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Harnessing Solar Energy : A Bright and Promising Future In India

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ABSTRACT

India and the world are in an era of great energy crisis. The requirement of energy is fulfilled by exploitation of natural sources like coal, oil and natural gas. To some extend nuclear, hydro and wind power is bridging gap between availability and demand of energy but the efforts and capabilities are still limited. RE contribute only 7.7% of total installed power. Solar energy, the most dependable source of RE, is an alternative which is promising for fulfilling energy demand which is around 12%. The country with around 200 sunny days has immense solar potential. Harnessing this is essential not only to reduce the countries dependency on non-renewable sources but also to preserve the natural resources for our offsprings. Thus using solar energy is the need of the hour and with initiatives taken by the Government and private sector; harnessing solar potential has a bright and promising future in India.

Keywords: Solar energy, solar potential, harnessing solar energy,

1. INTRODUCTION

Our earth, a beautiful planet in our solar system and even in the known universe, is empowered every day with an incredible amount of solar energy continuously and that too free of cost. Utilizing the solar radiations incident is commonly called solar energy. Solar energy has a wide range of applications both in industrial and domestic purposes which include generation of solar power and use of solar radiations for water heating, space heating, process heat generation, water treatment, etc. Further solar energy is an abundant and renewable energy source. India, geographically situated near equator, is a country that has tremendous solar energy potential. Under the weather conditions providing more than 200 sunny days it is essential to harness openly available solar potential to meet the energy needs is essential.

2. THE SOLAR POTENTIAL OF INDIA

The annual solar energy incident at the ground in India is about 20,000 times the current electrical energy consumption. The immense solar energy potential in India, which is clear from figure (1) and table (1), is due its convenient location near the Equator beneath the weather conditions which enables to receive nearly 200 days of sunshine every year (55%), which is equivalent to 5000 trillion kWh of energy. Hence this open and never-ending source of energy that can be brought in use by harnessing it is the need of time and in the developing country like India this need extends multifold times as providing energy to the people in a cost effective and efficient manner is a very challenging job in a scenario where the divergence between demand and supply of energy is ever increasing. In this perspective the government has also taken major initiatives towards harnessing solar potential. This step is not only to surmount the ever-increasing gap between availability and demand of energy but also to safeguard the conventional sources of energy for future generations.

Table 1. Solar potential in India

Total Land Area (sq km)	3,287,590
No of sunny days	200
Unit potential from 1 sq. m	4kwh/day
Conversion efficiency	15%
1 sq. km (Mn units per year)	120
0.5% of land used (in sq km)	16,438
Potential units (in billions)	1,972

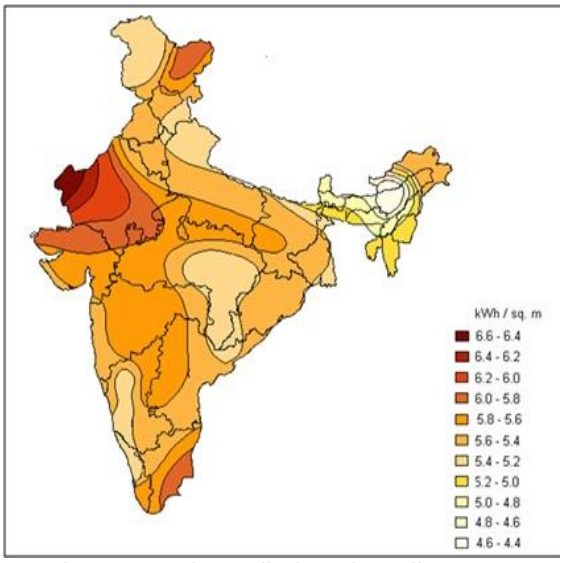

Figure 1. Solar radiations in India

3. APPLICATIONS OF THE SOLAR POTENTIAL

Solar power which is eco-friendly, cleanest and available in affluence for free can be exploited by active and passive methods of energy conversion. The classification is done on the basis of the ways of capturing, converting and distributing solar potential. Active techniques make the use of photovoltaic panels and solar thermal collectors to harness energy. Passive techniques include orienting a building to sun, selecting material with favorable thermal mass and designing spaces etc

A few applications of solar energy include water heating, air heating, heating of buildings, drying of crops and timber, water distillation, solar cooking, solar power generation, solar refrigeration and air conditioning and solar electricity generation by solar cells and solar panels.

