



# Potential of Solar Energy in India: A Review

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**Abstract:** After the oil crisis in 1973, the world have to think about the alternative resource of energy apart from conventional energy resources (coal, gas and petroleum etc.). Solar energy is the most important alternative resource of the world and has a large potential of green energy. India has a huge potential for generating green electricity from the renewable energy sources. To promote the green energy, government of India launching many schemes for the renewable energy resources. Jawahar Lal Nehru National Solar Mission (JNNSM) is one of them launched on 11<sup>th</sup> January 2010, under National Action Plan on Climate Change (NAPCC–2008). In this paper, efforts have made to summarize the availability, current status, promotion policies and future potential of different form of solar energy in India.

**Keywords:** Solar Energy, Solar policy and Renewable policy in India.

## 1. INTRODUCTION

In the today's world the fastest growing thing is the energy requirement by world, with the reduction in the conventional resource. The most challenging thing in front of the world is how fulfill the requirement of energy. Due to the limitation of the conventional resources, the world has to think about the alternate source of energy. Now a day's most of the countries are emphasizing on the development of renewable energy resources. In the renewable energy resources, solar energy plays important role and it is a tremendous source of energy. The sun is the planet's most powerful source of energy and also the most unused source of energy by humans. Solar energy is abundant and offers a solution to fossil fuel emissions and global climate change. The rate of energy received by the earth from solar energy is approximately 1,20,000 TW (1 TW =  $10^{12}$ W or 1 trillion watt). This is much high from both the current annual global energy consumption rate of about 15 TW, and any additional requirement in future [1]. Solar power is a clean, environmental friendly source of energy [2]. There are no toxic byproducts or emissions.

Sun Heat is directly utilized for water heating, room heating, vaporization etc. Solar water heating systems are in high demand. Typically 30–40% of a family's electricity bill is devoted to water. Sun Heat's system can save the individual family from 70% to 90% of the total amount spent on the electricity used for heating water. The system generally meets all of the summer time heating needs [1, 2, 3, 4]. During times of decreased sunlight, the system will preheat the water then bring it up to temperature by the conventional water heating system already in place. The first serious attempts to deploy the technology were made with the formation of Department of Non-Conventional Energy Sources (DNES) in 1982, though the history of research and pilot-demonstration go back to 1960s. The total installed collector area increased from 119,000 m<sup>2</sup> in 1989 to 525,000 m<sup>2</sup> in 2001 and to estimated 3.1 million m<sup>2</sup> by December 2009 [4, 9, 8, 10].

## 2. SOLAR POTENTIAL IN INDIA

Power sector is one of the key sectors contributing significantly to the growth of country's economy. Power sector needs a more useful role to be played in defining, formulating and implementing the research projects with close involvement of all utilities such that the benefit reaches the ultimate consumer. In India there is a huge gap between the energy generation and energy consumption. India has a great potential for solar power and it is estimated so many times of the energy requirement which is about 5000 trillion kWh per year. The solar radiation incident over India is equal to 4–7 kWh per square meter per day with an annual radiation ranging from 1200–2300 kWh per square meter. It has an average of 250–300 clear sunny days and 2300–3200 hours of sun shine per year. India's electricity needs can be met on a total land area of 3000 km<sup>2</sup> which is equal to 0.1% of total land in the country [2, 3, 4].

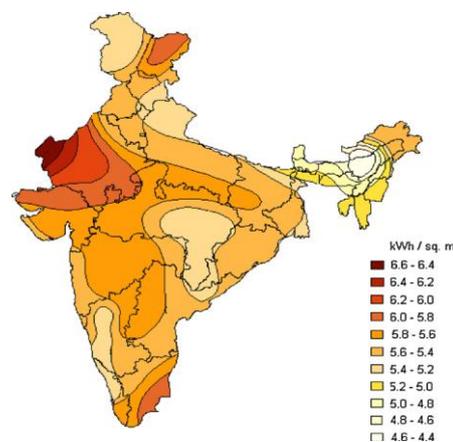


Fig.1. Solar radiations in India

Government of India is trying to improve the share of energy generation from the solar energy and launched Jawaharlal Nehru Solar Mission. Under First Phase of 200 Jawaharlal Nehru National Solar Mission (JNNSM) to be implemented between 1<sup>st</sup> April 2010 and 31<sup>st</sup> March 2013



MW capacity equivalent off grid solar PV systems and 7 million square meter solar thermal collector area to be installed in the country. Table.1 shows the development progress of JNSM [6, 7, 8].

