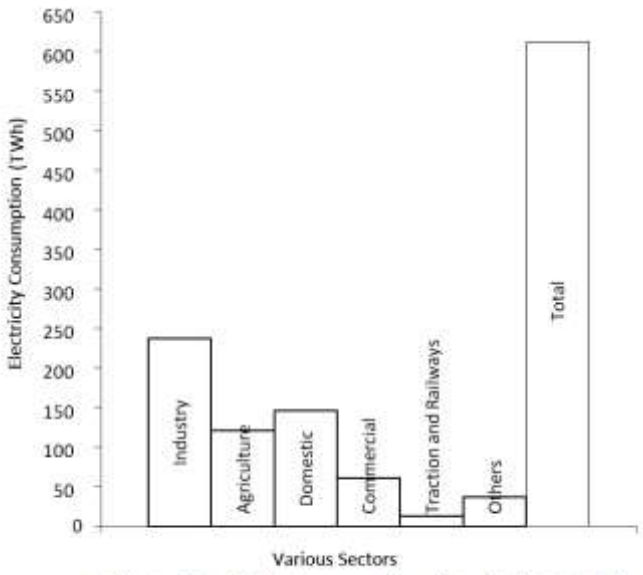

Fig. 1. Electricity Consumption in India (2009-10)

II. UTILIZING SOLAR ENERGY

Solar energy can be utilized directly via the thermal and photovoltaic routes as explained below: -

A. Solar Thermal Power

Electricity can be generated in solar thermal power plants by using concentrating collectors to collect the sun's energy at high temperatures and use this energy to generate high-pressure steam which can be used in a conventional Rankine cycle to generate electricity. Under the Jawaharlal Nehru National Solar Mission there are plans to have an installed capacity around 10,000 MW by 2022 [6]. The major obstacle is the initial cost of such plants which is estimated to be around Rs. 15 crores /MW. The Government is offering attractive feed-in tariffs over a period of many years to cover up for this disadvantage. The other obstacle is availability of open land. At least 3–4 ha would be required per megawatt of installed capacity of such plant [3]. Acquiring the land may not be an easy task in most states therefore the total potential for generating electrical power through solar thermal power plants in India is limited.

B. Photovoltaic Converted Power

Photovoltaic conversion is the other direct method of utilizing solar energy. Current production of photovoltaic modules in India is around 100 MW, with a major part being exported. The current cost is high and is about US$ 4–5/peak watt [3]. Manufacturers provide guarantee from 10 to 20 years on photovoltaic modules in the market, while many of these shall provide over 30 years of useful life. The photovoltaic's cost effectiveness increases with the distance of the location from the main power grid lines. A major part of this requirement could eventually come from photovoltaic systems

which are not connected to the grid. These plants would also require about 4 ha/MW. It is also stated that high initial costs will not be a barrier in the long run. However, it is fairly clear that the real issue is the availability of open land so instead rooftops of the houses can be used to install photovoltaic cells.

C. *Photovoltaic Cell*

The photovoltaic cell is based on the photovoltaic effect. The photovoltaic effect is the creation of voltage or electric current in a material upon exposure to light. In the photovoltaic effect the electrons are transferred between different bands (i.e., from the valence to conduction bands) within the material, resulting in the buildup of voltage between two electrodes. In most photovoltaic applications the radiation is sunlight. In the case of a p-n junction solar cell (Fig. 2.), illuminating the material creates an electric current as excited electrons and the remaining holes are swept in different directions by the built-in electric field of the depletion region. The solar cells can be joined in series or parallel to get the desired voltage or current.

