

A Review of Solar Energy: Potential, Status, Targets and Challenges in Rajasthan

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Abstract: - Rajasthan has a huge potential of solar energy, the climatic conditions of state makes it ideal for capturing the solar rays in sufficiency. The climate of Rajasthan is semi-arid; the desert of Thar is spreads on the 66.66 % of total area of state. These climatic specialties makes it suitable to receive almost 300-325 sunny days in a year and 6-6.4kwh/m²/ sun radiation per day, which is second highest amount of sun radiation all over the world. The average temperature of western cities of Rajasthan is between 35-40 degree, and in summer, it reaches above 45 degree. The availability of solar energy in Rajasthan is 6 to 7 kw/km², which provides the potential of 100000MW electricity yearly, out of which only 442.25 MW is currently being produced. Certainly, it is not a satisfactory situation. This paper describes the potential, status, targets and challenges in solar energy in Rajasthan.

Keywords-solar photovoltaic, solar potential, sun radiation

Abbreviations:

SEEZ	Solar Energy Enterprises Zone
ISCC	Integrated Solar Combined CYCLE
GBI	Generation Based Incentive Scheme
RERC	Rajasthan Electricity Regulatory Commission
RPO	Renewable Procurement Obligation
RECL	Rural Electrification Corporation Ltd.
REC	Renewable Energy Certificate
RREC	Rajasthan Renewable Energy Corporation
PV	Photovoltaic
MW	Megha Watt
TW	Tera Watt
US	United State
USA	United State of America

I. INTRODUCTION

India's population is more than 1210.19 million is growing at an annual rate of 1.58% [1]. As fossil fuel based energy resource depleting rapidly, India will face huge energy shortages significantly due to increase in energy prices and energy insecurity within the next few decades. Increased use of fossil fuels also causes environmental problems both locally and globally. There is a very high demand for energy, which is currently satisfied mainly by coal, foreign oil and petroleum, which apart from being a non-renewable, and therefore non-

permanent solution to the energy crisis, it is also detrimental to the environment. Thus, it is imperative that India obtains energy security without affecting the booming economy, which would mean that the country must switch from the non-renewable energy to renewable energy. Solar power is attractive because it is abundant and offers a solution to fossil fuel emissions and global climate change and able to satisfy future energy demand. Earth receives solar energy at the rate of approximately 1, 20,000 terawatt. This extremely exceeds both the current annual global energy consumption rate of about 15 TW, and any conceivable requirement in future [2]. In fact, solar energy is the largest absorbable renewal resource as more energy from sunlight strikes Earth in 1 hour than all of the energy consumed by humans in an entire year. Use of Solar energy is also requirement of the day because the fossil fuel reserves are rapidly depleting and greenhouse gases and are to be substantially reduced to limit the carbon emission from the power sector in near future.

II. SOLAR POTENTIAL IN RAJASTHAN

Rajasthan, the largest state of India constitutes about 10.4% geo-graphical area of India. Notwithstanding the recently discovered large hydrocarbon reserves of more than

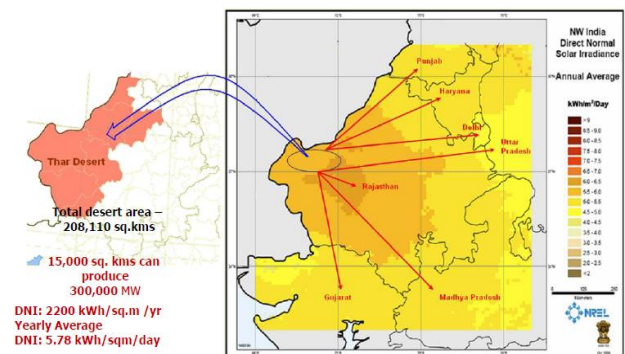


Figure: 1 Solar Power Potential in Rajasthan (NREL, India)

1, 75,000 barrel oil per day and oil equivalent in Barmer basin, there are limited available traditional sources of energy such as coal [3].

There are only two perennial rivers, Chambal and Mahi, whose hydroelectric potential has been almost fully achieved. In view of the above, Rajasthan faces two unique challenges in terms of power generation from the conventional sources: one, there are not many hydropower projects due to non-availability of large rivers; two, as coal needs to be transported from other states, the transportation alone contributes to 50% cost of energy production [4].

Rajasthan has around 208,110 Sq.km of desert land. Rajasthan has more than 325 sunny days in a year with solar radiation of about 6-7Kwh/sq-m/day. The direct normal isolation over Rajasthan varies from 1800Kwh/m² to 600Kwh/m² [5].

