JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SOLAR ENERGY FOR SUSTAINABLE DEVELOPMENT IN INDIA

[1]Dr. Roshan Lal and [2]Dr. Suram Singh

[1]Assistant Professor, Department of Chemistry, Govt. Degree College Kathua-184104.

[2]Assistant Professor, Department of Chemistry, Govt. Degree College Billawar-184204

UT of Jammu and Kashmir (India).

ABSTRACT: Solar energy obtained from the sun is one of the largest contributors of renewable energies in India and also in most of other countries. Other renewable energy resources are wind energy, hydropower energy, geothermal energy, tidal energy, biomass and biogas energy. Solar energy being cost effective, everlasting and reliable as compared to all other form of renewable energies is being harnessed on larger scale for mitigating the energy crisis and climate crisis in India and other developing as well as developed nations. In fact solar energy has become a major tool for sustainable socio-economic development of the countries as it does not produce any waste gases or materials which are harmful to the environment. In order to achieve its ambitious installed capacity target of 280 Giga watt (GW) by 2030, the government of India has established 42 solar parks across the country and India being the founder member of international solar alliance (ISA) has put forward the concept of "world solar park" so as to harness the solar energy on commercial scale and become self sufficient in terms of energy demand.

Keywords: Renewable Energy Resources, Energy Crisis, Climate Crisis, Solar Energy, Sustainable Development.

1. INTRODUCTION

Conventional resources of energy such as coal, oil and natural gases are the non renewable resources of energy which are depleting day by day all over the world. The depletion of these energy resources is likely to cause major energy crisis not only in India but in all other countries in near future. In order to mitigate the problem of energy crisis and to improve energy security and access to energy, large number of renewable energy resources such as solar energy, wind energy, tidal energy, geothermal energy, hydropower energy, biogas energy and biomass energy are being used all over the world. Solar energy among other renewable resources of energy is the most promising, affordable, cost effective and easily available energy resource for managing long term issues in energy crisis and because of this the solar industry is developing steadily all over the world. This harnessing of solar energy would definitely be a best option to meet future energy demand of the world as compared to other renewable energy resources [1].

The national electricity plan (NEP) promulgated by the Ministry of Power (MoP) has developed a detailed 10 year action plan to ensure that power is supplied to all the citizens efficiently and at a reasonable cost across the country [2]. According to the World Resource Institute Report 2017, India is responsible for nearly 6.65% of total global carbon emissions, ranked fourth next to China (26.83%), the USA (14.36%), and the EU (9.66%) which might change the ecological balance of the world.

India being one of the largest coal consumers in the world imports about 74% of its total energy demands. According to the report from the centre for monitoring Indian economy, the country imported 171 million tons of coal during 2013-2014, 215 million tons in 2014-2015, 207 million tons in 2015-2016, 195 million tons in 2016-2017 and during 2017-2018, 213 million tons of coal was imported. Therefore there is an urgent need to shift for alternative energy resources for generating electricity [3].Renewable energy resources and technologies have great potential for mitigating the longstanding energy crisis being faced by the developing countries like India and also have potential for addressing the environmental concerns. Solar thermal electricity (STE) also known as concentrating solar power (CSP) is an emerging renewable energy technologies used for electricity generation in India [4].

Various awareness programs have been launched by the Government of India to make public aware about the use of renewable energy resources instead of conventional non renewable energy resources for meeting the energy requirements. India is aiming to attain 175 Giga watt (GW) of renewable energy which would consist of 100 GW from solar energy, 10 GW from bio-power, 60 GW from wind power, and 5 GW from small hydropower plants by the year 2022[6]. Recent estimates show that the solar potential will be more than 750 GW by

2047andit is anticipated that the renewable energy sector will create large number of employment opportunities over the following years [7-9].

In 2016, India was the fourth largest energy consumer in the world after China, USA, and the organization for economic co-operation and development (OECD) in Europe having 724 million tons of oil equivalent (Mtoe) overall energy consumption which is expected to rise to 1921 million tons of oil equivalent (Mtoe) by 2040 with an average growth rate of 4.2% per annum [10]. This projected estimation of global energy consumption demonstrates that energy consumption in India is continuously increasing. The increase in India's energy consumption will push the country's share of global energy demand from 5% in 2016 to 11% by 2040.

