

Potential of Green Energy: Current Status in Indian Subcontinent

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Abstract – India ranks third in the world in terms of production of green energy. Extensive use of fossil fuels led to environmental issues, like carbon emissions, cleaning the air, mitigating climate change. Alternatives venues like wind, solar, biomass, geothermal, ocean, wave hold promise to provide long-lasting sustainable solutions to these issues. Deployment of green energy sources is needed for energy security and economic development. Currently, green energy accounts for ~37% of India’s total energy consumption and its demand is expected to rise by 256 Mtoe by 2040, clocking average annual growth of ~16%. Installed green energy capacity was 159.95 GW in May 2022. This paper identifies the green energy sources available in India and their potential.

Keywords: Renewable energy, Green energy, Solar energy, Wind energy, Biomass, Geothermal energy, Tidal wave energy

I. INTRODUCTION

GROWING consumption of conventional energy resources gave rise to various problems like emission of greenhouse gases, polluted air and climate change. Such negative environmental impacts require clean energy production for a high quality of life. Rising gap between demand and supply requires increase in green energy with ease in installation procedures and policies.

Green energy is estimated to grow from 41 Mtoe in 2020 to 256 Mtoe in 2040. The energy demand, according to expert discussion, is 1300 TWh of electricity demand and 1345 Mt of coal demand in 2020-21. By March 2014, India had 76.37 GW of installed capacity and it rose to 159.95 GW by May 2022. The installed power capacity in the country was around 408.72 GW as of November 30th, 2022. India has already stated its intention to achieve net-zero emissions by 2070, with renewable energy sources meeting 50% of its energy needs by 2030. This aim is considered sufficient to mitigate climate change. With strong government support, India is ranked third in the world in terms of green energy production capacity.

Adoption of green energy such as solar energy still depends upon various factors such as finances, investments, and consumer behavior. Liming [1] classified the financial systems into several categories, such as government financing, international funding, public stock markets, private sector financing, venture capital, subsidies, etc. Sisodia identified various barriers, investments, subsidies, perceptions, and gaps

between green energy generation and implementation [2]. Identified gaps were mostly in investment planning, regulations and finances. Ansari identified 13 barriers that are responsible for delayed solar power plant installation in India [3]. A huge increase in energy demand demands an alternative need for green, workable, inexpensive, and ecologically sound energy sources. The generation of power from green energy sources steadily increased since 2002. Three separate government bodies are working hard to meet target, *i.e.*, MNRE, IREDA and SEC.

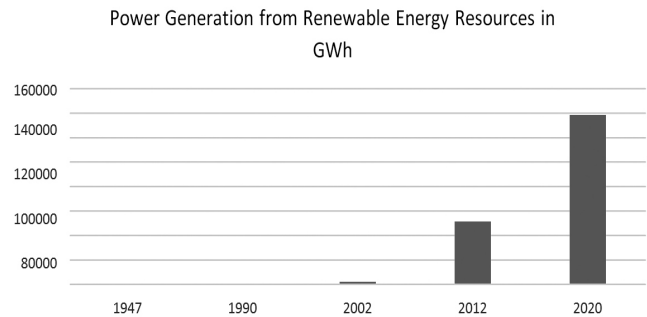


Figure 1. The journey towards renewable energy in India [4]

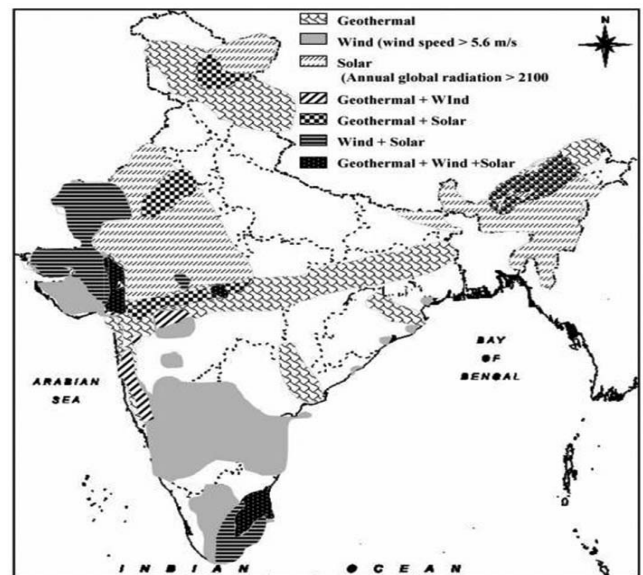


Figure 2. Green resource map India [5].

