Power Generation Scenario in India with special reference to Solar Energy

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Abstract:

Development of any society is based on Energy consumption which is mostly generated by non-renewable energy sources like fossil fuel, Oil, natural gas etc., which is very hazardous for our environment. So, the world along with India are changing their path of power generation from non-renewable sources to green energy technology with more focus on solar energy. International Solar Alliance (ISA) is also a great initiative of India towards reduction of conventional power generation. Sun is largest source of renewable energy available in the world. Till 31st August 2021, India has generated 11.45% solar power which is far above world average of 5.5%. The UN Development Program in its 2000 World Energy Assessment report calculated that the annual Solar Energy Potential was 1,575–49,837 exajoules (EJ). India is blessed to have good amount of annual average diffused radiation (5.65 kWh/m^2/day) & annual average beam radiation (5.4 kWh/m^2/day) which indicates that Average availability of solar radiation in India is adequate throughout the year.

***Keyword*: Solar Energy, Power Generation, Solar Panels, Solar radiation, Smart Energy etc.**

1. Introduction:

Population of India is increasing rapidly as compared to rest of the world. India ranks second in terms of population accounting for 17% of world's overall population. So, for development, the country needs massive amount of energy which should be eco-friendly (Green Energy Technology) because of scarcity of non-renewable energy (which is very harmful for our climate). India is the third largest electricity producer as well consumer in the world. India has massive scope of harnessing Solar Energy. The reason being the geographical location and receiving solar radiation almost throughout the year, which amounts to 3000 h of sunshine [(1)]. This is equal to more than 5000 trillion kW h. Almost every part of India receives 4–7 kW h of solar radiation per sq meters [(1)]. National Institute of Solar Energy has assessed the Country's solar potential of about 748 GW assuming 3% of the waste land area to be covered by Solar PV modules. Solar energy has taken a central place in India's National Action Plan on Climate Change with National Solar Mission as one of the key Missions. National Solar Mission (NSM) was launched on 11th January, 2010. NSM is a major initiative of the Government of India with active participation from States to promote ecological sustainable growth while addressing India's energy security challenges. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The Mission's objective is to establish India as a global leader in solar energy by creating the policy conditions for solar technology diffusion across the country as quickly as possible. The Mission targets installing 100 GW grid-connected solar power plants by the year 2022. This is in line with India's Intended Nationally Determined Contributions (INDCs) target to achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources and to reduce the emission intensity of its GDP by 33 to 35 percent from 2005 level

by 2030 [2]. India also proposed for an International Solar Alliance (ISA) in Nov 2015 consisting of 124 Sunshine countries with the primary objective to work for efficient consumption of Solar Energy to reduce dependence on conventional fuels [15].

Recently, India achieved 5th global position in solar power deployment by surpassing Italy. Solar power capacity has seen a growth of more than 11 times in the last five years from 2.6 GW in March 2014 to 30 GW in July 2019. Presently, solar tariff in India is very competitive and has achieved grid parity [2].

2. Power Generation through Renewable Energy:

Renewable energy share 25.24% in the total installed generation capacity in the country. India is now 5th largest renewable energy producer in the world with a goal of world largest renewable energy programme (175 GW) till 2022 & 450 GW till 2030. India achieved rapid growth of 226% in renewable energy in last 5 years [3]. India is continuously increasing its non-conventional energy generation over conventional energy generation specially in the past 5 years i.e., after 2017.

