Current Trends in Technology and Science
ISSN : 2275-0535. Volume : II, Issue : I

Rajasthan Solar Park – An Initiative Towards Empowering Nation

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Abstract - Solar power is attractive because it is abundant and offers a solution to fossil fuel emissions and global climate change. Solar energy is the largest exploitable renewal resource as more energy from sunlight strikes Earth in 1 hour than all of the energy consumed by humans in an entire year. The average intensity of solar radiation received over India is 200 MW/km square (megawatt per kilometer square) with 250–325 sunny days in a year. Solar energy intensity varies geographically in India, but Western Rajasthan receives the highest annual radiation energy. A dedicated 400 kV network with associated 220 & 132 kV strong transmission network in Barmer, Jaisalmer, Jodhpur, Bikaner area was created. Indeed, Rajasthan is the only State in India which has established a strong power evacuation network in desert area. . Hence current status, various issues, regulatory policies and incentives for promotion of Solar PV Power Parks in Rajasthan along with a case study of Solar Park Project at Village Bhadla of Jodhpur district which includes site report and geotechnical investigation for Photovoltaic Solar Power Plant has been discussed in this paper.

Keywords - RSP, Bhadla-Jodhpur District, PV Solar Power, Renewable Energy.

Abbreviations:

ADI	Asian Development Bank
CSP	Concentrated Solar Power
EMP	Environment Management Plan
GoI	Government of India
GoR	Government of Rajasthan
GBI	Generation Based Incentive Scheme
GSS	Grid Sub-Station
IIT	Indian Institute of Technology
MoU	Memorandum of Understanding
PV	Photovoltaic
R & D	Research & Development
RSP	Rajasthan Solar Park
RERC(L)	Rajasthan Electricity Regulatory Commission (Ltd).
RPO	Renewable Procurement Obligation
RREC	Rajasthan Renewable Energy Corporation
RIICO	Raj. State Indus. Dev. and Investment Corporation
SEZ	Special Economic Zone
RRVPNL	Rajasthan Rajya Vidyut Prasaran Nigam Limited

Weights & Measures:

Bigha	1618 sq m in western Rajasthan
ha. (Hectare)	10,000 sq m

1. INTRODUCTION

Rajasthan has about 2,08,110 km^2 of desert land, which is 60% of the total area of the state. Rajasthan receives solar radiation of 6.0-7.0 kWh/m^2. As the area has low rainfall, about 325 days have good sunshine in a year. [8]

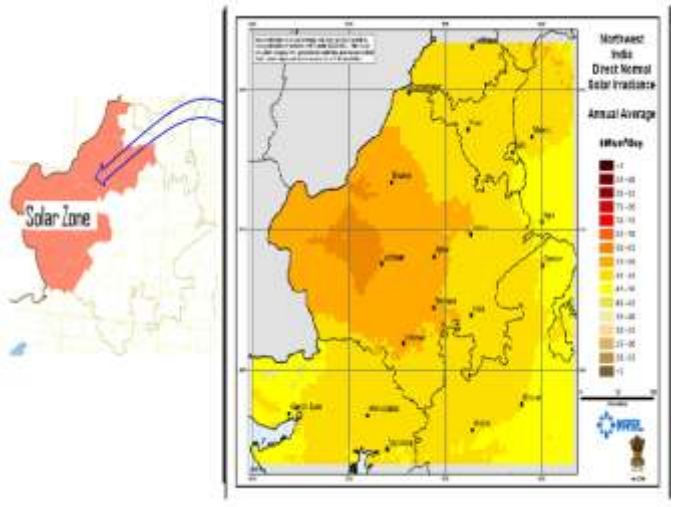

Fig. 1. Solar Power Potential in Rajasthan(CSP)

Rajasthan faces two unique challenges in terms of power generation from the conventional sources. On the one hand, Rajasthan does not have many hydropower projects due to non-availability of large rivers. On the other, because coal needs to be transported from far off areas of the country, the transportation alone contributes to 50% cost of energy production. [2]

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In view of above, even before the creation of National Solar Mission, Govt. of Rajasthan has taken an initiative in 2008 and approved two Solar Projects each of 5 MW under Generation Based Incentive Scheme (GBI).