Because of rapid industrialization in India, large numbers of manufactured product are being exported to developed nations and their demand for energy is continuously increasing. This demand for energy is greatly affected by the growth and size of the population. India being the second most populous country in the world is expected to have more than 1.658billion people by the end of 2050. Each year India adds a higher number of people to the world than any other nation and the specific population of some of the states in India is equal to the population of many countries. It has been found that by 2040 the growth of India's energy consumption will be the fastest among all significant economies. The demand for renewable in India will have a tremendous growth of 256 million tons of oil equivalent (Mtoe) in 2040 from 17 million tons of oil equivalent (Mtoe) in 2016, with an annual increase of 12%.
In February 2022, Andhra Pradesh has a total 4137 MW Installed photo-voltaic capacity and the state is planning to add 10,050 MW solar power capacities to provide power supply to farming sector during the day time. The state has also offered five Ultra Mega Solar Power Projects with a total capacity of 12,200 MW, so as to provide renewable power supply to the adjoining states.

Gujarat being the leader of solar power generation in India has commissioned Asia's largest solar park of 500 MW capacities and has been cited as an innovative and environmentally-friendly project by the Confederation of Indian Industry. The state government has launched rooftop solar-power generation scheme which aims to generate 5 MW of solar power by putting solar panels on the roof of the buildings [11]. In fact large number of solar parks of reasonable capacity such as Bhadla Solar Park, Pavagada Solar Park, Kurnool Ultra Mega Solar Park, NP Kunta, Rewa Ultra Mega solar Park, Charanka Solar Park etc. is also located in different states of India [12-14]. Greater is the availability of wastelands, more the number of solar panels can be installed and hence greater will be the solar power potential of that particular area [15]. The development of Rewa Ultra Mega Solar (RUMS) Park helped the policy makers for designing best policies and planning for new upcoming large solar power projects in India [16].

METHODOLGY FOR HARNESSING SOLAR ENERGY

Solar energy is used all over the world for generating electricity or for heating purposes. It is harnessed directly from the sun, even during cloudy weather conditions. Various methods are used for the harnessing of solar energy, but the most promising method involves the use of Photovoltaic Solar Panels

Photovoltaic Solar Panels

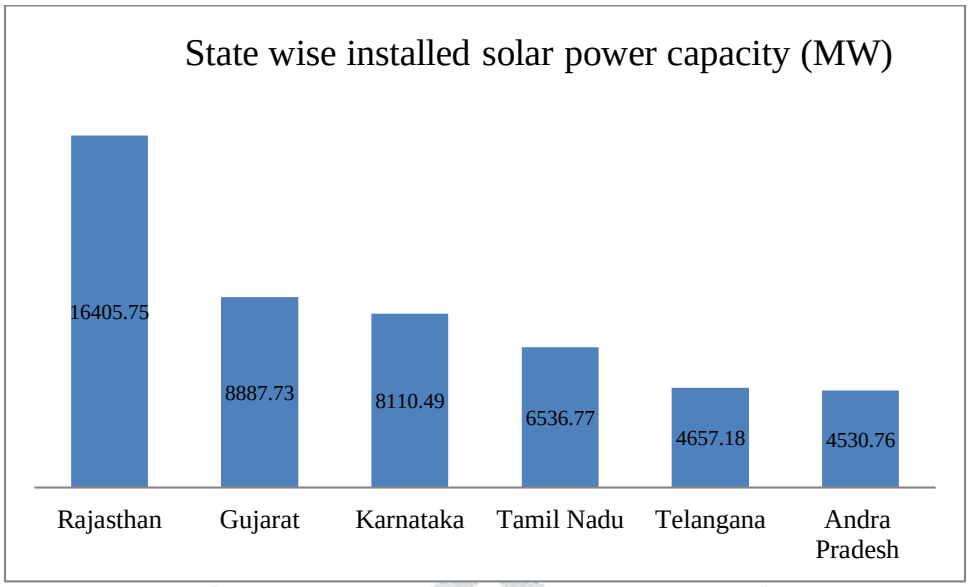
Photovoltaic (PV) solar panels are most commonly used for the harvesting of solar energy. These panels, which range in size from a few square centimeters to a few square meters, are constructed from many PV cells arranged in an intricate matrix. It has been found that larger the surface area available for sunlight to penetrate the PV cells, the more will be the harvesting of solar energy.

