

Solar Energy In India - Present And Future

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Abstract: The sun can be one of the most possible powerful renewable energy sources. Solar energy is finite energy resources to meet up long term global energy crisis. The recent energy crisis and environmental burden are becoming increasingly urgent and drawing enormous attention to solar-energy utilization. The recent energy crisis and environmental hazards are drawing enormous attention to solar-energy utilization. The utilization of solar energy in India has got prime importance in the present scenario of energy crisis in the country. India is situated in sunny belt India is endowed with vast solar energy potential. Government of India had launched Jawaharlal Nehru National Solar Mission (JNNSM) in 2009. The target was to start Grid connected Solar Projects of 20 GW by 2022. In May 2015 government increases the target to 100 GW by 2022. Solar Power in India is the fastest growing industry and continuing to develop the electricity with solar power projects in Tamil Nadu, Rajasthan, Gujarat and Maharashtra. These states are also the top five states in India with highest wind electricity generation. The price of solar energy has come down from Rs. 17.90 per unit in 2010 to about Rs. 7 per unit in 2015. It is expected that with technology improvement and market competition solar power will reach grid parity by 2017-18. The Ministry of non- convection energy resources, government of India is trying to increases the power capacity and achieve the target of 100 GW by 2022. 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 Power projects, Indian Policies, growth of solar energy in India.

I. Introduction

Solar energy is the energy that is in sunlight. It has been used for thousands of years in many different ways by people all over the world. Solar radiation reaches the Earth's upper Earth's atmosphere with the power of 1366 watts per square meter (W/m^2). Since the Earth is round, the surface nearer its poles is angled away from the Sun and receives much less solar energy than the surface nearer the equator. At present, solar cell panels convert, at best, about 15% of sunlight hitting them into electricity. The dark disks in the third diagram on the right are imaginary examples of the amount of land that, if covered with 8% efficient solar panels, would produce slightly more energy in the form of electricity than the world needed in 2003.

The sun can be one of the most possible powerful renewable energy sources. Solar energy is finite energy resources to meet up long term global energy crisis. The recent energy crisis and environmental burden are becoming increasingly urgent and drawing enormous attention to solar energy utilization. The recent energy crisis and environmental hazards are drawing enormous attention to solar energy utilization. The utilization of solar energy in India has got prime importance in the present scenario of energy crisis in the country. India is facing an acute energy scarcity which is hampering its industrial growth and economic progress of the country. In India there has been a continuous effort in the direction of the use of lesser amount of fossil fuels and increased supply of energy which can only be met by a planned harnessing of more renewable energy sources and the government is serious in the planned development of these sources.

The National Action Plan on Climate Change (NAPCC) also points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level"

In India, till 2012, no commercial solar thermal power plant generating bulk electricity has been installed. There is ample scope in India to meet the energy problems through solar thermal technologies which will help to protect the global climate by reducing GHG and CO₂ emissions for sustainable economic and social development of the country. The main features of the radiation climatology of India are as follows:

- About 3300 to 3700 hours of bright sunshine are available in a year in the northwest and West Central regions of the sub-continent and 2900 hours over Central peninsula except Assam, Kerala and Kashmir where it is appreciably lower.
- About 7.5 Kwh/m²/day of solar energy is received over the country as a whole, for the major portion of the year, of which the maximum about 210 Kwh/m²/month is received during cloud free winter months and pre-monsoon months and the minimum 140 Kwh/m²/month is received during monsoon seasons.
- During winter, the lowest radiation is received in North India and the highest in the South India. During summer, a reversal occurs with high values in North and low in South.
- Diffused solar radiation is a minimum 740 KWh/m² over Rajasthan increasing eastwards to 840 KWh/m² in Assam and to 920 KWh/m² in extreme south of the peninsula.
- The total solar energy received by this subcontinent is over 60 x 10¹³MWh. There are between 250 to 300 days of usual sunshine per year in most parts of the country.