4. METHODS OF HARNESSING SOLAR ENERGY

A. SOLAR POWER

Solar power is produced by collecting sunlight and converting it into electricity. The complete process is depicted in figure 2. This is done by using solar panels, which are large flat panels made up of many individual solar cells. It is most often used in remote locations, although it is becoming more popular in urban areas as well.

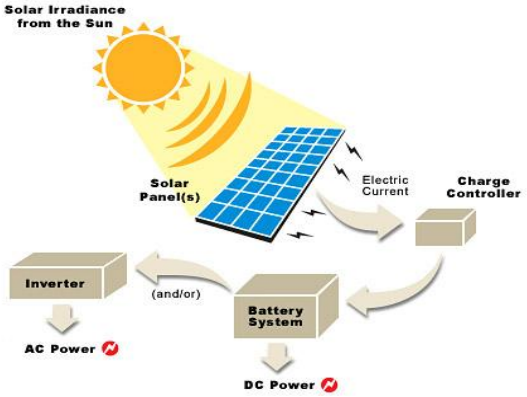

Figure 2. Solar power generation

B. SOLAR OVEN

The first harnessing of solar energy was to cook food in a specially-designed oven that captured the sun's rays to heat food as depicted in figure 3. These small ovens were originally built for camping, but they work great for outdoor summer cooking as well. Rather than mess with charcoal or propane tanks, solar ovens are inexpensive and easy to use without all the waste of conventional cooking techniques. These small ovens can cook food at a temperature of up to about 350 degrees and are fully solar-powered. A unique system of glass and reflective material absorbs the sun's heat like a solar cell and then magnifies it so that it is hot enough to cook. It's economical and it's friendly to the environment!

Figure 3. Solar Cooker

C. SOLAR WATER HEATER

For a fraction of the cost of a complete solar-power system, a solar-powered water heater system to generate hot water can be installed for home. They can be used in any climate, and the fuel they use—

sunshine—is free. These systems include storage tanks and solar collectors

Figure 4. Solar water heater

D. PASSIVE HEAT STORAGE TUBES

These innovative greenhouse fiberglass tubes to drastically cut down on the heating bills. The tall fiberglass cylinders – which look like pillars, as shown in figure 5, but are hollow - can be used as room dividers or attractive accents. These are simply filled with water and place them where they will get a lot of exposure to bright light where they can catch and store energy from the sun and fill the room with heat and greatly reduce expensive heating bill.

Figure 5. Solar heat storage tubes

E. SOLAR PONDS

A solar pond is an area of land to be covered with water and receives thermal energy by isolation as shown in figure 6. The depth of water is ranging from (1-1.5) m. The area of the pond is 1.49 or 1.2 km on a side. Convection heat transfer is prevented by salting the water by the addition of NaCl or $MgCl_2$ or $NaHCO_3$ in the lower 40-50cm depth of the pond. Thus a density gradient of water is established. This would produce a temperature gradient and heat accumulation in the lower depth of pond. The temperature may reach up to 90C. A binary/isobutanol power cycle incorporated with a goal of producing 10MWe electrical power. The increase of thermal power produced from solar pond will increase electricity production, the largest values of flow rate occur for the use of $MgCl_2$ salt and the lower value for NaCl

