STUDY OF UTILIZATION OF SOLAR POWER FOR HOUSEHOLD PURPOSES IN NAGPUR AREA

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ABSTRACT

The quality of human life depends to a large degree on the availability of energy. This is threatened unless renewable energy resources can be developed in the near future. Chemistry is expected to make important contributions to identify environmentally friendly solutions of the energy problem. One attractive strategy discussed in this Forum Article is the development of solar cells that are based on the sensitization of macroscopic oxide films by dyes or quantum dots. These systems have already reached conversion efficiencies exceeding 11%. The underlying fundamental processes of light harvesting by the sensitizer, heterogeneous electron transfer from the electronically excited chromophore into the conduction band of the semiconductor oxide, and percolative migration of the injected electrons through the mesoporous film to the collector electrode will be described below in detail. A number of research topics will also be discussed, and the examples for the first outdoor application of such solar cells will be provided.

1. INTRODUCTION

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic's, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.

It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of systems, concentrated and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

The Ministry of New and Renewable Energy (MNRE) of Government of India states that, India is endowed with abundant of solar radiation. The country receives solar radiation equivalent to more than 5,000 trillion kWh/year, which is far more than its total annual energy requirement. The radiation available could be utilized for thermal as well as for photovoltaic applications. Solar thermal technologies have already found ready acceptance for a variety of decentralized applications in domestic, industrial and commercial sectors of the country. The most widely acceptable application is the solar water heating technology. However, solar steam generating and air heating technologies and energy efficient solar buildings are also attracting attention in urban and industrial areas. Among solar photovoltaic technologies, there are some devices/ systems such as solar lanterns, solar home systems, solar street lights, solar pumps, solar power packs, roof top SPV systems etc which could be useful both in rural and urban areas for the purpose of reducing burden on conventional fuels.

The MNRE under decentralized systems has also proposed Solar/Green Cities.

1.1 Need of Solar Cities

Urbanization and economic development are leading to a rapid rise in energy demand in urban areas in our country leading to enhanced Green House Gas (GHG) emissions. Many cities around the world are setting targets and introducing polices for promoting renewable energy and reducing GHG emissions and the countries like Australia and USA are developing the solar cities.

Several Indian cities and towns are experiencing rapid growth in the peak electricity demand. The local governments and the electricity utilities are finding it difficult to cope with this rapid rise in demand and as a result most of the cities/towns are facing electricity shortages. In this context, the “Development of Solar Cities” programme is designed to support/encourage Urban Local Bodies to prepare a Road Map to guide their cities in becoming ‘renewable energy cities’ or ‘solar cities’.

The Ministry has already initiated various programmes in the Urban Sector for promoting solar water heating systems in homes, hotels, hostels, hospitals and industry; deployment of SPV systems/devices in urban areas for demonstration and awareness creation; establishment of ‘Akshya Urja Shops’; design of Solar Buildings and promoting urban and industrial waste/ biomass to energy projects. The solar city programme aims to consolidate all the efforts of the Ministry in the Urban Sector and address the energy problem of the urban areas in a holistic manner.

2. WHAT IS SOLAR CITY?

The Solar City aims at minimum 10% reduction in projected demand of conventional energy at the end of five years, through a combination of enhancing supply from renewable energy sources in the city and energy efficiency measures. The basic aim is to motivate the local Governments for adopting renewable energy technologies and energy efficiency measures. In a Solar City all types of renewable energy based projects like solar, wind, biomass, small hydro, waste to energy etc. may be installed along with possible energy efficiency measures depending on the need and resource availability in the city.

2.1 Solar RPO

Among the various renewable energy resources, solar energy potential is the highest in the country. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The annual radiation varies from 1600 to 2200 kWh/m2, which is comparable with radiation received in the tropical and sub-tropical regions. The equivalent energy potential is about 6,000 million GWh of energy per year.

The National Action Plan on Climate Change also points out: “India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level”.

With the objective to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible Government of India launched National Solar Mission.

3. LITERATURE SURVEY

In the 20th century, the population quadrupled and our energy demand went up 16 times. The exponential energy demand is exhausting our fossil fuel supply at an alarming rate.1,2 About 13 terawatts (TW) of energy is currently needed to sustain the lifestyle of 6.5 billion people worldwide. By year 2050, we will need an additional 10 TW of clean energy to maintain the current lifestyle.(solar energy) So many aspects such as Energy Challenge, End of cheap oil, Green House Gas Emission and meeting clean energy demand has raised a demand for new and renewable energy source.