II. Potential Of Solar Power In India

India has a great potential to generate electricity from solar energy and the Country is on course to emerge as a solar energy hub. The techno-commercial potential of Photovoltaics in India is enormous. With GDP growing in excess of 8%, the energy ‘gap’ between supply and demand will only widen. Solar PV is a renewable energy resource capable of bridging this ‘gap’. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year – more than India’s total energy consumption per year. Average solar incidence stands at a robust 4 – 7 kWh/sq.meter/day. About 66 MW of aggregate capacity is installed for various applications comprising one million industrial PV systems – 80% of which is solar lanterns, home/street lighting systems and solar water pumps, etc. The estimated potential envisaged by the Ministry for the solar PV programme, i.e. solar street/home lighting systems, solar lanterns is 20 MW/sq. kilometer.

Solar power is attractive because it is abundant and offers a solution to fossil fuel emissions and global climate change. Earth receives solar energy at the rate of approximately 1,73,000 TW. This enormously exceeds both the current annual global energy consumption rate of about 15 TW, and any conceivable requirement in the future. India is both densely populated and has high solar isolation, providing an ideal combination for solar power in India. India is already a leader in wind power generation. In solar energy sector, some large projects have been proposed, and a 35,000 km² area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 GW. The India Energy Portal estimates that if 10% of the land were used for harnessing solar energy, the installed solar capacity would be at 8,000GW, or around fifty times the current total installed power capacity in the country. For example, even assuming 10% conversion efficiency for PV modules, it will still be thousand times greater than the likely electricity demand in India by the year 2015. **Figure 1** shows solar radiation data map of India. It can be observed that highest annual global radiation is received in Rajasthan and northern Gujarat.

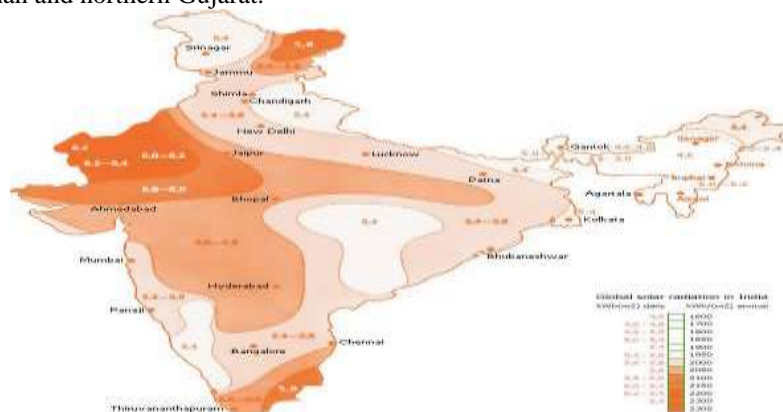


Fig. 1: Solar radiation of India

. Daytime production peak coincides with peak electricity demand making solar ideal supplement to grid. With around 300 sunny days a year nationwide, solar energy’s potential in India is immense. And with \$10.2 billion investments in clean energy, money is starting to follow the opportunity. India received \$95 million in venture-capital funding and over \$1.1 billion in large-scale funding for solar projects in 2011, according to a report by Mercom Capital, a clean-energy consulting firm. The biggest funding deal was a \$694 million loan raised by Maharashtra State Power Generation Co. for its 150-MW Dhule and 125-MW Sakri solar projects.

III. Largest Solar Power Plants In India

India is one of the few countries in the world with highest solar electricity production per watt installed; Solar Power in India is the fastest growing industry and continuing to develop the electricity with solar power projects in Tamil Nadu, Rajasthan, Gujarat and Maharashtra. These states are also the top five states in India with highest wind electricity generation.

The Gujarat solar policy initiated a process of the states formulating their own policy frameworks independent of the federal guidelines. The renewable purchase obligations for state distribution companies, a demand-driven scheme, further accelerated the formulation of solar policies at the state level. These policies exist independent of each other as well as the NSM. Other states like Karnataka, Andhra Pradesh and Rajasthan have followed suit in developing solar power development programs.