TABLE: I STATE WISE INSTALLED SOLAR POTENTIAL

Sr. No.	States	Installed Capacity (MW)
4	Gujarat	824.09
3	Rajasthan	442.25
16	Maharashtra	34.50
2	Andhra Pradesh	23.15
8	Tamil Nadu	17.055
7	Jharkhand	16.00
11	Karnataka	14.00
15	Odisha	13.00
9	Uttar Pradesh	12.38
13	Madhya Pradesh	11.75
1	Punjab	09.33
5	Haryana	07.80
19	Uttarakhand	05.05
17	Chhattisgarh	04.00
18	Delhi	2.53
6	West Bengal	02.00
14	Goa & UT	01.69
10	Arunachal Pradesh	0.025
12	Kerela	0.025
	Total	1440.605

Source: MNRE [6]

Mostly the western part of Rajasthan is blessed with abundant solar energy. Jodhpur in Rajasthan is receiving maximum solar radiation which is known as Sun City of India. Rajasthan is also blessed with abundant land, so it would be ideal for solar PV. Solar has huge untapped potential on account of the State's high solar insulation level, the best in the country. Solar Industry is expected to be an economic engine in Rajasthan creating jobs across the State and spur billions in economic growth and tax revenue along with powering remotely connected households. Barmer, Bikaner, Jaisalmer and Jodhpur are the key regions with best solar radiation in the

State [7]. Daily average radiation ranges between 5kWh/m² in north-eastern hilly areas and 7kWh/m² in western regions. Reliance and Moser Bear both are developing solar power plants of 1 to 5 MW each. Rajasthan, the largest state in India receives maximum solar radiation intensity in India. According to US Department of Energy, Rajasthan receives the second largest amount of solar radiation in the world. Rajasthan is best suited for solar power generation since average rain fall is very low. Solar radiation in Rajasthan is similar to California and Nevada in USA [8]. As shown in Figure 2 comparison of desert sites across the world, we can see from this comparison the Thar desert in India receive second highest amount of solar radiation in the world.

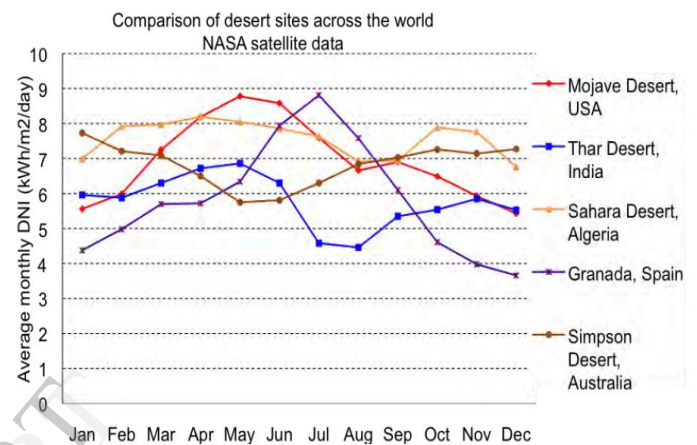


Figure 2: Comparison of DNI on a monthly basis for desert sites across the world [9]

III. INITIATIVES IN SOLAR SECTOR IN RAJASTHAN:

Solar energy industry is still in its initial stage. However, the government of Rajasthan is encouraging private sector investment through various fiscal and promotional incentives these incentives given for both solar thermal and SPV projects. The state government has made a project to develop Jodhpur, Jaisalmer and Barmer as Solar Energy Enterprises Zone (SEEZ). The Mathania solar power project (140MW) is a milestone in this field, as it is the first solar/thermal hybrid power plant of country. This project is based on integrated solar combined cycle (ISCC) technology, it will use parabolic trough mirrors to focus sun heat and further drive the turbine to generate power. This plant will produce 40MW energy, which will cost 1 million/MW and still cheaper than other methods like SPV. Besides these steps, few more small solar power based projects are working successfully, such as, 100KW capacity power plant in Gourir (Jhunjhunu), which is first of its kind in country, a solar energy driven refrigerator in Balesar (Jodhpur), state's first totally solar energy electrified village in Jaipur etc. In private sector, many companies are taking interest in solar energy.

Reliance and Moser Bear both are developing solar power plants of 1 to 5 MW each. In which Moser Bear's project will be the largest grid connected solar farm in India. The Rajasthan government has signed a memorandum with Clinton foundation on January 2010. According to which the

foundation will provide technical assistance and other necessary help to establish solar parks of 3,000 MW to 5,000 MW capacities in the state. Before the creation of National Solar Mission, Govt. of Rajasthan has taken an initiative in 2008 and approved 2 Solar Projects each of 5 MW under Generation Based Incentive Scheme (GBI). To provide encouragement in solar sector, Rajasthan Electricity Regulatory Commission (RERC) issued orders on 2nd April 2008, first time in India, imposing solar specific renewable procurement obligation (RPO) for Discom in Rajasthan. To meet out RPO requirement, the State Government approved Solar Projects of 11 private sector developers for setting up of 66 MW capacities utilizing all available technologies in solar photovoltaic and concentrated solar thermal.

