

“Current Status of Solar Energy in India: An Overview”

Aashish Ranjan¹, Jyoti Purohit², Ramswaroop³

¹Student, SGI, Sikar, India, aashishranjanwide@gmail.com

²AP, BKBIET, Pilani, India, jyoti.purohit5@gmail.com

³AP, SGI, Sikar, India, burdak.ramswaroop@gmail.com

Abstract:

India is a fast growing country having more than one billion people. It is the third largest commercial energy consumer in the world after China and the United States. The commercial sources are usually fossil fuels like: coal and petroleum. These are available in limited amount. The over consumption of fossil fuels can lead to energy crisis and serious environmental issues such as: Ozone depletion, global warming and acid rain. The future of renewable energy sources is bright because it is abundant, inexhaustible, pollution free and universal sources of energy. The sun is an enormous source of energy on the earth. So, it will play an important role to solve the energy crisis of India because it is situated in the equatorial sun belt of the earth. With about 300 clear and sunny days in a year, India receives abundant radiation energy from the sun.

Keywords: Energy crisis, Fossil fuels, Renewable energy, solar potential, solar radiation

1. Introduction

In today's world we can't assume life without electricity. All of us have become so dependent on electricity that we can't ignore it even after our will. Electricity has many uses in our daily life, it is used for charging phone, lighting, operating fans, and many more. But, approximately 200 years ago when there was no means of electricity, and humans' life was very tough. People lived

without electricity. On that time the day started with the sun rising and the sun would end with setting. But in today's time, every work is easily done with the help of electricity. At, this time energy demand is being met through Non-conventional energy sources. But non-conventional energy sources are incapable to full fill current electricity demand with efficient manner. These sources are not for a long time, as this is available only in limited amount. Energy planners know the boundaries of these sources and started thinking about the non-traditional sources. Solar energy can easily overcome the problem of electricity in India. India covers a large geographical area of approximately 32 million square kilometers [1]. And receive average intensity of 32 MW/km of solar radiation. And it can give 657.4 million MW of energy in India[2].If 1% of this energy is used ,the available energy will be three times more than the total energy being produced by India. In order to promote India's solar power generation capacity, the Indian government has set up Jawaharlal Nehru national solar mission a separate organization in 2010[3].

JNNSM gave good direction to solar generation and therefore, in short span of 7 years ,India's solar power generation capacity has increased from 161MW to 12,288 MW [4].The Indian government has planned to spend 100 billion US Dollars by 2022 to generate 100 GW(including 40 GW from rooftop solar) of solar energy[5,6,7].This 100GW solar energy is part of the 175 GW energy targeted by India, which is to be produced by renewable energy sources by 2022[5].This new solar goal is expected to reduce CO₂ over 170 million tons in its life cycle[8]. After achieving this goal, India will become a global leader in solar energy [9].

2. Overview of Solar Power

The solar Photovoltaic system is a non-conventional method of power generation [10].it directly transform solar energy into electrical energy [11].Solar cell is the core unit of solar photovoltaic

system. Solar cell works on the principle of photovoltaic effect [12]. Basically, photovoltaic effect are seen in many substances found in nature, but the substances which perform well in the sunlight are semiconductors [13]. Generally, a solar cell is made of two types of semiconductors called n-type and p-type, and we connect a positive terminal of the battery to the P-side and the negative terminal to the N-side so that a closed circuit can be made for electric current [14]. Light is the source of solar cell and it consists of packets of energy called photons [15]. When photons are absorbed by the solar cells it has enough energy to free some electrons from it and these free electrons causes the flow of electric current [11].

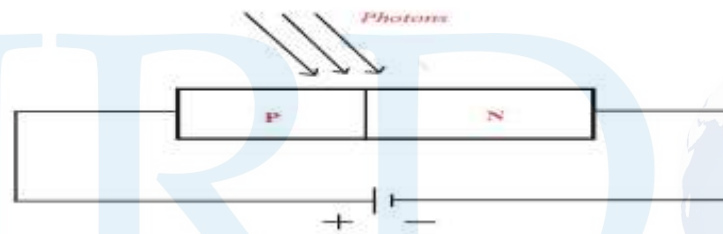


Fig.No.-1

A single solar cell can generate 0.5 volts of energy, so to achieve a desired voltage and current level these solar cells are connected in series and parallel combination [16]. These types connections are known as Solar photovoltaic array. However, solar photovoltaic arrays are added differently so that solar photovoltaic system can be made, which is used to generate large amount of electricity from solar energy [17]. According to the method of utility, solar photo-voltaic systems are classified into two main groups.

1. Grid -connected PV system.
2. Off-grid PV system.

In some cases combination of these two is also seen, and such system is called hybrid system. This can supply power to the grid or work completely independently. Due to higher investment cost, hybrid system hardly used for needs of households.