Table.1 Solar Mission- JNSM Targets

S. N.	Application Segment	Target for Phase I (2010-13)	Target for Phase II (2013-17)	Target for Phase III (2017-22)
1.	Solar collectors	7 million sq meters	15 million sq meters	20 million sq meters
2.	Off grid solar applications	200 MW	1000 MW	2000 MW
3.	Utility grid power, including roof top	1000-2000 MW	4000-10000 MW	20000 MW

During first year of first phase (2010-11) a target of 32 MW solar PV off grid systems and 5 lakh square meter solar thermal collector area was set. The targets are to be achieved through various channel partners mentioned in the scheme. As on February 2011, the achievements figures are 38.5 MW for off grid PV systems and 1.2 Lakh square meter solar thermal collector area [1, 3, 5, 7].

The policy visions to install 22,000 MW through grid connected and off grid power plants. As of April 2014, India's total installed capacity through grid connected solar power plants has crossed 2.2 GW with major contribution coming through grid connected solar PV power plants. Table.2 shows the current status of install urban solar energy status categories wise [11].

Table.2 Rural status of solar energy uses

Source	Cumulative capacity
Rural /Semi Urban Biogas Plant	42,77,000 MW
SPV Street Lighting System	1,21,634MW
SPV Home Lighting System	6,19,428 MW
SPV Pump	7,495 MW
Solar Cookers	6,64,000 MW

The amount of solar energy produced in India in 2007 was less than 1% of the total energy demand. The grid-connected solar power as of December 2010 was merely 10 MW. Government-funded solar energy in India only accounted for approximately 6.4 MW-yrs of power as of 2005. However, India is ranked number one in terms of solar energy production per watt installed, with an

insolation of 1,700 to 1,900 kilowatt hours per kilowatt peak (kWh/KWp). 25.1 MW was added in 2010 and 468.3 MW in 2011. Table.3 shows the current installed capacity of the solar power state wise [8, 9, 10, 11, 12].

Table.3 Status of solar power in India

State	MW Power	% Power
Andhra Pradesh	127.85	4.00%
Chhattisgarh	4.00	0.30%
Delhi	2.50	0.19%
Gujarat	654.80	49.80%
Haryana	7.8	0.59%
Jharkhand	4.00	0.30%
Karnataka	9.00	0.69%
Madhya Pradesh	132.00	9.15
Maharashtra	20.00	1.38%
Odisha	13.00	0.99%
Punjab	9.00	0.69%
Rajasthan	510.25	38.89%
Tamil Nadu	15.00	1.14%
Uttar Pradesh	12	0.91%
Uttarakhand	5.00	0.38%
West Bengal	2.00	0.15%
<b>Total</b>	<b>1,442.10</b>	<b>100%</b>

### 3. EMERGING FUTURE OF RENEWABLE ENERGY IN INDIA

New project development for 100 MW capacity of grid (below 33 kV) connected solar projects (of 100 kW to 2 MW capacities each) have also been selected. It is expected that 150–200 MW of solar power will be installed in the country by December 2011. By end September 2014, the installed grid connected solar power had increased to 2,766 MW and India expects to install an additional 10,000 MW by 2017, and a total of 20,000 MW by 2022. Table.4 Shows a state wise distribution of renewable energy generation, tentative target set by the ministry of new and renewable energy under the 12<sup>th</sup> financial plan.

