Future Scope of Solar Energy in India

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ABSTRACT

Generation of solar energy has tremendous scope in India. The geographical location of the country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. This is equal to more than 5,000 trillion kWh. Almost, all parts of India receive 4-7 kWh of solar radiation per sq metres. This is equivalent to 2,300–3,200 sunshine hours per year. States like Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, and West Bengal have great potential for tapping solar energy due to their location. Since majority of the population live in rural areas, there is much scope for solar energy being promoted in these areas. Use of solar energy can reduce the use of firewood and dung cakes by rural household. Many large projects have been proposed in India, some of them are: i).Thar Desert of India has best solar power projects, estimated to generate 700 to 2,100 GW, ii). The Jawaharlal Nehru National Solar Mission (JNNSM) launched by the Centre is targeting 20,000 MW of solar energy power by 2022, iii).Gujarat's pioneering solar power policy aims at 1,000 MW of solar energy generation, and Rs. 130 billion solar power plan was unveiled in July 2009, which projected to produce 20 GW of solar power by 2020. Apart from above, about 66 MW is installed for various applications in the rural area, amounting to be used in solar lanterns, street lighting systems and solar water pumps, etc.

Thus, India has massive plan for Solar Energy generation that may not only fulfill the deficit of power generation but also contribute largely in Green Energy Production to help to reduce the Climatic Changes globally.

Keywords: *Solar energy, Solar Mission, Solar radiation, Solar power projects, Green Energy Production.*

1. INTRODUCTION

In an indication of growing appetite for electricity in India, the country's per capita electricity consumption has reached 1010 kilowatt-hour (kWh) in 2014-15, compared with 957 kWh in 2013-14 and 914.41 kWh in 2012-13, according to the Central Electricity Authority (CEA), India's apex power sector planning body.

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The per capita electricity consumption reached 1010 kWh some time back, said a senior government official, requesting anonymity. But, experts are far from enthused from the increasing consumption figure. "Per capita electricity consumption crossing 1,000 units a year is certainly a milestone, but without much significance. One-fourth of the households in the country still have no access to electricity, with some states in East and North East having less than even 30% households with (electricity) access. Most significant milestone that the nation must achieve is 100% households having 24x7 quality supply of electricity, said Debasish Mishra, senior director, consulting, Deloitte Touche Tohmatsu India Pvt. Ltd.

India's per capita power consumption is among the lowest in the world. Around 280 million people in the country do not have access to electricity. In comparison, China has a per capita consumption of 4,000kWh, with developed nations averaging around 15,000kWh per capita. Interestingly, while the peak shortage in the country was at 2.3% in May, many believe that the demand still looks artificially suppressed as state electricity boards (SEBs) are not buying power. SEBs have been unwilling to procure electricity because of their weak financials due to low tariffs, slow progress in reducing losses, higher power purchase costs and crippling debt. India has an installed power generation capacity of **272,503**MW **(Annexure-I** and **II).**

The Minister for Power, Coal and Renewable energy Piyush Goyal has maintained that the states have not been buying power. "Some state governments haven't cooperated as much as they should... we urge them to increase it. Otherwise they would receive an appropriate response from the electorate in the coming days," Goyal said at a press conference on 25 May 2015. Electricity generation was the silver lining in the May index of industrial production data. Electricity output, which contracted 0.5% in April, recovered to grow 6% in May, 2015. Of our installed capacity, only around 145,000MW is operational.

India needs as much as $200 billion to meet its target of installing 100,000MW of solar power capacity and around 60,000MW of wind power capacity by 2022. The Government of India had made energy security and launched a scheme aimed at ensuring about eight hours of quality power supply to agricultural consumers and 24-hour electricity to households in April-May 2014.

2. INDIA'S SOLAR POWER POTENTIAL

India's plan to become of the largest solar power markets in the world has received a massive boost as the latest estimated of its solar power potential.

Fig.1: Future of Solar Energy in India

The National Institute of Solar Energy in India has determined the country's solar power potential at about 750 GW, a recently released document by the Ministry of New & Renewable Energy (MNRE) shows. The solar power potential has been estimated using the wasteland availability data in every state and jurisdiction of India. The estimate is based on the assumption that only 3% of the total wasteland available in a state is used for development of solar power projects.

3. WHY SOLAR POWER GENERATION

Solar energy is genesis for all forms of energy. This energy can be made use of in two ways the Thermal route i.e. using heat for drying, heating, cooking or generation of electricity or through the Photovoltaic route which converts solar energy in to electricity that can be used for a myriad purposes such as lighting, pumping and generation of electricity. With its pollution free nature, virtually inexhaustible supply and global distribution- solar energy is very attractive energy resource. Solar Energy can be utilized for varied applications. So the answer to "Why Solar" question can be sought from two different perspectives: utilizing solar energy for grid-interactive and off-grid (including captive) power generation.

