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Solar Energy – A Perspective

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***Abstract*— A nation's stability depends on its energy security. Conventional methods of energy production have its limitations on being exhaustible and also being responsible for production of greenhouse gases. The trend, thus, is to move towards a more reliable, renewable source of energy.**

India, realizing the importance of Solar Energy has taken up the cause in right earnest spearheaded by few states, prominent amongst them being Rajasthan.

We, in this article present a bird eye's view on Solar Energy production with special emphasis on Rajasthan.

I INTRODUCTION

Energy security is the key to economic growth of a country and a state. Fossil fuel such as coal, gas, oil etc. is fast depleting and will be exhausted in the coming few decades. The conventional generation is also responsible for the emission of greenhouse gasses which in turn is responsible for global warming. This has an adverse effect on our climate. Thus, the shift towards a sustainable renewable energy generation is being witnessed.

India is blessed with abundant solar energy and if harnessed efficiently can be capable of producing trillion-kilowatts of electricity. Solar energy is extremely beneficial as it is non-polluting and its production can be decentralized.

Rajasthan, by virtue of its geography enjoys the highest number of cloud-free days of around 325. It has high potential for development of stand-alone off grid applications. Having realized this opportunity, the state of Rajasthan is investing in its capacity building for generation of electricity through solar power.

The percentage breakup of energy production from different sources is given in the table 1. In table 2 we list the different states in order of their production.

Table 1: percentage breakup of energy production from different sources

Sources	Production in %
Coal	58.8
Hydro	14.9
Wind	9
Solar	4
Others	18.2

Table 2: different states in order of their production.

State	Total Installation (MW)	Under Development (MW)
Rajasthan	1577	485
Tamiln-adu	1324	1205
Gujrat	1100	300
Andhra Pradesh	1009	1494
Teleng- ana	1006	2418

II BRIEF HISTORY

Solar cell was first introduced in the year 1839 through the discovery of photovoltaic effect by Edmond Becquerel. In 1873 Willoughby Smith discovered the photoconductivity of Selenium and three years later William Grylls Adas and Richard Evans Day showed that Selenium could produce electricity from light. In the year 1883 Clarles Fritts created the first line solar cell by coating selenium with thin layer of gold. An efficiency of 1% was achieved. In the year 1953 silicon was found to be more efficient than selenium which stood around 6%. In 1956 Western Electric began the process for production of solar cells commercially. Research with low grade silicon helped reduce the cost of production of solar cells and in 1982 Arco Solar built the first solar park. A 100 KW light bulb could be powered for 10 hours. In the year 2015 solar cells as thin as paper were manufactured with an efficiency of 20% thus paving the way for wider propagation of its use. In the year 2016 a new property called magnetic hyperbolic dispersion of nanomaterials [1] was discovered. The material glowed when heated and when combined with thermovoltaic cells could turn heat into electricity.

III CONSTRUCTION OF SOLAR CELLS

Pure silicon is derived from such silicon dioxides as quartzite gravel (the purest silica) or crushed quartz. The resulting pure silicon when doped with phosphorous and boron produces either an excess of electrons or deficiency of electrons respectively. This doping helps increase the conductivity of the semiconductor. The silicon disks are shiny and require an anti-reflective coating, usually of titanium dioxide.

The solar module consists of the silicon semiconductor surrounded by protective material in a metal frame. The protective material consists of an encapsulate of transparent silicon rubber or butyryl plastic (commonly used in **automobile**

windshields) bonded around the cells, which are then embedded in ethylene vinyl acetate. A polyester film (such as mylar or tedlar) makes up the backing. Terrestrial arrays have a glass cover while a lightweight plastic cover is put on satellite arrays. The electronic parts are standard and consist mostly of copper. The frame is either steel or aluminium. Silicon is used as the cement to put it all together.

Most of the solar panels convert 15-20% of the Sun's energy but an efficiency of 46% has been attained by solar cells produced by SoiTech and Cealite, a French Company.

IV LOOKING AHEAD

From the present state of relatively expensive, inefficient solar cells, the future can only improve. It is predicted that it would be a billion-dollar industry. This prediction is supported by evidence of more rooftop photovoltaic systems being developed in such countries as Japan, Germany, and Italy. Manufacture of solar cells have been established in Mexico and China. Likewise, Egypt, Botswana, and the Philippines (all three assisted by American companies) are building plants that will manufacture solar cells.

Most of the research aims for reducing solar cell cost or increasing its efficiency. Innovations in solar cell technology include developing and manufacturing cheaper alternatives to the expensive crystalline silicon cells. These alternatives include solar windows that mimic photosynthesis, and smaller cells made from tiny, amorphous silicon balls. Already, amorphous silicon and polycrystalline silicon are gaining popularity at the expense of single crystal silicon. Additional innovations include minimizing shade and focusing sunlight through prismatic lenses. This involves layers of different materials (notably, gallium arsenide and silicon) that absorb light at different frequencies, thereby effectively increasing electricity production from sunlight.