3. **Solar :**

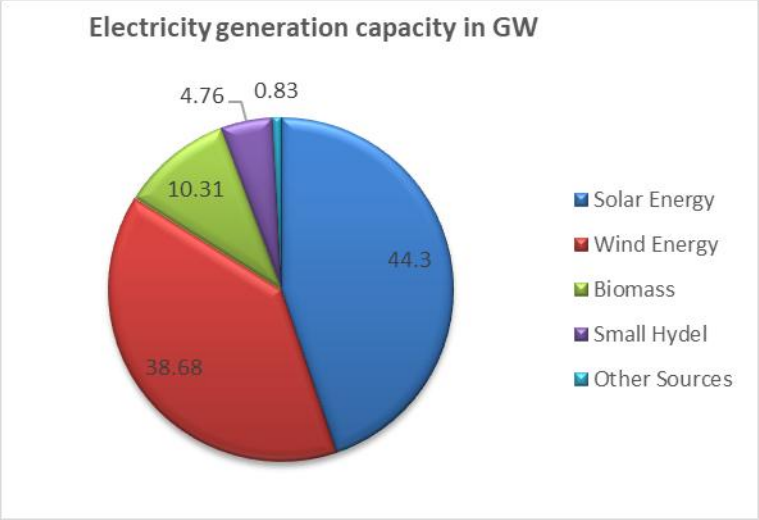


Figure 1: India's Power generation capacity

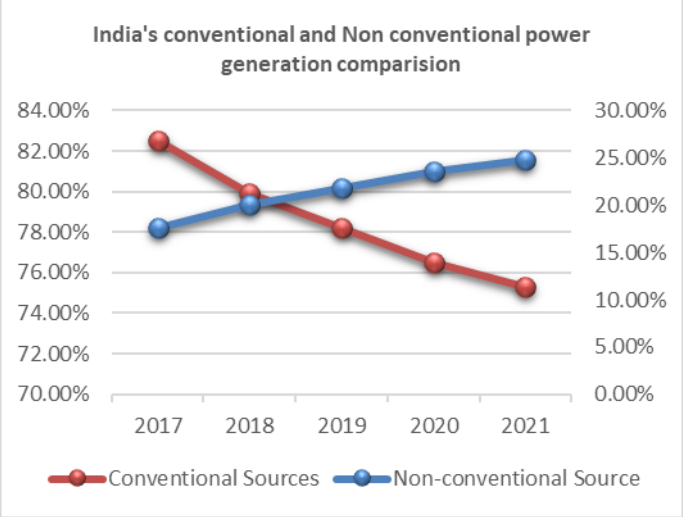


Figure 2: India's Conventional and Non-conventional Power Generation comparison & Growth [16]

This energy is equal to all the energy that can be supplied by 3 trillion barrels of total oil resources found on Earth. The total annual energy used by the humans in 1 year is 4.6 x 1020 J. This energy is supplied by the sun in 1 hour. The energy from the sun is, therefore, quite capable of fulfilling all the needs of humanity single handedly [5]. India secure 5th rank in solar power conversion after China, USA, Japan & Germany. The Solar Power generation has seen a tremendous growth in India over Few years.

4. **Solar Energy Utilization in India:**

Majority of paper mills in India those are using agro residues and recycled fibers as raw feedstocks are in the states with adequate Direct Normal Irradiation availability (1900kWh/m^2). Annual process heating potential for the paper industry in India has been estimated at 43 PJ. [7].

In India agriculture sector is most important for Rural Economy as well as Rural Survival have required huge amount of Energy from crop production to packaging and so many sectors have required huge amount of energy like Auto, Manufacturing, Water heating, Air Heating & other industries.

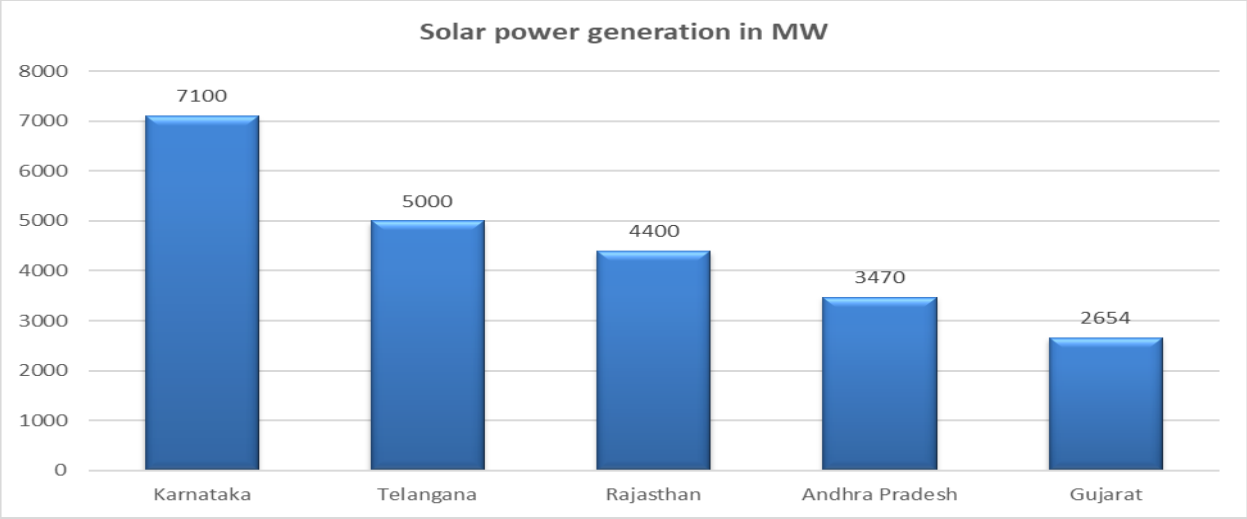


Figure 4: Top 5 Solar Energy Producing states in India till 26 March 2021 [8]