Fig.2: Solar Generation Unit

3.1. Solar for grid connected electricity

Grid interactive solar energy is derived from solar photovoltaic cells and CSP Plants on a large scale. The grid connection is chosen due to following reasons:

- Solar Energy is available throughout the day which is the peak load demand time.
- Solar energy conversion equipments have longer life and need lesser maintenance and hence provide higher energy infrastructure security.
- Low running costs & grid tie-up capital returns (Net Metering).
- Unlike conventional thermal power generation from coal, they do not cause pollution and generate clean power.
- Abundance of free solar energy throughout all parts of world (although gradually decreasing from equatorial, tropical, sub-tropical and polar regions). Can be utilized almost everywhere.

3.2. Solar for off-grid solutions

While, the areas with easier grid access are utilizing grid connectivity, the places where utility power is scant or too expensive

to bring, have no choice but to opt for their own generation. They generate power from a diverse range of small local generators using both fossil fuels (diesel, gas) and locally available renewable energy technologies (solar PV, wind, small hydro, biomass, etc.) with or without its own storage (batteries). This is known as off-grid electricity. Remote power systems are installed for the following reasons:

- Desire to use renewable - environmentally safe, pollution free.
- Combining various generating options available- hybrid power generation.
- Desire for independence from the unreliable, fault prone and interrupted grid connection.
- Available storage and back-up options.
- No overhead wires- no transmission loss.
- Varied applications and products: Lighting, Communication Systems, Cooking, Heating, Pumping, Small scale industry utilization etc.
- Captive power generation is done mainly considering the replacement of diesel with solar.

3.3 Current Projects (includes both-installed and under installation projects)

The statewise Solar Power Generation (installed and in process) capacity is shown in the Table-I. This shows that the leading efforts have been made in Gujarat where about 720 MW solar generations has been installed and next falls in Maharashtra where about 133 MW Solar Power generations is in progress. We have to now focus in other state also.

Table-1: Statewise Solar Power Generation

S.No	State	Photo voltaic Capacity (MW)	Solar Thermal Capacity (MW)
1.	Rajasthan	43	400
2.	Gujarat	722	45
3.	Maharashtra	133	-
4.	Karnataka	10	-
5.	Andhra Pradesh	20.5	-
6.	Uttarakhand	4	-
7.	Punjab	5	-
8.	Haryana	7.8	-
9.	Uttar Pradesh	11	-
10.	Jharkhand	16	-
11.	Chhattisgarh	4	-
12.	Madhya Pradesh	7.25	-
13.	Odisha	11	-
14.	Tamil Nadu	12	-
TOTAL		**1006.55**	**445**

4. SOLAR PLANS IN INDIA

India has tremendous scope of generating solar energy. The geographical location of the country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. This is equal to more than 5,000 trillion kWh. Almost all parts of India receive 4-7 kWh of solar radiation per sq metres. This is equivalent to 2,300–3,200 sunshine hours per year. States like Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, and West Bengal have great potential for tapping solar energy due to their location. Since, majority of the population live in rural

areas, there is much scope for solar energy being promoted in these areas. Use of solar energy can reduce the use of firewood and dung cakes by rural household.

According to the estimates, Rajasthan and Jammu & Kashmir have the highest solar power potential. Rajasthan, with its healthy resource of solar radiation and availability of vast tracts of wasteland in the form of the Thar Desert, has a potential of about 142 GW. Jammu & Kashmir receives the highest amount of solar radiation in India, and has a significantly large area of wasteland in Ladakh. The state has an estimated potential of 111 GW. However, this estimate may also include the land currently under Pakistan's control.

Madhya Pradesh and Maharashtra both have more than 60 GW of solar power potential. These are among the largest of the Indian states and thus have large wasteland resources. Both these states have ambitious solar power policies and plans to implement large-scale solar power projects.

Gujarat, the leading Indian state in terms of installed solar power capacity, has an estimated potential of 36 GW. The state has large tracts of land covered with marshes but these lands also support a wide variety of wildlife. Gujarat already has an installed capacity of close to 900 MW of solar power and has already started developing utility-scale solar power projects over water canals.

Agricultural states like Punjab and Haryana expectedly rank low in terms of estimated solar power potential. Punjab would find it difficult to make available land for large solar power projects and has thus decided to concentrate efforts to set up solar power projects over rooftops and canals.

India's current solar power installed capacity is around 3 GW, or less than 0.5% of the estimated potential. Naturally there exists a massive opportunity to tap this potential. As a result, the Indian government has increased its solar power capacity addition target five-fold. Instead of the initial target to installed 22 GW solar power capacity by 2022, the government now plans to add 100 GW capacities. This includes 20 GW of ultra mega solar power projects, with installed capacity of 500 MW or more, across 12 states as against the India total Solar Capacity is 750 GWh (**Annexure-III**).

5. ADVANTAGES AND DISADVANTAGES OF SOLAR ENERGY IN INDIA

5.1 Advantages of Solar Energy in India

Some of the advantages of solar energy which makes it all the more suitable for India are as follows:

- This is an inexhaustible source of energy and the best replacement to other non-renewable energies in India.