A few experts foresee the adaptation of hybrid houses; that is, houses that utilize solar water heaters, passive solar heating, and solar cells for reduced energy needs. Another view is that the space shuttle could be used for placing more and more solar arrays into orbit so that solar power could be beamed to Earth.

Germany and Chile had free electricity at a certain place due to the over production of solar cells at one place and having less consumers.

V IN INDIA

Solar Energy in India too has attracted massive interest. The Jawaharlal Nehru National Solar Mission (JNNSM) also known as Solar Mission is an initiative of the Government of India and the state governments to promote solar power. It was initiated on 11th January 2010 and with a vision of production of 20GW by the year 2022 and it has now been augmented to produce 100GW.

1 Rajasthan

For better utilisation of the competitive edge of Rajasthan in solar sector provided by nature, Government of Rajasthan has issued a new "Rajasthan Solar Energy Policy, 2014" on 8th October 2014 with a vision of solar capacity addition of 25,000 MW in the State. The Policy provides a conducive frame work to the prospective investors in the field of solar power generation and it is expected that the new policy will enable rapid scaling up in establishment of solar power plants in the State.

Rays Power Infra has established two solar plants in Rajasthan. Based within the city limits of Kolayat and Bikaner, these plants are capable of generating 100 MW of power which could extend upto 500 MW. An important takeaway from the use of such power is that it also helps to make the place a lot cleaner.

India's installed solar capacity has crossed the 4,000 MW mark. With close to 1,128 MW of projects, Rajasthan has taken the lead ahead of all other states. It has elbowed out Gujarat, which has 957 MW of solar power projects. Following closely behind are Madhya Pradesh, Maharashtra and Tamil Nadu.

Apart from the regular solar power-rich states, Uttar Pradesh, Punjab and newly formed Telangana have now joined the solar bandwagon.

2 Some Initiatives

In an attempt to further encourage investments, the state government of Rajasthan has exempted off 40 paise per unit for rooftop solar and captive units. The decision is expected to help Rajasthan reach closer to 2300 MW rooftop solar capacity by 2022, a target set for it by the Central Government. The duty cut is expected to have a positive impact on the new capacity lined up. Recently, Rajasthan Renewable Energy Corporation (RREC) issued rate contract order for 25 MW rooftop plants and empanelled companies to design, supply and install these projects. People interested to put up rooftop plants can reach these vendors who are also required to guarantee 5 years of maintenance. The managing director of RREC has confirmed that those projects would enjoy a subsidy of 30% which would be provided by the government. Capacity of these plants could vary from 1 kWh to 500 kWh. The 2300 MW target given to Rajasthan by the Centre for solar rooftop is steep, but all the necessary policies had been put in place to achieve that. Projects for another 5 MW would come up on government buildings in the divisional headquarters of the state. A power purchase agreement would be signed between the installer and the consumer. The installing company would make the investment and the consumer would pay for the power.

Rooftop has received a fillip after the Rajasthan Government announced net-metering policy by which an

individual can use the power he or she generates and the surplus can be fed into the discom's grid. The state already has an installed rooftop capacity of 47 MW. The duty exemption will create a lot of momentum in the rooftop segment by encouraging individuals and institutions to set up their own plants.

Six Public Sector Units (PSUs) have signed a Memorandum of Understanding (MoU) that will lead towards setting up of the World's largest 4000 MW ultra solar power project in Rajasthan.

Table 3 below lists the PSU's Percentage contribution towards project

S.No.	PSUs	MW(%)	Role
1.	BHEL	26	Equipment supply
2.	SECI (Solar Energy Corporation of India)	23	Sale of electricity
3.	SSL (Sambhar Salt Ltd)	16	
4.	Power Grid	16	Power evacuation infrastructure
5.	SJVNL (Satluj Jal Vidyut Nigam)	16	Project management
6.	REIL (Rajasthan Electronics & Instruments Ltd)	03	Operation and maintenance

The project will be the largest single location solar plant and will be on 19000 acres at Sambhar in Rajasthan. The project will be developed in two phases in 7 to 8 years.

In the first phase of the project 1000 MW will be made operational within three years and the remaining 3000 MW will be covered in the next subsequent phases. The First phase will require an investment of 7500 crore rupees. The department of heavy industry will set up a Special Purpose Vehicle (SPV) for the investment.

The solar photo-voltaic power plant will use PV modules based on crystalline silicon technology.The plant life is estimated to be 25 years and is expected to supply 6400 million units of energy per year. The plant will help to reduce CO emissions by over 4 million tonnes per year

VI CONCLUSION

Thus, from the data at hand we can safely conclude that the solar revolution on India's rooftops is gaining momentum. The country has added more rooftop solar power capacity in the last financial year (715MW) than in the previous four years combined. It has become the fastest growing segment in the country's clean energy space. The country's total installed capacity now stands at 1,3GW. By 2022, we would have an estimated capacity of 9.5GW – still short of the target 40GW as set by the Narendra Modi's government.

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