GLOBAL civilization requires inexpensive, reliable, and sustainable energy sources. The lack of stability in fossil fuel prices, supply challenges, risks from nuclear power, and the growing environmental concerns on the combustion of fossil fuels is driving a renewed interest in developing solar photovoltaic (PV) devices, which convert sunlight directly into electricity and offer enormous potential as a source of sustainable energy.(paper 8)

3.1 Research

According to Solar Radiation Hand Book (2008) of Ministry of New and Renewable Energy and Indian Metrological Department, basics of solar radiations are –

- Solar radiation is the radiant energy emitted by the Sun in the form of electromagnetic waves.
- The sun emits vast amount of radiant energy.
- The earth intercepts only a fraction of it.
- It is essential to drive directly or indirectly all biological and physical processes on the Earth.
- The earth is the only planet in the solar system, which receives an optimum amount of solar radiation that makes life sustainable on it.
- Solar spectrum resembles to that of a black body at approximately 5800K.
- 98% of the total emitted energy lies in the spectrum ranges from 250nm to 3000nm. About half of the radiation is in the visible short-wave part of the electromagnetic spectrum. The other half is mostly in the near-infrared part, with some in the ultraviolet part of the spectrum.
- Solar radiation having wavelength less than 0.286nm (called ultraviolet) is absorbed by ozone layer in stratosphere. The ultraviolet radiation not absorbed by the atmosphere is responsible for the change of color in skin pigments.
- The solar radiation, that traverse the atmosphere further, is subjected to scattering, reflection and absorption by air molecules, aerosols and clouds.
- The **radiation budget** represents the balance between incoming energy from the Sun and outgoing thermal (long wave) and reflected (shortwave) energy from the Earth. Globally, the budget is balanced. Otherwise the temperature would rise constantly. Locally, the budget is not balanced. Tropical areas get more than they release, while higher latitudes of the winter hemisphere release more than they receive.

3.2 Solar Radiation Budget

The radiation from the Sun travels in the space as electromagnetic wave. Above the earth's atmosphere, sunlight carries 1367 watts of power per square meter. This is known as solar constant. We define solar constant as the amount of solar radiation received outside the earth's atmosphere on a unit area perpendicular to the rays of the sun, at the mean distance of the earth from the sun.
The Earth receives 1.8 x 1017 W of incoming solar radiation continuously at top of its atmosphere. But only half of it reaches the earths' surface. Factors like absorption, scattering and reflection of light during its passage through the atmosphere are responsible for reduction of the amount of solar radiation available on the earth's surface (Fig.1). Solar energy is, by nature, a low density energy source.

3.3 The solar spectrum

When solar radiation is passed through a prism, it gets split into several colours. This is the visible portion of the solar radiation. In fact, the radiation from the sun extends into the ultraviolet and infrared spectral regions as well (Fig.2). Solar spectrum resembles to that of a black body at approximately 5800K. 98% of the total emitted energy lies in the spectrum ranges from 250nm to 3000nm. About half of the radiant energy is in the visible short-wave part of the electromagnetic spectrum. The other half is mostly in the near-infrared part, with some in the ultraviolet part of the spectrum. Solar radiation having wavelength less than 0.286nm (called ultraviolet) is absorbed by ozone layer in stratosphere. The ultraviolet radiation not absorbed by the atmosphere is responsible for the change of color in skin pigments. The solar radiation that traverses the atmosphere further, is subjected to scattering, reflection and absorption by air molecules, aerosols and clouds.

Individual particles of light are called photons. An individual photon is considered to possess single wavelength depending on its energy content. The range of wavelengths in the solar spectrum is directly due to collection of photons of much different energy. The distribution of photons in a wide energy spectrum has a deciding role in the performance of many solar energy utilization devices.