Table (1).Max. Potential Sites For Concentrated Solar Power Rajasthan

District	Max. Solar Potential KWh/m^2
Jodhpur	5.89
Jaisalmer	5.58
Barmer	5.88
Jalore	5.81
Baran	5.79
Chittorgarh	5.74
Ajmer	5.74
Bikaner	5.73
Dungerpur	5.63

Source: RREC

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 capacity 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 in which solar power plant at Bhadla is one of them. [8]

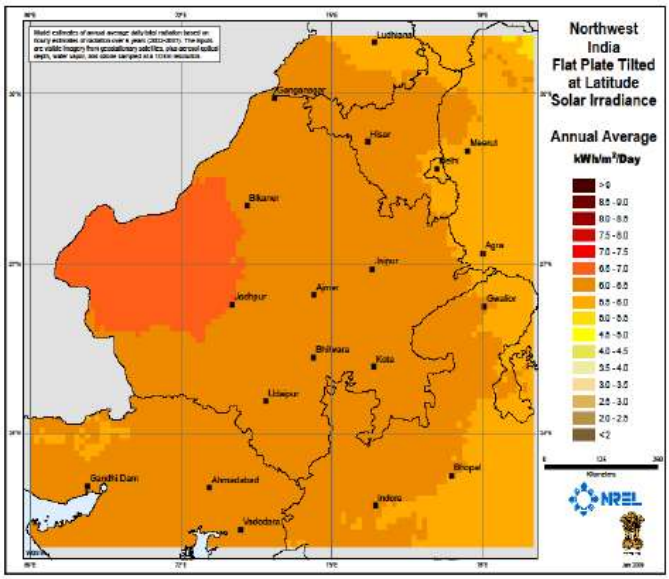

Fig. 2. Solar Power Potential (PV)

Government of Rajasthan on April 19, 2011 issued Rajasthan Solar Energy Policy, 2011 to promote the Solar Energy. The main objectives of this policy includes leverage maximum benefit from National Solar Mission, to develop Solar Power Plants for meeting RPO of Rajasthan, to develop Solar Power Plants for meeting RPO of other States, to promote off-grid applications of solar energy and the development of solar parks. [3, 8]

In coherence with the Rajasthan Solar policy, Rajasthan state will develop Solar Parks of more than 1000 MW capacity in Jodhpur, Jaisalmer, Bikaner, Barmer and districts in various stages. To begin with, solar park at Jodhpur has been initiated. Clinton Foundation signed a memorandum of understanding (MoU) with the Government of Rajasthan in January 2010 for setting up 3000 MW Solar Parks. Rajasthan solar Park Private Ltd (RSP Ltd), a subsidiary company of RREC will formulate policy and rules for land allotment, selection and qualification of firms, grid connectivity and infrastructure plans, sharing of development cost by the developers and management of solar parks. About 10,000 ha government owned land has already been identified at Bhadla in Jodhpur district. Solar Park at Bhadla has 5000 ha in zone I and 2500 ha in zone II and III each. Survey and soil testing work of 3000 ha of Zone I has already been completed. The survey and soil testing of additional 5000 ha of solar park is in process. Consultant appointed by Asian Development Bank (ADI) has already prepared Master plan of Solar Park at Bhadla, Jodhpur. [7, 8]

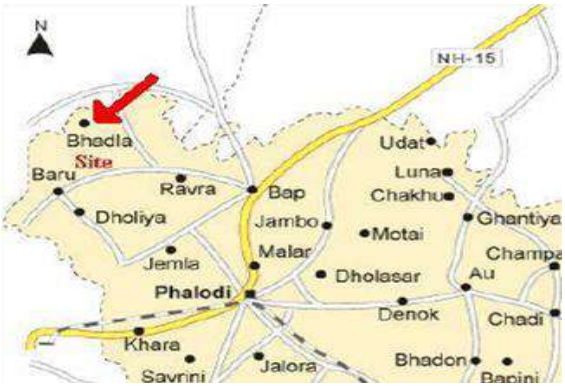

Fig. 3. Bhadla Village @ Jodhpur District.