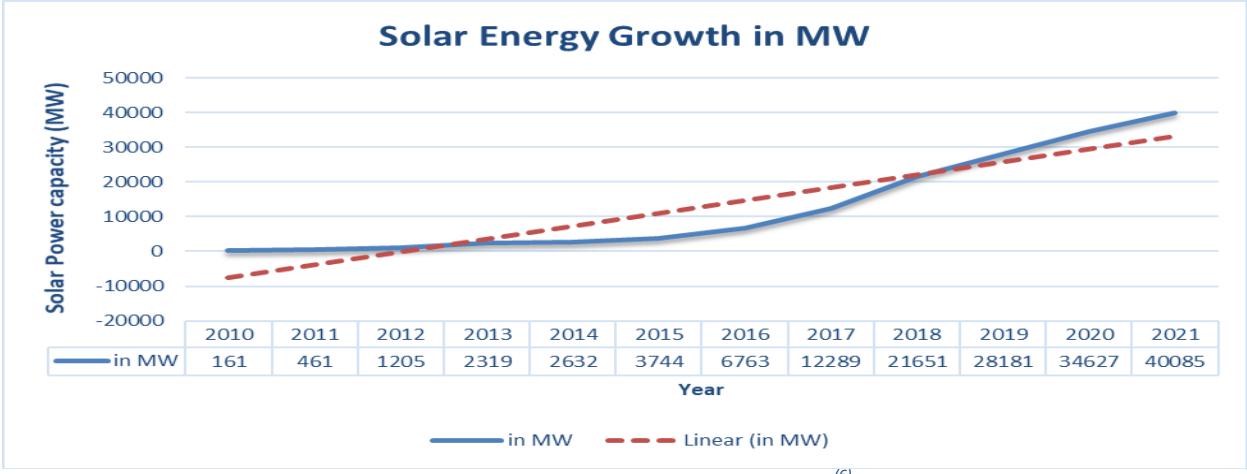


Figure 3: Yearly Solar Energy Growth in India [6]

3600 remote villages/hamlets, including those in Sunderbans, Bastar, Ladakh and the North East electrified through solar energy. Largest solar–steam cooking system for 15,000 persons/day set up at Tirupati Tirumala Devasthanam. 7 lakh m^2 collector area solar water heating systems installed [9].

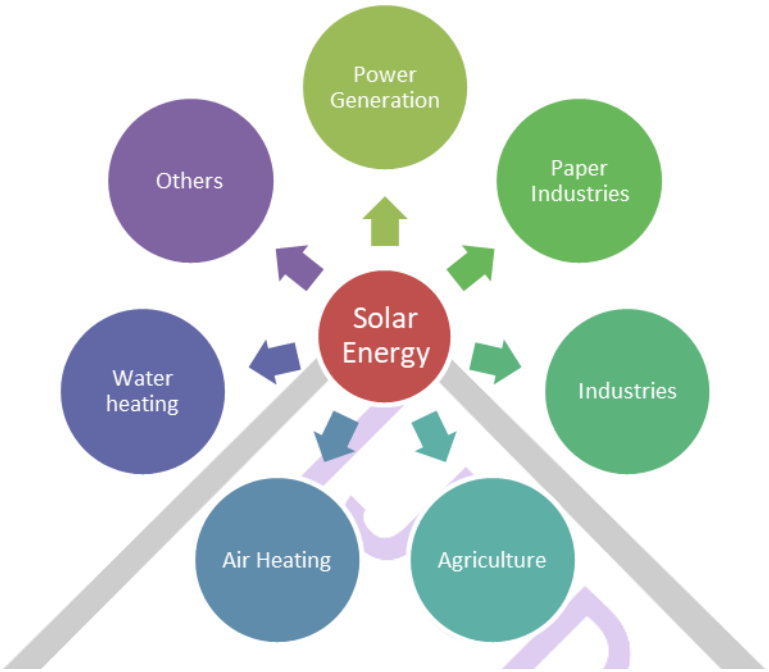
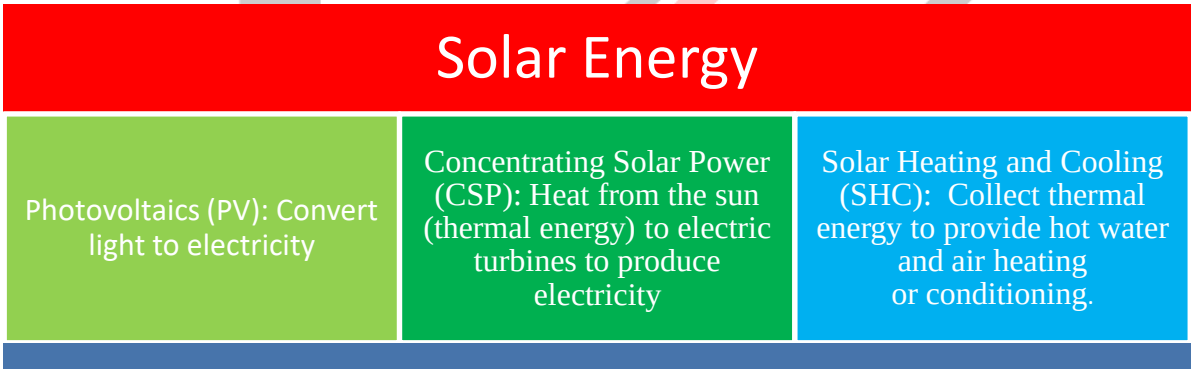