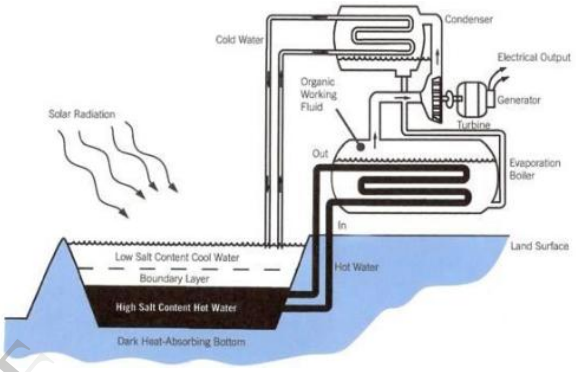

Figure 6. Solar Pond Power Generation Unit

5. GOVERNMENT INITIATIVES TO DEVELOP THE SOLAR ENERGY SECTOR

In India, Ministry of New and Renewable Energy (MNRE), India Renewable Energy Development Agency (IREDA) and Solar Energy Centre (SEC) are established to endorse solar potential of the country. MNRE is the nodal unit for all issues relating to Renewable Energy. In MNRE, SEC acts as dedicated unit for the development of solar energy technologies along with promotions of its applications through product development. IREDA is a public limited company established in 1987 to encourage, build up and pull out fiscal assistance for renewable energy and energy efficiency/conservation projects. Above and beyond the government has also rolled out an assortment of policies, schemes and subsidies to promote this sector. Further, eight critical missions are identified by National Action Plan on climate change (NAPCC) to promote climate mitigation and adaptation. A part of this is National Solar Mission, which has the specific goal of increasing the usage of solar and thermal know-how in urban areas, industry, and business organization. Jawaharlal Nehru National Solar Mission (JNNSM)", launched by MNRE in

2009, has the ambitious goal of making India an international leader in solar energy. The three-phase approach planned by JNNSM is clear in Table 2. JNNSM also aims for pursuing grid parity (same production cost as current electricity source) by 2022 and parity with coal based power generation in 2030.

Table 2 JNNSM Targets

Solar Application	Target- Phase I 2010-2013	Target- Phase II 2013-2017	Target- Phase III 2017-2022
Solar Thermal collectors	7 Mn Sq m.	15 Mn Sq m.	20 Mn Sq m.
Off grid solar applications	200 MW	1000 MW	2000 MW
Utility grid applications	1000-2000 MW	4000-10,000 MW	20,000 MW

6. MOTIVATIONS AND CHALLENGES OF SOLAR ENERGY SECTOR

The factors propelling the growth in the solar energy segment are segregate into demand side growth drivers and supply side growth drivers.

A. MOTIVATIONS OWING TO DEMAND

The demand of energy is constantly increasing against the supply leading to the present state with persistent energy shortage with average demand-supply gap revolving around 12%. As forecasted by the Power Ministry electricity consumption will increase from the present 660 kWh to around 1900 kWh by 2032. This measure to 1.87 times rise in 20 years. Hence encouraging investment in the solar energy sector shall help develop a market for solar energy for driving down costs. Further the increasing awareness among the common man about issues such as energy scarcity and environmental preservation of our mother planet, which is only available space to leave in the universe as on today, shall also stimulate the requirements for eco-friendly power, knocking for growth opportunities in harnessing solar potential.

B. MOTIVATIONS OWING TO SUPPLY

India's power sector makes use of coal and petroleum products to generate the required energy. These are non-renewable natural resources depleting fast has forced the government and the power generation companies to look for the alternatives into Renewable sources. Owing a location near the Equator beneath the weather conditions which enables to receive nearly 200 days of clear sunshine every year the best renewable alternative thus available is solar power. Under this scenario the favorable environment created by government through subsidy schemes and policies is also encouraging power generation companies to invest in solar power. Over and above this the there is huge demand of electric power in rural India which lacks in having effective grid connectivity but has abundant availability solar potential. Hence power generation companies also find it more economical in harnessing the solar power in the country.