2. RAJASTHAN SOLAR PARK- THE CONCEPT

The Rajasthan's Bhadla Solar Park will be developed by Rajasthan Renewable Energy Corporation Limited (RREC), Government of Rajasthan (GoR) similar to a special economic zone (SEZ) dedicated for generation of power through solar energy. The park will have adjoining manufacturing area for solar energy components being developed by Rajasthan State Industrial Development and Investment Corporation (RIICO). The Solar Park will hold a number of solar power plants each developed by separate or the same groups/ promoters. The

concept aims to accelerate the development of Solar power generation projects by providing developers with a developed area that has facilitation of the permissions process; is well characterized, has proper infrastructure which minimizes the risk of the project development.[1]

The solar park site will be enabled by the provision of necessary infrastructure build-up in the form of developed land, water access, gas availability and access infrastructure, power evacuation/transmission system, which will be provided to individual developers through a lease arrangement. The state and national government will conduct the necessary evaluation of the environmental and social impacts of utility-scale solar deployment before allocating the land to prospective developers, allowing developers to save time and money often spent on development work for multiple, individual plants in different locations. [1]

The RREC, GoR will be the nodal agency for the development of the solar parks in Rajasthan. In addition, Rajasthan State Industrial Development and Investment Corporation Limited (RIICO), an Industrial catalyst of Rajasthan will develop an Industrial area to facilitate the Industrial production of solar equipment in the area, and Indian Institute of Technology (IIT) Rajasthan, Jodhpur will provide all Research and Development (R & D) support to the Solar industries in Rajasthan and Rajasthan Rajya Vidyut Prasaran Nigam Limited (RRVPNL), the power transmission utility licensed to operate in the state of Rajasthan, will develop the Power evacuation system for pooling of generated power. [1, 4]

3. RSP LOCATION AT BHADLA

Proposed Solar Park is to be developed on 10,000 Ha. vacant Government land in village Bhadla in Phalodi sub-division of Jodhpur district in Rajasthan in 2-3 phases. The Government of Rajasthan has designated areas of land that will allow for the build-up in "convoy" of multiple plants over the next 5 to 10 years, eventually totaling 2 to 3 GW of generation capacity. The following sets of coordinates provide the detail of available land, which is estimated to be a total of 10,000 hectares. [1]

Majority of the land in the park is waste uncultivable land with sand dunes due to deserted conditions and lack of water for irrigation. Some portion of land is under seasonal cultivation of castor oil seed, Gawar and Bajara, though the agriculture in the area is purely depended on rainfalls or bore pumps.

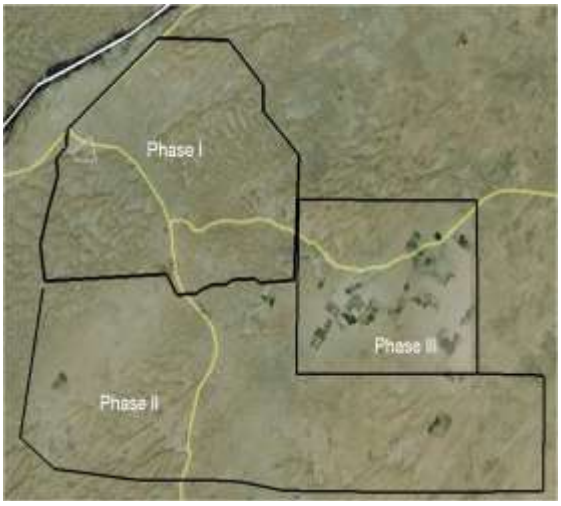

Fig. 4. Layout Plot for STP at Bhadla Village.

Table (2). Latitude Longitude And Area Of Alloted Plot Phase

Phase	Latitute	Longitude	Area (Ha.)
1st phase	27.561436° 27.561003° 27.536027° 27.509074° 27.505844° 27.508915° 27.541685°	71.929246° 71.949858° 71.970592° 71.969121° 71.934704° 71.896030° 71.902458°	3000
2nd Phase	27.469911° 27.463404° 27.464040° 27.488111° 27.488480° 27.509074° 27.508915°	71.891085° 71.967841° 72.038529° 72.041165° 71.967818° 71.969121° 71.896030°	5000
3rd Phase	27.525330° 27.488111° 27.488849° 27.488480° 27.536027°	72.023196° 72.041165° 72.023203° 71.967818° 71.970592°	2000

Source: RRECL

Table (3).Description Of Solar Park Site

Sr. No.	Description	Site
1.	Area of Land	10,000 Ha
2.	Slope of Land	Sloping Land with Sand Dunes
3.	Aprox. Amount of outing Land Required	To be determined after Survey
4.	Owner of Land	Government