3. Current status of solar Power in India

According to the Ministry of New and Renewable Energy, India has estimated that the total solar generating capacity should be 748 GW. By June 2017, only 12.2 GW of solar Power has been generated. However, by the end of 2017 India has planned to become the third largest solar Power market ahead of Japan by generating 18.7 GW of solar Power[18]. Since there is a Population density of 393.0/km² in India, the government has planned to set-up 10000 MW large solar project with 5000 MW of rooftop solar project to avoid the huge demand of land in the current financial year[18,19]. In 2015, the government of India has stepped in to increase the required funds for the grid connected rooftop solar system. Under this, 30 % subsidy will be given to all states and up to 70% will be given to special category state[20]. In various states, Tamil Nadu, Andhra Pradesh and Telangana have emerged as the fastest growing states in the field of solar power establishment in the 2017[21].

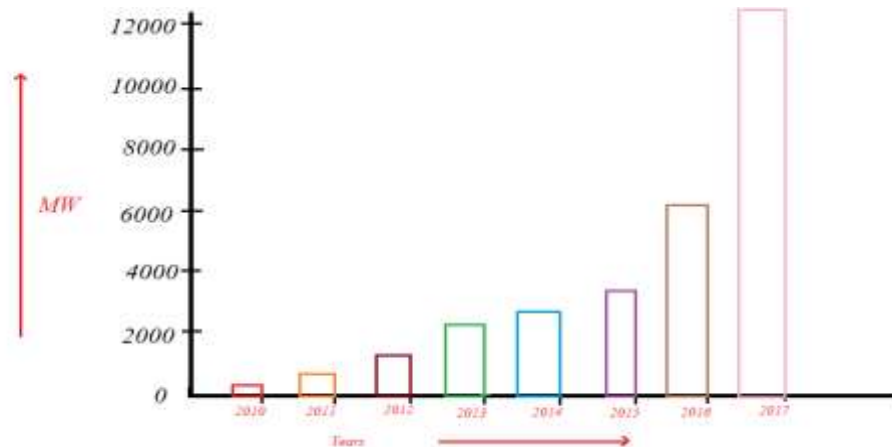


Fig.no.2: Year cumulative capacity (in MW)

India has added 3.01GW solar energy in 2015-16 and 5.525 GW of solar capacity in 2016-17; so far it has been the highest in any year [4].India is a land of villages where 5 lakhs villages are spread over its geographical area. But, due to poor rural electrification, only 55% of all rural households are using electricity till 2015[22,23].Therefore to provide good and reliable quality of electricity in the rural areas, the government has planned to develop a local off-grid in addition to a large-scale grid-connected solar PV [22].

Recently the government has allotted tender to NTPC under national solar mission for 3000 MW grid-connected solar PV power, and also NTPC has issued other PSUs tender for Andhra Pradesh (1000 MW in solar parks), Rajasthan (420 MW in solar parks) and Telangana (100 MW outside from solar parks)[22].In 2010,the cost of solar energy which was 17.90 Rs/unit, has been reduced to 7 Rs/unit in 2015[8].And now, the 850 MW solar PV project of Kurnool district proved wrong about the higher per unit cost of solar energy by obtaining the lowest bids of 4.63/units [22].The National solar energy institute has calculated the state-wise solar capacity by taking data from Census 2011.According to this report Rajasthan (with 142 GW),Jammu Kashmir (with 112 GW) and Maharashtra (with 64 GW) has been observed as one of the India's largest solar potential states[24,25].Estimated Solar capacity of all the states of India is shown in descending order in the table[24,25].

Table I. Indian states solar potential ^[24, 25]

State	Solar Potential(GWp)
Rajasthan	142.2GW
Jammu & Kashmir	111.05 GW
Maharashtra	64.32 GW

Madhya Pradesh	61.66 GW
Andhra Pradesh	38.44 GW
Gujarat	35.77 GW
Himachal Pradesh	33.84 GW
Orissa	25.72 GW
Karnataka	24.70 GW
Uttar Pradesh	22.83 GW
Telangana	20.41 GW
Chhattisgarh	18.27 GW
Jharkhand	18.18 GW
Tamil nadu	17.67 GW
Uttarakhand	16.80 GW
Assam	13.76 GW
Bihar	11.20 GW
Mizoram	9.09 GW
Arunachal Pradesh	8.65 GW
Nagaland	7.29 GW
West Bengal	6.26 GW
Kerala	6.11 GW
Meghalaya	5.86 GW
Sikkim	4.94 GW
Haryana	4.56 GW
Punjab	2.81 GW

Tripura	2.08 GW
Delhi	2.05 GW

And, due to geographical situation, India's north-east region get less solar radiation compared to other Indian region, that's why they have very little solar power generating capacity.

Government has proposed 40 MW of distributed grid-connected solar PV project to deliver carbon free and cheap electricity on island like Andaman& Nicobar and Lakshadweep. For this purpose, there is plan to set up 40 MW solar system at port-Blair of Andaman&nicobar with a 5 MW floating solar system in different islands of Lakshadweep[26].After 2010, some large solar power plants have been set up in different states of India[27].