Figure 5: Solar Energy Utilization in various sector in India

5. Methods for Solar Power Generation:

Three basic methods by which solar energy can utilize in various sector in India under:



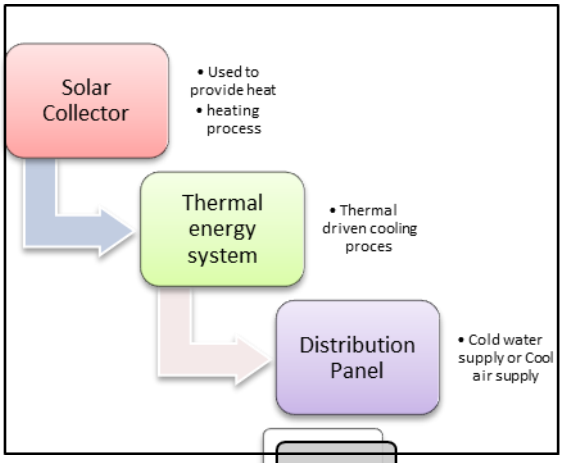


Figure 8: Direct Solar conversion (SHC)

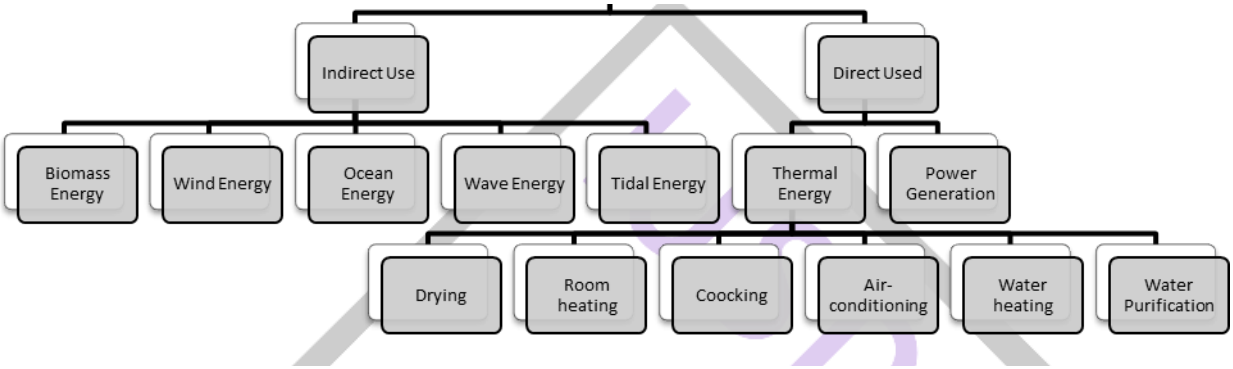


Figure 6: Solar Energy Application

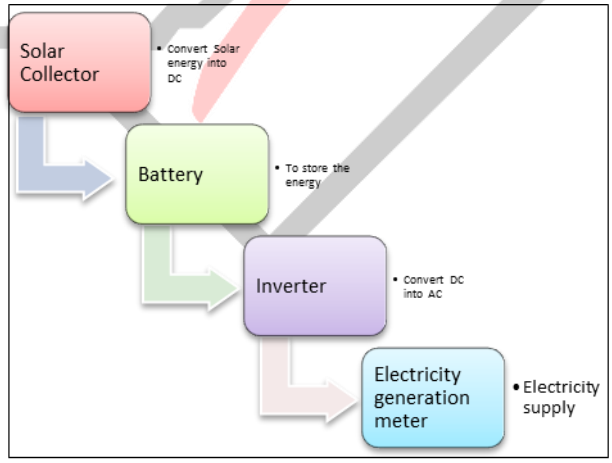


Figure 7: Basic Solar Energy Conversion for power generation (PV)