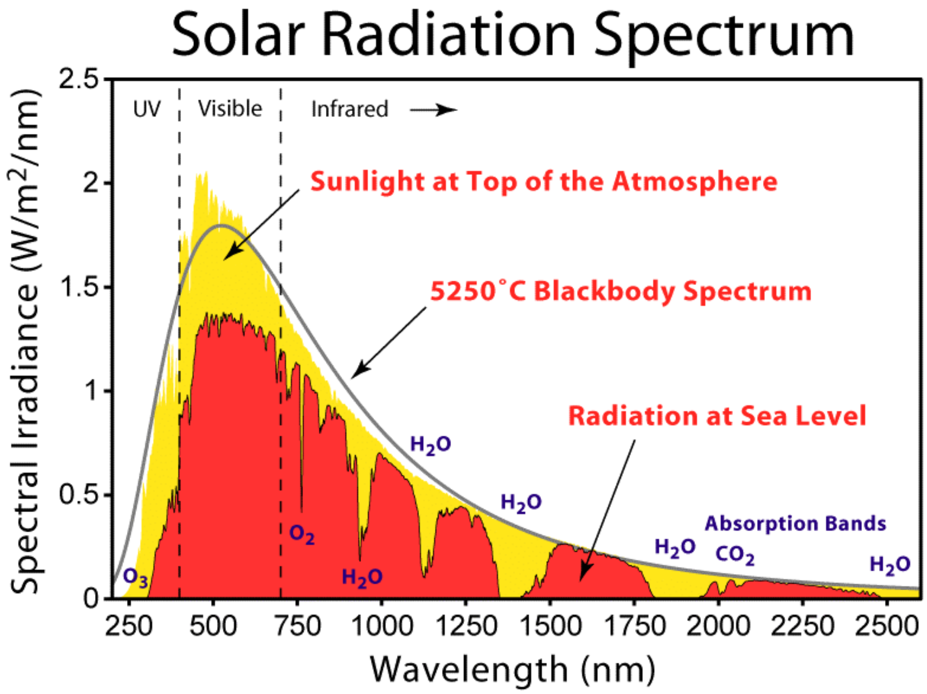

Fig 1: Solar Radiation Spectrum

Mean hourly air temperature(^{0}C) at Nagpur

Time in IST

	01	02	03	04	05	06	07	08	09	10	11	12
January	17.4	16.9	16.4	16.0	15.6	15.2	14.8	15.7	19.3	22.2	24.5	26.2
February	19.9	19.2	18.6	18.1	17.7	17.3	16.9	18.5	22.0	24.8	27.0	28.6
March	24.2	23.5	23.0	22.5	21.9	21.4	21.3	23.9	27.2	29.8	31.7	33.1
April	29.0	28.3	27.6	27.1	26.7	26.2	26.6	29.6	32.6	34.6	36.4	37.6
May	31.9	31.4	30.9	30.5	30.1	29.7	30.6	32.9	35.2	36.9	38.4	39.6
June	28.9	28.5	28.2	28.1	27.9	27.7	28.1	29.2	30.5	31.8	33.0	34.0
July	26.1	25.9	25.8	25.7	25.6	25.5	25.7	26.3	27.2	28.0	28.8	29.4
August	25.3	25.2	25.1	25.0	25.0	24.9	25.0	25.5	26.5	27.2	27.9	28.5
September	25.2	25.0	24.8	24.7	24.5	24.4	24.6	25.8	27.3	28.6	29.7	30.5
October	22.7	22.3	22.1	21.8	21.6	21.3	21.4	23.5	26.2	28.4	30.0	30.9
November	19.1	18.7	18.3	18.0	17.7	17.4	17.3	19.4	22.7	25.4	27.4	28.7
December	16.1	15.6	15.1	14.8	14.4	14.1	13.9	15.3	19.0	22.2	24.4	25.9

	13	14	15	16	17	18	19	20	21	22	23	24
January	27.3	27.9	28.2	28.1	27.0	24.3	22.3	21.0	20.0	19.2	18.6	18.0
February	29.7	30.4	30.7	30.7	30.1	27.9	25.6	24.2	23.0	22.2	21.4	20.7
March	34.0	34.6	34.9	34.9	34.4	32.8	30.3	28.7	27.6	26.7	25.9	25.1
April	38.6	39.1	39.4	39.3	38.9	37.7	35.3	33.5	32.4	31.5	30.6	29.7
May	40.5	41.0	41.1	40.8	40.4	39.2	37.3	35.8	34.8	34.0	33.3	32.6
June	34.8	35.2	35.0	34.7	33.9	33.0	32.0	31.2	30.5	29.9	29.4	29.0
July	29.7	30.0	29.9	29.8	29.5	29.1	28.5	27.8	27.3	26.9	26.6	26.2
August	28.9	28.9	28.9	28.7	28.3	27.8	27.2	26.6	26.3	26.0	25.7	25.5
September	30.9	31.1	30.8	30.4	29.8	28.8	27.7	27.0	26.5	26.1	25.8	25.4
October	31.5	31.7	31.6	31.1	29.7	27.5	25.9	24.9	24.1	23.6	23.2	22.9
November	29.3	29.5	29.4	28.9	27.0	24.4	22.9	21.7	20.9	20.3	19.9	19.4
December	26.7	27.0	27.1	26.7	25.0	22.1	20.4	19.1	18.2	17.5	17.0	16.5

Fig 2: Mean Hourly air temp in Nagpur

Lets take a look at the Solar Radiation Spectrum Graph of Nagpur. It clearly shows that the annual average of solar radiations incident in Nagpur is 5.47KWh/m sq. every day.