3.1. Andhra Pradesh

Photovoltaic capacity established in Andhra Pradesh is more than 2049 MW by 31 July 2017[28].

Name of Plant	Capacity in MW	Commission Year
NP Kunta Ultra Mega Solar Power Project ^[29]	250	-----
Kurnool Ultra Mega Solar Park ^[30]	900	April 2017

3.2. Rajasthan

Rajasthan is India's largest solar potential state, and its production capacity has reached 2023 MW till 31 July 2017[4].Three districts of Rajasthan – Jaisalmer, Bikaner and Jodhpur are currently among the most likely districts for solar power.

Name of Plant	Capacity in MW	Commission Year
Dhirubhai Ambani Solar Park ^[31]	100 MW	-----
Bhadla Solar Park	2,255 MW	-----

3.3. Tamil nadu

Solar capacity in Tamilnadu is about 17.67 GW, which is lower than other states like Rajasthan, Jammu & Kashmir, and Maharashtra, yet by 21 September it was the largest solar power producing state [32].

Name of Plant	Capacity in MW	Commission Year
Kamuthi Solar Power Project ^[32]	1697	31 July 2017

3.4. Gujarat

Gujarat is one of the largest solar powered states in India, it is estimated that the capacity is about 35.77GW, and by July 2017 solar plants with about 1262 MW capacity have been set up. Gujarat will remain at the top in solar power sector for long time, due to good availability of solar potential, vacant land, and better infrastructure [33, 34].

Name of Plant	Capacity in MW	Commission Year
Gujrat Solar Park ^[35]	1100	March 2016
Charanka Solar Park ^[36]	500	March 2016

3.5. Maharashtra

Maharashtra with 64.2GW is India's third largest Solar potential state .Osmanabad in Maharashtra is considered as India's third best solar insolation region.

Name of Plant	Capacity in MW	Commission Year
Sakri Solar Power Plant ^[37]	125	-----
Osmanabad Solar Power Plant	10	-----

3.6. Madhya Pradesh

Madhya Pradesh is one of the most solar-power developed states in India, because it is the fourth largest solar potential state in India [38].

Name of Plant	Capacity in MW	Commission Year
Bhagwanpur Solar Power Plant ^[38]	130	-----

Rewa Solar Power Plant	750	-----
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4. Future of solar energy

The earth is getting warm every year. NASA's Goddard institute for space studies (GISS) has reported that from 1880 onwards the global temperature of the earth has increased by 0.8 degree Celsius. Growing 1 degree Celsius of Global Temperature is important, because it uses a vast amount of heat to warm the oceans, the atmosphere and the ground [39]. Apart from India, leaders of 195 countries have signed the Paris agreement on 10th April 2016 for the purpose of limiting the growth of 1.5 degree Celsius instead of 2 degree Celsius in global temperature by the end of this century [40, 41]. Globally, India's contribution to the emission of total harmful gases is only 6%, and the thermal power plant contributes a big share in this emission [42, 43]. According to industries estimate, carbon emission of some of Indian thermal power plant are 120% more than the average emission of the plant in Europe [44]. Solar power will be very useful energy sources to minimize this 6% emission of India [43]. Therefore, solar energy can support India in reducing the emissions of these 6% harmful gases. India has ensured that by 2030, it will reduce the emission of harmful gases by one-third and 40% of its electricity requirements will be made from non-renewable sources [45, 46]. According to the International Energy Agency (IEA), if today's rate of development of renewable energy sources is maintained, production of renewable energy will increase up to 60% by 2035 and this can be doubled by 2060. Besides, solar energy will be contributing maximum. Emission of carbon dioxide in the energy sector will be reduced to 3 gigatons from current 30 gigatons per year [47].

5. Challenges of Solar Power in India

It can't be denied that developing countries like India, where technological growth is very slow, installation of solar power plant is a very expensive deal. Therefore, India has to rely on international resources for technology and fund, but international co-operation in this field is very little. The capital cost of solar system is more than a conventional energy sources based power plant. Inadequate financing of India has hindered the development of solar project. According to report given by Institute for energy, Economics and financial analysis, a US-based research organization, for renewable energy only \$10 billion of public and private wealth have been invested by India in 2015[18].while the required amount is \$26.6 billion [18]. Presently, at least 1 km² land is required for 20-60 MW of solar power generation [48].But India's high Population is a hindrance to the growth of solar. Because land has a lot of burden to meet the needs of today's population and it requires more land in future. So it is difficult to implement any such schemes/projects which will create problems in the future.

6. Conclusion

In this paper, current status of India's solar energy is discussed. And it is also seen that the availability of solar Power in India is very good .But despite some economical reason, India achieved a lot in this sector in less time. At the same time, the organization like Jawaharlal Nehru solar mission is a boon for solar energy has helped in solving the problems of the area. In the field of solar sector, the strong will power of the Indian government will not only strengthen the future of solar energy, but it will brighten India's future also. So, we have to move ahead with a future plan to provide adequate financial support to this region, along with the infrastructure.

7. References

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