The State Government of Andhra Pradesh is developing a solar farm cluster called solar city on a 10,000 acre land at Kadiri in Anantapur district. Solar city is expected to attract investments worth Rs. 3000 crore in the first phase. Four firms (Sun borne, Lance Solar, AES Solar and Titan Energy) have signed a memorandum of understanding with the State to set up their units there. These companies will be the anchor units in solar city and have a combined capacity of 2000 MW. Karnataka Power Corporation Ltd. has implemented two projects– each of 3 MW power capacities and has awarded a third project of same capacity recently. The solar plants, located in Kola and Chickadee districts, have been implemented under the Arunodaya scheme for ensuring assured power supply to rural areas, especially irrigation pump sets [2, 4, 7 9]. These PV power plants are intended as tail end support/powering of irrigation pumps.



Table.4. Tentative State-wise break-up of Renewable Power target to be achieved by the year 2022 So that cumulative achievement is 1,75,000 MW [6, 7, 8]

State/UTs	Solar Power (MW)	Wind (MW)	SHP (MW)	Biomass Power (MW)
Delhi	2762	-	-	-
Haryana	4142	-	25	209
Himachal Pradesh	776	-	1500	-
Jammu & Kashmir	1155	-	150	-
Punjab	4772	-	50	244
Rajasthan	5762	8600	-	-
Uttar Pradesh	10697	-	25	3499
Uttrakhand	900	-	700	197
Chandigarh	153	-	-	-
<b>Northern Region</b>	<b>31120</b>	<b>8600</b>	<b>2450</b>	<b>4149</b>
Goa	358	-	-	-
Gujarat	8020	8800	25	288
Chhattisgarh	1783	-	25	-
Madhya Pradesh	5675	6200	25	118
Maharashtra	11926	7600	50	2469
D. & N. Haveli	449	-	-	-
Daman & Diu	199	-	-	-
<b>Western Region</b>	<b>28410</b>	<b>22600</b>	<b>125</b>	<b>2875</b>
Andhra Pradesh	9834	8100	-	543
Telangana	-	2000	-	-
Karnataka	5697	6200	1500	1420
Kerala	1870	-	100	-
Tamil Nadu	8884	11900	75	649
Puducherry	246	-	-	-
<b>Southern Region</b>	<b>26531</b>	<b>28200</b>	<b>1675</b>	<b>2612</b>
Bihar	2493	-	25	244
Jharkhand	1995	-	10	-
Orissa	2377	-	-	-
West Bengal	5336	-	50	-
Sikkim	36	-	50	-
<b>Eastern Region</b>	<b>12237</b>	<b>-</b>	<b>135</b>	<b>244</b>
Assam	663	-	25	-
Manipur	105	-	-	-
Meghalaya	161	-	50	-
Nagaland	61	-	15	-
Tripura	105	-	-	-
Arunachal Pradesh	39	-	500	-
Mizoram	72	-	25	-
<b>North Eastern Region</b>	<b>1205</b>	<b>-</b>	<b>615</b>	<b>-</b>
Andaman & Nicobar Island	27	-	-	-
Lakshadweep	4	-	-	-
Other	-	600	-	120
<b>All India</b>	<b>99533</b>	<b>60000</b>	<b>5000</b>	<b>10000</b>

## 4. CONCLUSION



Country like India has very much unbalanced in electricity production. Production is less and consumption is very much. Solar power is very good option in India to increase power production. This is also very good for our environment protection and economic development. Solar power is unlimited source of energy and our country also provide suitable climate for this energy but we need some better idea to increase efficiency and decrease production cost. Our government launches some schemes for production of solar power and achieves some successes but we need education and publicity in society for these schemes so that people take some initiative for use renewable energy as much as at a place of conventional energy sources. Currently we are generating 4.59% of solar energy of total produced renewable energy installed capacity in India. It is very low in comparison of total installed capacity of renewable energy and scope is very much for this solar PV.

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