Each PV solar cell is made up of mono crystalline or polycrystalline compound semiconductor. Both P-type and N-type semiconductors are grown separately and are placed one above the other and the natural reaction that occurs between the two types of semiconductor creates a depletion zone that reaches an equilibrium point, without generating any electricity.

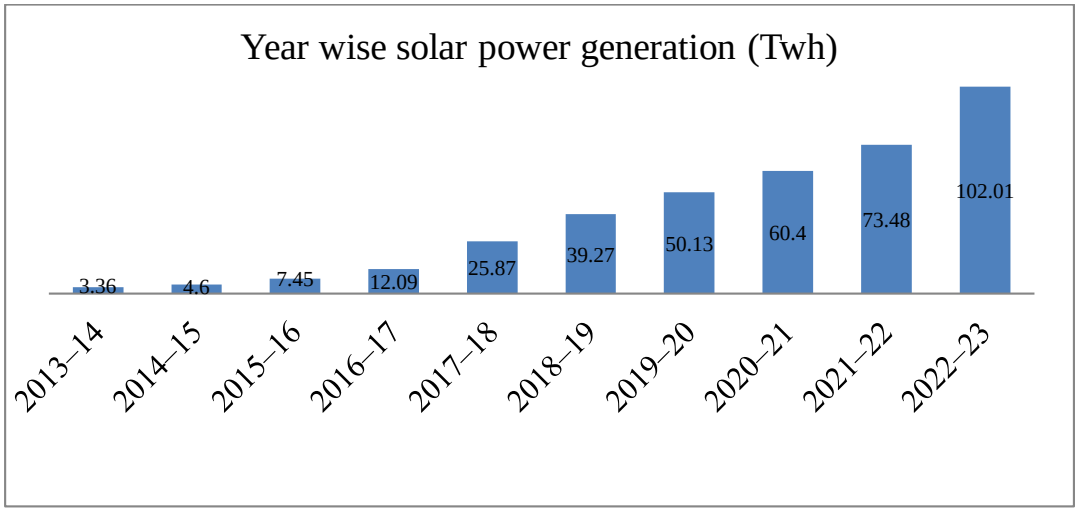
The energy released when light strikes the semiconductor creates an equilibrium disruption in the depletion zone between different layers of semiconductor. As a result of which a brief flow of electricity took place. Due to the constant presence of light, this interaction occurs continuously and large amount of electricity is produced. However the Photovoltaic (PV) solar panels produce DC power and in order to integrate it with modern power transmission technology, it must be converted to AC by using an inverter.

RESULT AND DISCUSSION

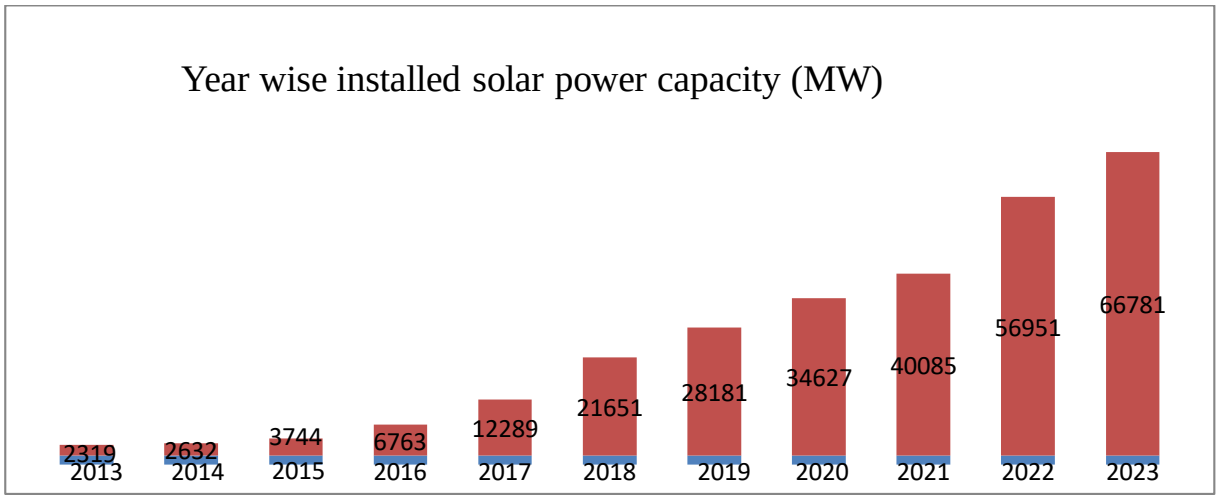
The statistical data pertaining to solar energy such as state wise solar power capacity of different states by taking the data of only six states having maximum installed solar energy; Year wise solar energy generation and year wise installed solar power capacity as on March 2023 have been analyzed. The data was taken from the website of Ministry of New and Renewable Energy (MNRE), Government of India and Solar energy federation of India (SEFI). Moreover the various schemes/ missions promulgated by the Government of India are also discussed in detail:



Source: National Solar Energy Federation of India (NSEFI) as on 28/02/2023.