Fig.2: Charanka Solar Park, Gujarat



Fig.3: Dhirubhai Ambani Solar Park, Rajasthan

3.1. Bhadla Solar Park, Rajasthan:

Bhadla Solar Park near Jodhpur district of Rajasthan is the largest solar park in India, spread over a total area of 10,000 acres. The park has total capacity of 2,255 MW and NTPC announced that it had commissioned 115 MW on 22 February 2017.

3.2. Kamuthi Solar Power Project, Tamil Nadu:

Kamuthi Solar Power Project is the largest single location solar power plant in the world, located at Kamuthi in Tamil Nadu. The Kamuthi solar plant the world's largest solar power plant with a capacity of 648 MW commissioned by Adani Power.

3.3. Charanka Solar Park, Gujarat:

Charanka village solar park is one of the Asia's biggest solar park, located at northern Gujarat. The site is the world's second largest photovoltaic power station and spread across 5,384 acres of unused land (Figure.2).

3.4. Sakri Solar Plant, Maharashtra:

Sakri Solar Power Plant is the largest solar power plant in Maharashtra, located at Dhule district in Maharashtra. The 125 MW Shivajinagar Sakri solar plants is also one of the largest of its kind solar projects in the country.

3.5. Welspun Solar MP Project, Madhya Pradesh:

Welspun Solar MP project of 151 MW is one of the largest solar power projects in India. The project will use solar energy for electricity generation and an upcoming 750MW solar power plant in Rewa district of Madhya Pradesh will be largest solar plant in India.

3.6. Dhirubhai Ambani Solar Park, Rajasthan:

Dhirubhai Ambani Solar Park was constructed by Reliance Industries near Pokhran in the Jaisalmer district of Rajasthan. The solar park is one of the largest in the Thar Desert and also biggest in the state of Rajasthan (Figure.3).

Upcoming Solar Power Plants in India are 750MW solar power plant in Rewa district of Madhya Pradesh, Kurnool Ultra Mega Solar Park, Ananthapuramu Ultra Mega Solar Park, biggest solar power plant in Tamil Nadu, India's largest solar park in Rajasthan, Reliance Group to develop more solar park in Rajasthan and also Karnataka to set up world's biggest solar park.

IV. Present Status Of Solar Energy In India

India is ranked 11th in solar power generation in the world as on Jan. 2014. Government funded solar energy in India only accounted for about 6.4MW/yr of power as of 2005. In 2010 capacity of 25.1MW was added and 468.3MW in 2011. In 2012 the capacity increase more than two times and become 1205 MW. During 2013 capacity added by 1114MW and during 2014 capacity added by 313MW. In August 2015, the installed grid connected solar power capacity is 4.22 GW. The price of solar energy has come down from Rs. 17.90 per unit in 2010 to about Rs. 7 per unit in 2015. It is expected that with technology improvement and market competition solar power will reach grid parity by 2017-18. The Grid parity means the cost of electricity generated from alternative energy becomes equal or less than the cost of purchasing power from the grid. Grid parity is very important term in the solar system and preferably photovoltaic panel. In India, Rajasthan has the largest share of solar power generation of 28.4% and Gujarat share is 24.4% as on September 2015.

V. Energy Crisis In India

Causes of Energy crisis:

- Land scarcity
- Overpopulation
- Overconsumption
- Poor Infrastructure & Distribution system
- Unexplored
- Delay in Commissioning of Power Plants
- Wastage of energy
- Major accidents & Natural calamities
- Wars & attacks etc.