Commercialized sources of Green energy are as follows.

Geothermal energy: Below the earth’s crust, an inexhaustible amount of heat energy exists due to physical processes. Most geothermal resources mapped by the Geological Survey of India, yield estimated potential as about 10600 MW [6]. It is stored in reservoirs beneath the earth’s crust in the form of hot water, which is tapped via drilling.

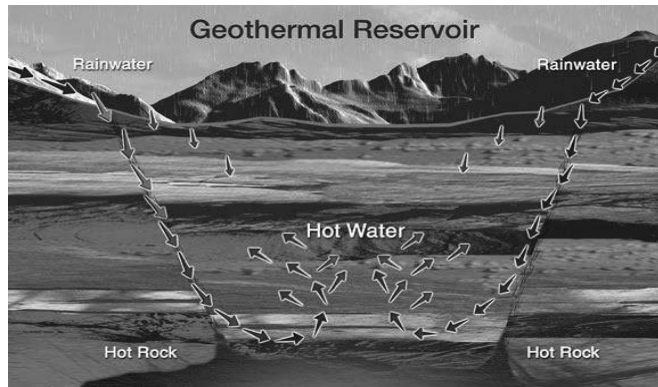


Figure 3. Geothermal reservoir [7].

Wind energy: The commercially exploitable potential of wind energy in India is estimated to be over 200 GW. As of May 2022, the total installed capacity of wind power was 41 GW [9]. The National Institute of Wind Energy (NIWE) installed about 700 wind monitoring stations, out of which 237 have a potential greater than 200 W/m². States with great wind energy potential are Rajasthan, Maharashtra, Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh and MP, possessing 293 GW of wind potential at 100 m hub-height and 652 GW at 120 m. The cost of wind power generation is going down day-by-day.

Solar energy: India receives 5000 trillion KWh of solar energy annually. In India, solar incident varies ~ 4-7 kWh/m² with bright sunshine. Solar power capacity projected as 749 GW, of which 62 GW was installed as on 30th November, 2022. Solar rooftop market potential is estimated as 124 GW in India. Solar rooftop is a distributed system that makes significant contributions to energy independence.

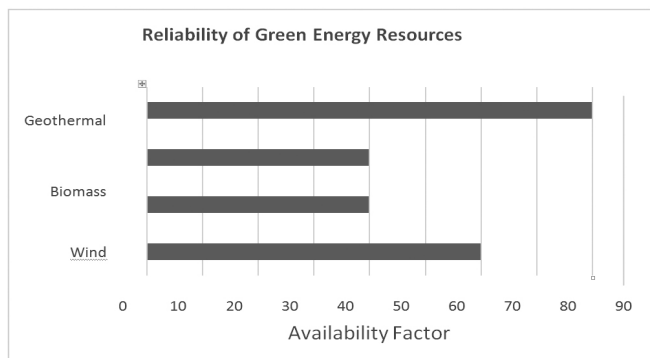


Figure 4. Green sources availability factor [7].

Availability factor of Geothermal sources are more than other kind of Energy sources.

Table 1 -- INDIA’S SOLAR MARK BY 2022 [12]

STATES	SOLAR MARK IN MW
Delhi	2762
Haryana	4142
H.P	776
J & K	1155
Punjab	4772
Rajasthan	5762
U.P	10697
Assam	663
A.P	39
Meghalaya	161
Manipur	105
Mizoram	72
Nagaland	61
Tripura	105

Hydro energy: It is a form of sustainable energy with no carbon emissions. The Himalayan states are capable of producing a large amount of hydroelectric power. MNRE located 6474 potential sites in India: small hydropower capacity is currently projected to be around 20,000 MW. India has so far used 15000 MW of hydropower potential. Worldwide, India ranks fifth in terms of hydroelectric power capacity production. Hydro-electric plants are low-operational cost and require low-maintenance. They provide water and flood control tools.