Source: Ministry of New and Renewable Energy (MNRE) as on 31/03/ 2023



Source: Ministry of New and Renewable Energy (MNRE) as on 31/03/ 2023

SCHEMES FOR THE PROMOTION OF SOLAR ENEGRY

Large number of initiatives/programs/missions has been taken by the Government of India for the promotion of solar energy in India and accordingly reasonable amount of funds have been allocated from time to time so as to achieve its targeted installed power capacity. Large number of solar parks of different capacity has been installed in different states of India and many of new solar parks are in pipeline. Some of the key initiatives are:

Jawaharlal Nehru National Solar Mission

This mission was launched by former Prime Minister of India, Dr. Manmohan Singh in January 2010. The mission is to reduce the cost of solar power generation and establish India as a global leader in solar energy sector. It offers large-scale grid-connected power though long term policy, large scale deployment, domestic production of raw materials and Research and development. The mission also aims to transform India's rural economy by installing solar lighting systems, water pumps, and other solar power-based applications in the rural areas.

Solar park scheme

The Ministry of new and renewable energy (MNRE) has started this scheme so as to set up large number of solar parks in different states of India, each with capacity of approximate 500MW. The scheme proposes to develop solar parks in collaboration with the State Governments and offers financial support by the Government of India to establish solar parks and to for the creation of infrastructure required for setting up new solar power projects in terms of access to roads, allocation of land, availability of water, transmission etc. The solar park will enable states to bring in investment from project developers and offer employment opportunities to the local population.

Rooftop scheme

This scheme is executed by Solar Energy Corporation of India (SECI) to set up 200 MW of projects across different states out of which 45 MW of capacity have been commissioned and an additional power project of 73 MW for warehouses and 50 MW for the CPWD (Central Public Works Department) have been launched. Solar Energy Corporation of India (SECI) also launched a tender by offering 30% subsidy for the residential sector, private education organizations, social sector, and the health institutions so as to achieve its targeted capacity of 40GW of rooftop solar power generation by 2022.

Solar Energy Subsidy Scheme

This scheme aims to provide financial assistance and capital subsidy to the applicant to the extent of 50 percent, 75 percent and 90 percent of the basis of basic cost of the solar energy plant but the applicant is eligible only if he installs solar panels on the rooftop and the subsidy is decided as per the capacity of installed solar power plant. The scheme is launched mainly to boost electric power generation from solar energy and to eradicate the light problem in both rural as well as urban areas. With the introduction of this scheme the citizens will be able to cut down on their electricity bills and the load on thermal power plants will also decreases to large extent.

Viability Gap funding scheme

Viability Gap Funding scheme (VGF) is implemented by Solar Energy Corporation of India (SECI) which has allocated large number of grid-connected solar photovoltaic (PV) projects of a minimum 2000 MW capacity across the country out of which 680 MW capacity has been installed and commissioned. This scheme also provides support for the setting up of by solar power projects by solar power developers on build own operate basis.

UDAY scheme

Ujjwal Discom Assurance Yojna or UDAY Scheme was launched by the Government of India in November 2015 as a revival package for electricity distribution companies of India so as to find permanent solution to the financial crisis that the electricity companies were facing

at that time. It also aims to rejuvenate the power sector by improving the operational and developmental activities, improving energy efficiency and by reducing the cost of electric power generation by utilizing the solar energy instead of conventional thermal energy.

Rooftop scheme

This scheme is also implemented by Solar Energy Corporation of India (SECI). Under this scheme the solar power projects of capacity 45MW are functioning properly out of total allocated projects of 200MW capacity. Various schemes have also been launched for the establishment of rooftop solar projects of 75MW for warehouses and 50MW for the central public works department (CPWD) so as to achieve the targeted capacity of 40 GW power from rooftop solar projects by 2022.