After announcement of Jawaharlal Nehru National Solar Mission, Government of Rajasthan permitted these proposals to be migrated to the National Solar Mission. The Seven solar Power plants, each of 5 MW, having Photovoltaic technology are already commissioned under the migration scheme of National Solar Mission, while the Solar Thermal Plants of 30 MW are under implementation. The Rajasthan Electricity Regulatory Commission (RERC) has also notified the RERC (REC and RPO Compliance Framework) Regulations, 2010 on 23rd December, 2010 [10]. Further, Rajasthan Electricity Regulation Commission has also issued from time to time the RPOs and feed-in tariff for Renewable Energy Projects. In the year 2011, Union Ministry of New and Renewable Energy under National Solar Mission selected investors for setting up of solar power plant of 800 MW capacities under the phase I of National Solar Mission. In fact, to offset the higher cost of solar power, the mechanism has been developed to bundle the solar power along with the unallocated portion of the power available with National Thermal Power Corporation. In the competitive bids, the tariff for solar energy came in the range of INR 10.50 to 12.75 per unit, whereas the cost of the unallocated conventional energy was about INR 3. Therefore, per unit cost of the bundled energy has been around INR 4.5 per unit [10].

IV. TARGET IN RAJASTHAN FOR SOLAR ENERGY DEVELOPMENT

As Rajasthan has a huge potential for Solar Energy development for this, it has its own target to generate the maximum energy form solar radiation. Target is divided in two parts one is under National Solar Mission and second one is under State Solar Policy.

TABLE II. TARGETS FOR SOLAR IN RAJASTHAN

Targets Under NMS	FY 2013	FY 2017	FY2022
Under utility Grid Power including Rooftop (MW)	1100	4000	20000
Off Grid Installation (MW)	200	1000	2000
Solar Collectors (Mn Sq.m)	7	15	20

Source: REEC [10]

As we have shown in table I under utility grid power including rooftop Rajasthan has 1100 MW for financial year 2013, 4000 MW for financial year 2017 and 20000 MW for

financial year 2022 respectively. This is 200MW, 400MW and 2000MW for financial year 2013, 2017 and 2022 respectively under off grid installation. Similarly these targets are 7, 15 and 20 Million square meter under solar collector [11].

V. CURRENT STATUS OF SOLAR ENERGY IN RAJASTHAN

Rajasthan is leader in utilisation of solar radiation for power generation, number of projects has been installed in western part of Rajasthan particularly in Jodhpur, Jaisalmer, Bikaner, Barmer and in remaining part of state. As we have shown in table III the total installed capacity as on 9th March 2013 was 442.25MW [6] and many projects are in pipelined in Rajasthan.

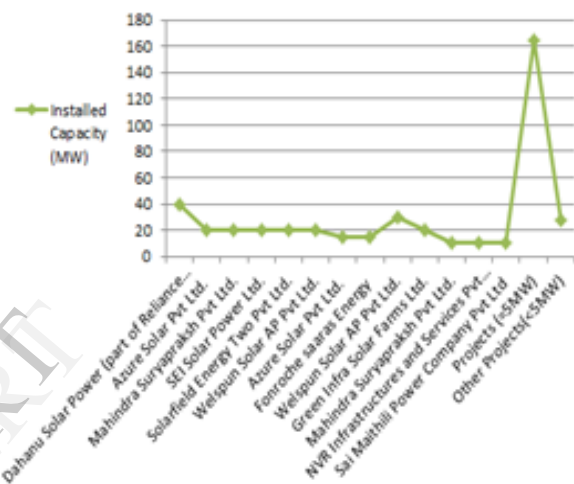


Figure3: Company wise Installed project [6]

Major project owner are Dahanu Solar Power, SEI Solar Power Ltd, Azure Solar Pvt Ltd, Welspun Solar AP Pvt Ltd, Mahindra Suryapraksh Pvt Ltd, Solarfield Energy Two Pvt Ltd, Azure Solar Pvt Ltd, Welspun Solar AP Pvt Ltd and Fonroche saaras Energy etc.

VI. CHALLENGES IN RAJASTHAN FOR SOLAR DEVELOPMENT

Rajasthan is a favourable destination due to the high radiation and almost 325 days sunny days, but the array soiling losses is high due to the dust and due to the extreme high temperature Photovoltaic losses is very high. Another challenge is price of solar energy versus conventional power means the higher per unit cost and renewable purchase obligations enforcement due to this private solar developer are being discouraged. Grid availability and open access and wheeling charges are also a major issue for solar project development in Rajasthan. Finally project implementation challenges also delay some project these challenges are land acquisition and statutory approvals.

VII. CONCLUSION

Rajasthan has a huge potential to develop solar power. The availability of solar energy in Rajasthan is 6 to 7 kw/km², which gives potential of 10000MW solar energy commercial production. Rajasthan has set quite good targets for electricity production from solar energy, it has 1300 MW, 5000MW and 22000MW for financial year 2013, 2017 and 2022 respectively. Currently there are many organizations working in the field of solar energy development major developers are Dahanu Solar Power, SEI Solar Power Ltd, Azure Solar Pvt Ltd, Welspun Solar AP Pvt Ltd, Mahindra Suryapraksh Pvt Ltd. A report published by MNRE show that Rajasthan current producing 442.25MW electricity from solar energy and this is a quite disappointing for Rajasthan. There are some challenges also like solar losses and temperature losses due to the high temperature in western part of Rajasthan. Private developer facing some challenges like finance, statutory obligations and Renewable Energy Certificate (REC). There is a pressing need to accelerate the power generation from solar energy to achieve its solar power targets.

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