- Solar energy is environment friendly. When in use, it does not release CO2 and other gases which pollute the air. Hence, it is very suitable for India, India being one of the most polluted countries of the world.
- Solar energy can be used for variety of purposes like as heating, drying, cooking or electricity, which is suitable for the rural areas in India. It can also be used in cars, planes, large power boats, satellites, calculators and many more such items, just apt for the urban population.
- Solar power is inexhaustible. In an energy deficient country like India, where power generation is costly, solar energy is the best alternate means of power generation.
- You don't need a power or gas grid to get solar energy. A solar energy system can be installed anywhere. Solar panels can be easily placed in houses. Hence, it is quite inexpensive compared to other sources of energy.

5.2 Disadvantages of Solar Energy in India

Some of the disadvantages of solar energy which needs further researches are as follows:

- We cannot generate energy during the night time with solar energy.
- And, also during day time, the weather may be cloudy or rainy, with little or no sun radiation. Hence, this makes solar energy panels less reliable as a solution.
- Only those areas that receive good amount of sunlight are suitable for producing solar energy.
- Solar panels also require inverters and storage batteries to convert direct electricity to alternating electricity so as to generate electricity. While installing a solar panel is quite cheap, installing other equipments becomes expensive.
- The land space required to install a solar plant with solar panel is quite large and that land space remains occupied for many years altogether and cannot be used for other purposes.
- Energy production is quite low compared to other forms of energy.
- Solar panels require considerable maintenance as they are fragile and can be easily damaged. So extra expenses are incurred as additional insurance costs.

5.3 Future of Solar energy in India

In solar energy sector, many large projects have been proposed in India.

- Thar Desert has some of India's best solar power projects, estimated to generate 700 to 2,100 GW.
- On March 1st, 2014, the then Chief Minister of Gujarat, Narendra Modi,

inaugurated at Diken in Neemuch district of Madhya Pradesh, India's biggest solar power plant.

- The Jawaharlal Nehru National Solar Mission (JNNSM) launched by the Centre is targeting 20,000 MW of solar energy power by 2022
- Gujarat's pioneering solar power policy aims at 1,000 MW of solar energy generation.
- In July 2009, a $19 billion solar power plan was unveiled, which projected to produce 20 GW of solar power by 2020.
- About 66 MW is installed for various applications in the rural area, amounting to be used in solar lanterns, street lighting systems and solar water pumps, etc.

5. CONCLUSION

As per the geographical location of the country, India stands to its benefit and has tremendous scope of generating solar energy. Solar Power Generation alone can cater more than 60-65% of our entire need of power. Thus, we have to focus on following future plans of installing large projects in Rajasthan and Jammu & Kashmir where as in Uttar-Pradesh, Banda district - is most suitable location to cater our need of Uttar-Pradesh. Apart from above, we also have to focus on Roof Top Solar Energy Generation that may cut down our need to more than 50% need of every house hold.

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Appendix-I

Total Installed Capacity as per Sectors
(As on 29.02.2016):

S. No.	Sector	Installed capacity (MW)	Generation (in MW)	% ge	Remarks
1.	State Sector	97,951		33.9	
2.	Central Sector	74,847		25.9	
3.	Private Sector	1,15,868		40.2	
	Total	**2,88,665**	**1,04,867.3**		

Appendix-II

Total Installed Capacity as per Fuel
(As on 29-02-2016)

S. No.	Type of Generation	Fuel	Installed Capacity (MW)	% ge	Remarks
1	Total Thermal	a). Coal	1,75,858	60.93	
		b). Gas	24,509	8.49	
		c). Oil	994	0.34	
	Total		2,01,360	69.76	
2.	Hydro (Renewable)		42,703	14.79	
3.	Nuclear		5,780	2.00	
4.	RES**		38,822	13.45	
	Total		**2,88,665**	**100**	

**Renewable Energy Sources (RES) include SHP, BG, BP, U&I and Wind Energy
SHP= Small Hydro Project, BG= Biomass Gasifier, BP= Biomass Power, U & I=U

Appendix-III

State wise Estimated Solar Power Potential

S. No.	State of India	Solar Potential (in Gwh)	Targets
1	Andhra Pradesh	38.44	
2.	Arunachal Pradesh	8.65	
3.	Assam	13.76	
4.	Bihar	11.20	
5.	Chhattisgarh	18.27	
6.	Delhi	2.05	
7.	Goa	0.88	
8.	Gujarat	35.77	
9.	Haryana	4.56	
10.	Himachal Pradesh	33.84	

11.	Jammu & Kashmir	111.05	
12.	Jharkhand	18.18	
13.	Karnataka	24.70	
14.	Kerala	6.11	
15.	Madhya Pradesh	61.66	
16.	Nagaland	7.29	
17.	Orissa	25.78	
18.	Punjab	2.81	
19.	Rajasthan	142.31	
20.	Sikkim	4.94	
21.	Tamil Nadu	17.67	
22.	Telangana	20.41	
23.	Tripura	2.08	
24.	Uttar Pradesh	22.83	
25.	Uttarakhand	16.80	
26.	West Bengal	6.26	
27.	UT	0.79	
	Total	**748.98**	

Urban & Industrial Waste Power, RES=Renewable Energy Sources