Suryamitra skill development programme

This programme was launched by the Ministry of New and Renewable Energy (MNRE), Government of India in 2015 so as to train persons to install, operate and maintain the solar photovoltaic system (SPV) particularly in the field of solar energy. The National institute of solar energy (NISE) has been assigned the task of creating skilled manpower for employment in Solar Power Projects with a target of producing 50,000 Suryamitras by 2019-2020.The duration of the Suryamitra Skill Development programme is of three months consisting of 600 hours which includes classroom training, lab practical and SPV plant exposure visits. The host institute will also facilitate the placement of Suryamitras on the completion of this skill development programme.

Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM KUSUM)

PM-KUSUM scheme is one of the largest initiatives in the world to provide water security and carbon dioxide free energy for more than 3.5 million farmers. This scheme aims to de- dieselize the agricultural sector and provide addition power by providing the farmers solar pumps with an additional solar capacity of 30.80GW with financial support of over ₹34,000 crore from Government of India.

Besides the above mentioned schemes the Prime Minister of India and the President of France also launched International Solar Alliance (ISA) in Paris the 30th of November 2015, during Conference of the Parties (COP-21) with 121 solar resource rich countries as its members. The main objective of this alliance is to collectively address all the common challenges which harnessing solar energy will face in ISA member countries.

CONCLUSION

India is a fast developing country and is highly dependent on conventional energy resources such as coal, petroleum, oil and natural gas which are depleting rapidly and are emitting harmful gases into the environment. Therefore Government of India has made remarkable shift towards the adoption of renewable resources of energy, most promising among them is solar energy which is easily accessible, economical and ecofriendly. Large numbers of policies have been promulgated from time to time and huge budgetary allocations have been made from last one decade for the establishment of solar parks and rooftop solar panels and other solar energy harvesting modules so as produce electricity on larger scale. Large number of private companies and organizations are investing in rooftop solar projects making it easier for individuals and businesses houses to install solar panels on their rooftops. The use of solar energy will reduce the country dependency on fossil fuels and reduces the overall cost of electricity.

REFERENCES

1. Charles R. K. and Majid J. M. A., (2020) “Energy, Sustainability and Society”, 10(1).
2. Kumar. J and Majid (2020) “Energy, Sustainability and Society 10(2) https://doi.org/10.1186/s13705-019-0232-1
3. Dimitrios P., *et al.* (2017) “ Energy Procedia”, 105, 3656-3652
4. National electricity plan (2016), Volume 1, Generation, Central Electricity Authority (CEA),Ministry of Power, GOI .Available at http://www.cea.nic.in/reports/committee/nep/nep_dec.pdf .Accessed 31 Jan 2018.
5. Preeti A. (2017) “Travel Behaviour and Society” 6 110-116
6. Blondeel, M., and Van de Graaf, T. (2018) “*Climatic Change* “volume 150, Pages 89–101.
7. Subhash K, and Reinhard M., (2016) CO_2 emission reduction potential assessment using renewable energy in India “Energy”, Volume 97, , Pages 273-282.

8. Charles R. K. *et al*. (2019) Sustainable waste management through waste to energy technologies in India—opportunities and environmental impacts . "International journal of renewable energy research" 9(1): 309-342.
9. Ravindra B. S. and Mahajan Y. S. (2015) Review of wind energy development and policy in India. "Energy Technology & Policy" 2:122–132
10. Harrison T. and Kostka G. (2014) Balancing priorities, aligning interests: developing mitigation capacity in India. "Comparative Political Studies" 47:450-480
11. Shukl A. K. (2017) Renewable energy resources in South Asian countries: challenges, policy and recommendations. "Resource-Efficient Technologies" 3: 342-346.
12. Yenneti K. and Day R. (2015) "Energy Policy" volume 86 , Pages 664-673,
13. Stock R. (2021) "Energy Research & Social Science" volume 82 , 102309,
14. Vyas B. K., *et al.* (2022) "Cleaner Engineering and Technology", Volume 6 (100) 396,
15. Sharma N. K., *et al* (2012) "Renewable and Sustainable Energy Reviews" , volume 16, (1) Pages 933-941.
16. Sharma A. K., *et al*. (2015) "Renewable and Sustainable Energy Reviews" , volume 42 Pages 902-912
17. Brijesh K. V., *et al*. (2022) "Cleaner Engineering and Technology" 6(100) 396