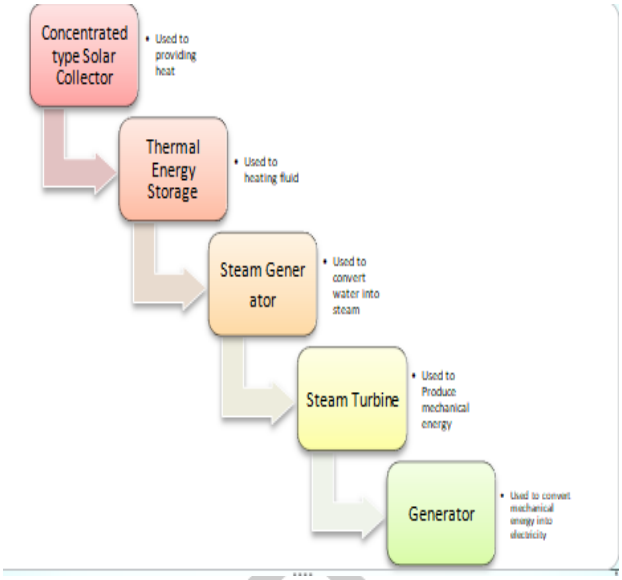


Figure 9: Hybrid Solar energy conversion for power generation (CSP)

conversion

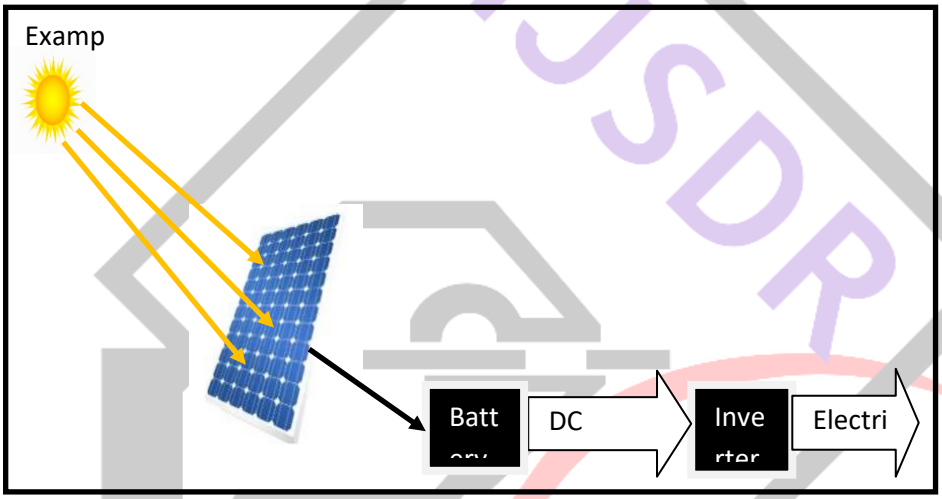


Figure 10: PV Type Power Generation System

6. Conclusion:

By 2021 India has total population 1.40 billion & Total annual energy consumption is 1598 TWh. Now due to New life style (development) & Climate (Uneven changes), consumption of power increases rapidly day to day. So, we conclude that in the future Conventional type of energy conversion will have reduces & renewable energy (Green Energy Technology) come into main stream, likely Solar energy conversion enlarge. As per The Hindu report (UN Projections), by 2050 India will have reach total population 1.64 billion & same time India will have annual energy consumption about 14500 TWh. As per intellicap report, India can overcome obstacles to allow investment in Renewable Energy supply options. In 2050, India will achieve reliable,

Figure 11: Hybrid Solar energy conversion for power generation (CSP)

economically competitive and environmentally sustainable electricity system, addressing the energy security and environmental strains.

7. Future Scope:

The International Energy Agency published in 2014 simultaneously two roadmaps on the expected role of solar electricity in the 2050 horizon. One was the Solar Thermal Electricity Technology Roadmap (STE/CSP) and the other for PV. When putting together the PV and the STE/CSP roadmaps, a total contribution of solar technologies of more than 25% was envisaged in 2050 becoming the single largest source of electricity production at world level at that time [(11)]. In the future India will have required more energy than conventional energy so solar energy can fulfil that gap with eco-friendly.

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