7. CHALLENGES FACED BY SOLAR ENERGY SECTOR

Higher Cost and lower R&D in solar sectors form the major challenges in front of the solar sector. The solar power generated using solar cells are manufactured from silicon and solar wafers of which about 80% come through imports raising the solar electricity cost on grid to Rs. 18.44 per unit. Further, solar projects capital intensive due to the huge dependency on imports. Added to it is the lack of an effective financing infrastructure for these projects which is another major factor impeding growth in this sector. Slower pace of research due to lack of collaborative and target driven efforts worsen the condition of the segment. Consequently the government has to outline comprehensive R&D schemes and provide incentives along with the current subsidy schemes which will endorse technological innovations for improving the efficiency of current solar energy systems necessary to exploit the solar energy potential in India. Facilitating closer industry – government cooperation can help in speeding R&D activities.

The other major challenge restricting the growth of this sector is the lack of standards, resulting in the fragmentation of the market among manufacturers and suppliers. Standardization of systems will lead to rationalization of cost as companies can invest in R&D and newer technologies to meet common specifications. Finally the government has to increase awareness among the common man about the opportunity and benefits solar energy.

8. SUCCESS STORIES

Efforts from the government and private sector in the use of solar energy have come with many success stories. These are from different parts of the country which reflect the awareness among people regarding the capabilities, methodology and benefits of solar potential. From these stories as well it is clear that the solar future of India is definitely bright as well as promising.

In Maharashtra, summer capital Nagpur is being developed as the first solar city out of the 60 cities selected in the country. The initial target is to reduce the use of conventional energy by 10% upto 2012. Also in Maharashtra, is the solar cooker at the temple complex at Shirdi, set up at a cost of $250,000 for feeding 20,000 devotees who visit the Sri Sai Baba Sansthan every day. Shirdi is not the first, but it is the worlds largest and several other religious sites like Mount Abu and Tirupati, among others -- have installed solar cookers for preparing meals for pilgrims. Hande, with the support from the Rockefeller Foundation, and with joint collaboration with the Bangalore-based SELCO initiated the use of solar lamps instead of kerosene lanterns in Silk farmers. The initiative along with saving energy has also helped in rising productivity of the farms by reducing the mortality rate of silkworms. The Crown Solar Power Fencing Systems in Bangalore involved in making of solar power fencing, solar lighting systems and security devices are successful in using solar energy not only in lanterns and home lighting but extended the capability in pumping water, in water heating, lightening of streets and even in powering the Sunbank solar power pack, a cost-effective solution for rural banks and the Sunbank solar power pack that offers a cost-effective solution for rural banks. TERI (The Energy and Resources Institute) has developed solar-powered television sets, fans and even a milk-churning device that runs on solar energy. Photon Energy Systems offers a desalination system making use of solar energy and the Reliance Industries offer a full range of water purifiers developed by their solar group. In the Lakshadweep islands Bharat Heavy Electricals has commissioned two solar power plants of 100 KW each in grid-interactive mode. Azure Solar became the first Indian company to sell power commercially in India supplying 1 MW to the Punjab State Electricity Board. Titan Energy has just completed the construction of a 1 MW unit for the West Bengal Green Energy Development Corporation. Andhra Pradesh has set aside 6,000 acres in Anantapur district for allotment to companies setting up solar power projects. In Gujarat, the government along with Clinton Foundation has launched the Clinton Climate Initiative (CCI) to create and advance solutions to the core issues driving climate change. This is a massive project; one of four solar parks planned across the world, costing $15 billion has a plan of 5,000 MW of solar generation capacity. The Gujarat project is likely to be the first to come up and will become the world's largest solar project.

CONCLUSION

Solar Energy possesses tremendous potential in bridging India's energy demand-supply gap in the future. Solar energy, one of the most dependable sources of renewable energy, is an alternative which is promising and consistent for the fulfillment of energy demand. The methods of extracting solar potential are simple but need a channelize research work to develop the best technologies for using this abundant yet free form of energy. There are various challenges for this industry, including lowering cost of production, increasing R&D, consumer awareness and financing infrastructure. Harnessing this is essential not only to reduce the countries dependency on non-renewable sources of energy like coal, oil and gas but also to preserve the natural resources for our offsprings. Thus using solar energy is the need of the hour and with the initiatives taken by the Government and private sector harnessing solar potential has a bright and promising future in India.

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