5.	Private Land (in Ha.)	Nill
6.	Agriculture land/Non Agriculture Land/Bhanjar Land	To be determined after Survey
7.	Housing /Building	Nill
8.	River /Canal	1.3Km from Indira Gandhi Canal
9.	National /State Highway	35Km from NH-15
10.	Forest Area	Nill
11.	Village/Town	Bhadla
12.	Market/Area of Economic Activity	50Km from Park: Phalod
13.	Road Accessibility	Connected with Nachna – Bhap Road
14.	EHV Line Passing Nearby (Distance)	None
15.	National / State Highway Passing	None

Source: RRECL

4. Technologies Used

The technologies used in Rajasthan Solar Park for energy generation will be PV – Photovoltaic, based on the photovoltaic effect and CSP – Concentrated Solar Power usually related to heat based conversion of radiation and use of that heat to generate electricity. Concentrated photovoltaic - has emerged in recent years and although it is similar in principle to PV, it is different in the way it harnesses solar energy.

5. Generation Level at RSP

The solar park in Bhadla for Phase I encompasses 150 MW of CSP and 100 MW of PV projects. Based on the numbers previously given on available radiation, it may be considered that 5 hours at nominal rate is available for both PV and CSP power plants.

Table(4). Overall Park Level Generation For Phase I

Technologies	MV	Hours	MWh (Years)
PV	100	5	182,500
CSP	150	5	273,750
Total	**250**	**5**	**456,250**

Source: RRECL

6. Geological Investigations

The project consists of a proposed solar plant, including photovoltaic (PV) panels; transformers and associated infrastructure - control room etc.

The project site is located at elevation ranging between approximately 168 to 185 m above mean sea level. The area is nearly flat, shallow, south – east to north –west sloping surface. The first stratum of sand layer consists of fine sand and silty sand (up to 0 to 3m) and the second stratum consist of cemented fine sand (between 3 to 6m). The ground water was not available up to 3 m depth.

7. Metrological Data at RSP Bhadla

Overall meteorological data and wind directions at the site are indicated below:

Table(5). Metrological Data

Parameter	Maximum	Minimum
Air Temperature (*C)	50	3
Wind Speed (m/s)	6.2	3.6
Relative Humidity (%)	100	5
Avg...Rainfall(mm)	380	.05

Source: RRECL

8. Power Evacuation System

In order to evacuate the power from the solar power plant, RRVPNL is developing an integrated power evacuation system according to solar power evacuation requirements comprising of one 400 kV sub-station at Bhadla and construction of 3 pooling sub-stations of 132 kV GSS in solar park for evacuation of power with provision of their up gradation to 220 kV at a later date and its interconnection with 400 kV GSS. Power from Bhadla 400 kV sub-station shall be evacuated by double circuit 400 kV line to Mokla 400 kV sub-station and double circuit 400 kV line from 400 kV GSS Bhadla to 765/400 kV Jodhpur sub-station. [1]

9. Environmental Issues

Based on the environmental assessment and site surveys conducted for the project, there are very minimal associated potential adverse environmental impacts, which can be mitigated to an acceptable level by adequate implementation of the measures as stated in the Environment Management Plan (EMP) documents. Overall, the major social and environmental impacts associated with project are limited to the construction period and can be mitigated to an acceptable level by implementation of recommended measures and by best engineering and environmental practices. Adequate budget provisions should be made in the project to cover the Environmental mitigation and monitoring requirements, with associated costs. [1, 9]

10. Conclusion

Initially the pace of work progress of development is somewhat slow, mainly because power generation from solar

energy is expensive and costly. The unusual bhanjar/non residential/non agricultural lands are successfully being used for establishing solar thermal power plant. And fulfilling the dreams to fill the energy gap between supply and demand in rural areas of Rajasthan State. Rajasthan Government is fully committed to the promotion of solar energy. We believe that implementation of the Rajasthan Solar Energy Policy 2011 will help develop Rajasthan as a global hub of solar power for 10000-12000 MW capacity over the next 10 to 12 years to meet energy requirements of Rajasthan and other states of India.

ACKNOWLEDGMENT

The present study report is in the continuation mode as a part of Dissertation / Project of M.Tech (Power Systems) course under the guidance of Mr. A K Sharma, Associate Professor, Dept. of Electrical Engineering, UCE-RTU Kota. The author Mr. Hemant Kumar gratefully acknowledges Mr. A K Sharma and other co-authors for their valuable guidance and support.

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