VI. Solar Energy Power For Future 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 (**Figure. 4**).

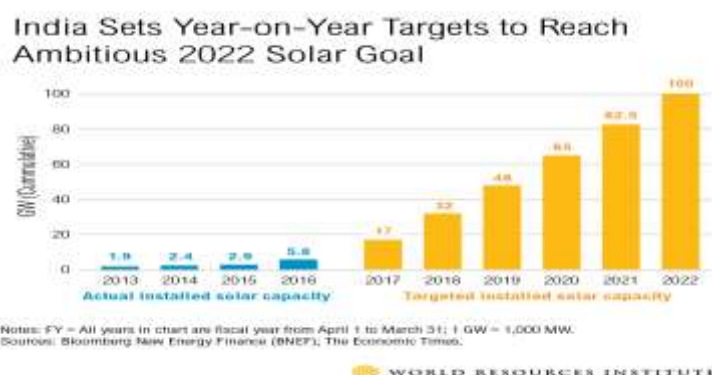


Fig.4: India sets Year- on- Year Targets

India is slowly gaining its prominence in the generation of solar power due to the comprehensive and ambitious state and the Centre's solar policies and projects and National Solar Mission. In the latest 2014 budget, Finance Minister Jaitley declared that the Government has proposed an amount of 500 crore rupees to develop some mega solar power plants in Gujarat, Tamil Nadu, Rajasthan, and Ladakh. He also said that solar power-driven agricultural water pumping stations and 1 MW solar parks on canal banks will be developed in the country at an estimated cost of \$74 million and \$18.5 million, respectively. Considering all these facts, we do have a bright picture in front of us as India's potential to be a solar power driven country of the world.

VII. 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 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.

VIII. Disadvantages Of Solar Energy In India

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.

IX. Conclusion

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. Development of solar sector in India has been visible ever since independence. Solar industry has uplifted the Indian society to an immense socio-economic growth opportunity. But solar industry requires supportive policies for its continuous growth. Investors are keen enough toward this sector in our country thereby contributing to the development of economy via three fold return (i.e. economically, socially & environmentally). The Ministry of non- convection energy resources, government of India is trying to increase the power capacity and achieve the target of 100 GW by 2022. It is very important to support and subsidize the solar power till it can compete with the conventional sources. The step of Indian government to increase the target is a very good to become India as one of the most solar powered countries in the world. Such types of steps will be required in the future.

References

Journals Papers:

- [1] Soumendra Nath Basu, 2 Avijit Karmakar & 3Pushmita Bhattacharya, "Growth of Solar Energy in India–Present Status and Future Possibilities", *International Journal of Electrical, Electronics and Computer Systems (IJECS)*, ISSN (Online): 2347 - 2820, Volume-3, Issue-5 2015
- [2] Teri (2011): Towards Energy Security, 10 January, accessed on 15 Jan 2011(www.teri.in.org)
- [3] Singh Manmohan (2010): To create solar Village, Jan, *Solar Energy Review*, New Delhi
- [4] Chatterjee, Pramita (2010): For Clean Green Energy, *Economic Times*, October 1st, 7.
- [5] Delhi International Renewable Energy Conference (DIREC-2010): accessed on 12 Dec, 2010 (<http://www.direc2010.gov.in/>)
- [6] US-India Energy Partnership Summit, Washington DC (2010); *Solar Energy Review*, New Delhi-India
- [7] <http://www.energymile.com>
- [8] <http://www.worldenergyoutlook.org/>
- [9] www.pcr.org
- [10] Rachit S*, Vinod KG, Solar Power – Current Status, Challenges and Policies in India, *Research & Reviews: Journal of Engineering and Technology (RRJET)*, Volume 5, Issue 2, June, 2016.
- [11] Amita U and Soni MS. Concentrating solar power – Technology, potential and policy in India. *Renewable and Sustainable Energy Reviews*. 2011;15:5161-5175.
- [12] Sharma BD. Performance of Solar Power Plants in India. *Central Electricity Regulatory Commission*, New Delhi. 2011.

- [13] Krithika PR and Siddha M. Background paper Governance of renewable energy in India: *Issues and challenges*. TERI-NEFI. 2014.
- [14] Vikas K, et al. Status of solar wind renewable energy in India. *Renewable and Sustainable Energy Reviews*. 2013;27:1–10.
- [15] Atul S. A comprehensive study of solar power in India and World. *Renewable and Sustainable Energy Review*. 2011,15,1767-1777.