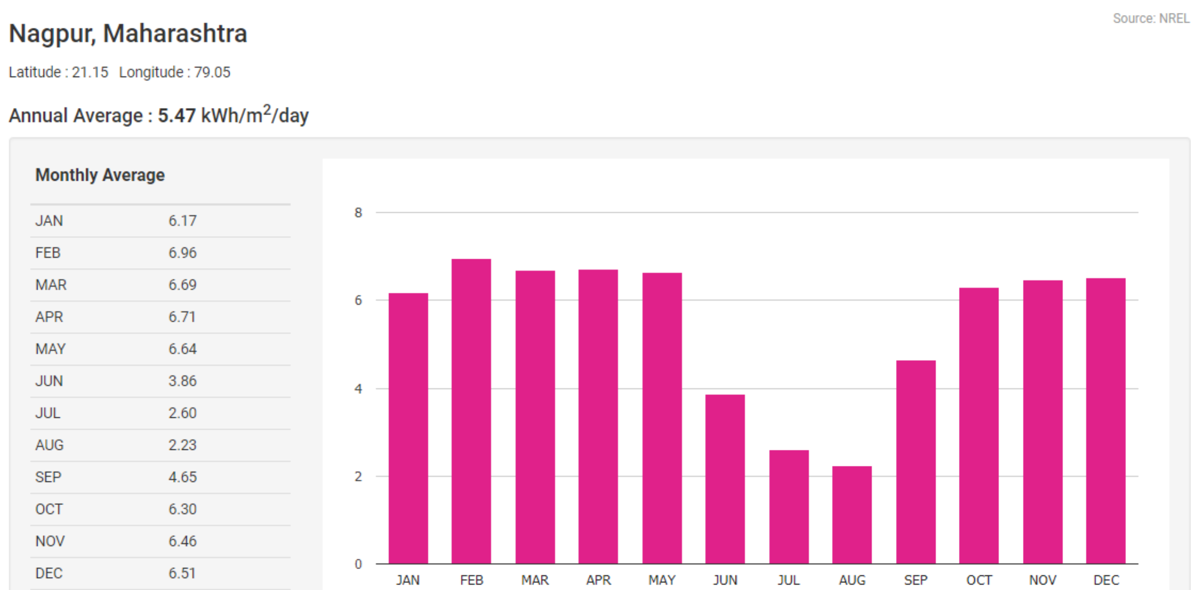

Fig 3: Solar radiation Spectrum graph of Nagpur

4. CONCLUSIONS

Considering the Solar/Green Cities Decentralization System, if we try to utilize Solar Power for a Hose hold, following assumptions can be made.

There are two types of Solar Power Generation Systems which can be used. They are –

1. With Tracking
2. Without Tracking

With Tracking –

In With tracking systems, the solar panel automatically moved to the direction of incident solar radiations so as to harness maximum energy from the solar radiations.

In a Tracking powered Solar System, the efficiency is 22% and an average per day production is of 12.6 units of electricity. And for this production, we need 8 Solar panels of area 15sq. m. each. The Power output of a single panel is 250W.The life of these solar panels and invertors is of 20 years. Approximately 150 to 200units of electricity is needed by a house per month, so the usual return of the investment will be seen after 5 year.

The approximate cost of this household system is Rs.2.1Lac.

Without Tracking –

In Without Tracking systems, the solar panels are stationary and harness the energy only from the incident solar radiations.

In a Without Tracking Solar System, the efficiency is 22% and an average per day production is of only 8.8 units of electricity. And for this production, we need 8 Solar panels of area 15sq. m. each. The Power output of a single panel is 250W. The life of these solar panels and invertors is of 20 years. Approximately 150 to 200units of electricity are needed by a house per month, so the usual return of the investment will be seen after more than 5 year. The approximate cost of this household system is Rs.1.85Lac.

Though the investment may look a bit painful, but from long term point of view it is very much helpful and safe also.

5. REFERENCES

[1]. http://www.mnre.gov.in/schemes/offgrid/solar-pv/
[2]. http://www.synergyenviron.com/tools/solar-irradiance/india/maharashtra/nagpur
[3]. http://romeo.if.usp.br/~mcsantos/INN/solarenergy.pdf Meeting the Clean Energy Demand: Nanostructure Architectures for Solar Energy Conversion Prashant V. Kamat* Notre Dame Radiation Laboratory, Department of Chemistry & Biochemistry and Department of Chemical & Biomolecular Engineering, Notre Dame, Indiana 46556-5674 ReceiVed: October 23, 2006; In Final Form: December 6, 2006
[4]. http://digitalcommons.mtu.edu/cgi/viewcontent.cgi?article=1008&context=materials_fp Progress in Indium Gallium Nitride Materials for Solar Photovoltaic Energy Conversion Dirk V. P. McLaughlin Queen's University Joshua M. Pearce Michigan Technological University
[5]. http://www.indiaenvironmentportal.org.in/files/srd-sec.pdf Typical Climatic Data for Selected Radiation Stations (The Data Period Covered : 1986-2000) Solar Radiation Hand Book (2008) A joint Project of Solar Energy Centre, MNRE Indian Metrological Department