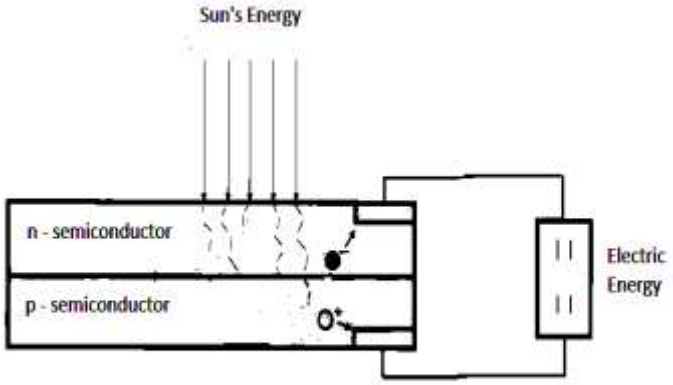

Fig. 2. Photovoltaic Cell

D. *Photo Methods Used voltaic Cell*

The estimate of solar power which can be generated by installing photovoltaic cells on rooftops of houses in India is based on the formula given below: -

Power (in TWh) = f * p * N * P_{pv} * H

Where:

f = Annual load factor of cell = 0.2 [3]

p = Power developed on each rooftop assuming area utilized on each rooftop 1 sq. m. = 0.4 kW

N = Number of residence houses in India (computed from census data) = 215480955 [5]

P_{pv} = Percentage of photovoltaic cells installed houses.

H = Number of hours in a year. = 8760

Percentage of residential houses installed with photovoltaic is limited to 60% considering constraints like financial condition of the owner or strength of the house etc.

III. Results and Discussion

Electric power generation using rooftop photovoltaic cells is shown in Fig. 3. If 60% of houses in India are installed with rooftop photovoltaic cells then about 61.61 % of total energy needed for domestic sector can be generated from these cells.

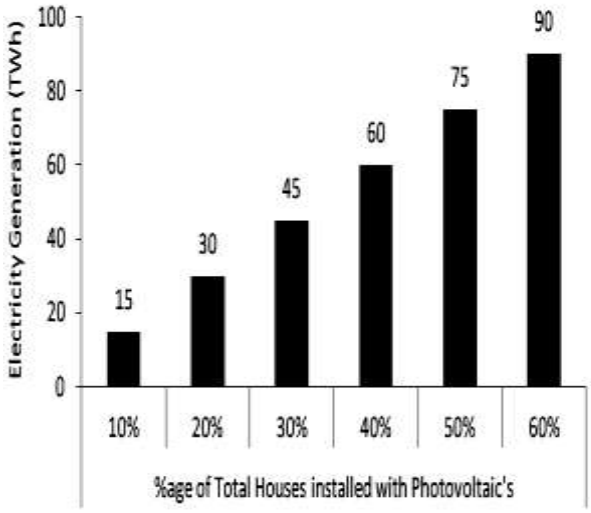

Fig. 3. Estimate of Electricity Generation using Rooftop Photovoltaic Cells in India

IV. Conclusions

Solar radiations are available abundantly in India. 90 TWh of electricity can be generated from rooftop photovoltaic cells if installed on 60% of houses in India. 61.61% of domestic energy can be supplied from rooftop photovoltaic cells. The problem of acquiring open land does not arise by installing photovoltaic cells on rooftops.

References

[1] S. M. Ganechari and Sandeep Kate, "Alternative Energy Sources" two days national seminar on alternate energy sources, VPM's Polytechnic, Thane pp 5-14, august 27-28, 2005.

[2] G.V. Gotmare "Economics of Solar Water Heating System", two days national seminar on alternate energy sources, VPM's Polytechnic, Thane, pp 47-51, august 27-28, 2005

[3] S. P. Sukhatme, "Meeting India's future needs of electricity through renewable energy sources", General Articles, Current Science, Vol. 101, No. 5, pp 624-630, 10 September 2011.

[4] Amit Barve, "Applications of Solar Power Generating Systems In Industry", two days national seminar on alternate energy sources, VPM's Polytechnic, Thane, pp 52-55, august 27-28, 2005

[5] Anon. "Population of India", 1951–2011; www.censusindia.gov.in.

[6] Anon., Ministry of New and Renewable Energy; www.mnre.gov.in and mnre.gov.in/pdf/mission-document- JNNSM.pdf.

[7] Anon. "Energy Statistics 2011", Central Statics office, National statistis organisation, ministry of statistics and program implementation, govt. of India. www.mospi.gov.in.