Biomass energy: The industrial revolution diminished biomass energy, which was the world’s dominant energy source before that. India’s farming economy relies heavily on bio-mass such as shells, grass, jute, fibre, and coconut shells. The bio-mass can be converted into liquid fuels and electricity. It is estimated that 350 million tons of farm waste are produced each year in India. States with large potential for biomass include UP, Punjab, Karnataka, Gujrat, Bihar and Tamil Nadu. During 2010, India had 3145 MW of installed biomass energy, which rose to 10,228 MW by end-2020. In India, about 56 biogas plants are operating, distributed across Kerala, Maharashtra and Karnataka.

Tidal energy and Wave energy: Tidal energy though not widely used globally, is a good source of green energy. This kind of energy is generated by ocean tides, which are generated by the relative movements among the Sun, Moon, and Earth centrifugal and gravitational forces are responsible for tidal flows or the periodic motion of water. India has a large potential for tidal energy generation due to its 7500 km coastline and 336 islands in the Bay of Bengal and Arabian Sea. The total

available potential of tidal energy is about 40,000 MW. Fluctuations present in tides carry a high power density. This power can be used in a Tidal power plant. Generation of tidal power is dependent on a suitable site, tidal range, and tide speed.

II. CONCLUSION

India's energy requirements are increasing day-by-day, leading to deployment of alternative options like green energy sources to meet the demand. The green sector has significant economic, environmental and social benefits. Strong government support for green energy sector will ensure its greater share in total energy consumption. Literature review reveals spatial variations of different green sources scaled across India.

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REFERENCES

- [1] H. Liming, "Financing rural renewable energy: A comparison between China and India", *Renewable and Sustainable Energy Reviews*, vol. 13, no. 5, pp. 1096-1103, 2009.
- [2] G. S. Sisodia, "The Status of Renewable Energy Research on India", *Energy Procedia*, vol. 95, pp. 416-423, 2016.
- [3] M. F. Ansari, "Analysis of barriers to implement solar power installations in India using interpretive structural modeling technique", *Renewable and Sustainable Energy Reviews*, vol. 27, pp. 163-174, 2013.
- [4] "RenewableEnergy in India,"2022.[Online].Available: <https://pib.gov.in/FeaturesDeatils.aspx?NotelD=151141&ModuleId%20=%202>.
- [5] I. R.Pillai, "Renewable energy in India: Status and potential", *Energy*, vol. 34, no. 8, pp. 970- 980, 2009.
- [6] A.Mahesh, "Role of renewable energy investment in India: An alternative to CO2 mitigation", *Renewable and Sustainable Energy Reviews*, vol. 26, pp. 414-424, 2013.
- [7] S. Kumar, "Resources and utilization of geothermal energy in India: An ecofriendly approach towards sustainability", *Materials Today: Proceedings*, 2020.
- [9] S. Sen, "Renewable energy scenario in India: Opportunities and challenges", *J. African Earth Sciences*, vol. 122, pp. 25-31, 2016.
- [10] Harish Puppala, "Identification and analysis of barriers for harnessing geothermal energy in India", *Renewable Energy*, vol. 186, pp. 327-340, 2022.
- [11] S. Kumar Kar, "Solar energy market developments in India", *Renewable and Sustainable Energy Reviews*, vol. 62, pp. 121-133, 2016.
- [12] M. GOEL, "Solar Roof Top Advancements in India", *Solar Energy*, pp. 149-160, 2022.
- [13] M. Irfan, "Prioritizing and overcoming biomass energy barriers: Application of AHP and G- TOPSIS approaches", *Technological Forecasting and Social Change*, vol. 177, 2022.



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