



EXPLORING RENEWABLE ENERGY'S POTENTIAL FOR DRIVING SUSTAINABLE DEVELOPMENT IN INDIA

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Abstract

The research paper explores India's relation between renewable energy and sustainable development. Despite energy challenges, renewable adoption can curb emissions, enhance security, and foster innovation. Hence, the present article made an attempt to understand the growth of electricity sector and potential of renewable energy sources for driving sustainable development in India through reducing carbon, boosting jobs, and equitable energy. This article deepens understanding of renewable energy's pivotal role in India's journey towards resilience, prosperity, and equity, amid rapid development, energy demand, and environmental concerns.

Key Words: Renewable Energy, Sustainable Development, Wind, Bio and Solar Power.

Introduction

Renewable energy sources have emerged as a key player in the pursuit of sustainable development, both globally and within the context of India. In an era characterized by rapid urbanization, industrialization, and heightened environmental concerns, the utilization of renewable energy has become imperative for mitigating the adverse impacts of climate change and fostering a greener, more sustainable future. On a global scale, the significance of renewable energy in sustainable development is underscored by the urgent need to address climate change and reduce carbon emissions. The reliance on fossil fuels has not only contributed to rising global temperatures and extreme weather events but has also resulted in the depletion of limited resources. In contrast, renewable energy sources harness natural elements like sunlight, wind, water, and biomass, which are perpetually replenished by natural processes, making them a viable long-term solution to the world's energy needs.

Growth of Indian Electricity Sector

In the pre-Independence era, the power supply was mainly in the hands of private sector and that too restricted to the urban areas. After independence number of hydro projects, installation of thermal and nuclear station was taken up and thus the power generation activities started increasing significantly. The following chart exhibiting all India Gross Electricity Generation during the past 10 years.

Table 1

Growth of Gross Electricity Generation Mode-Wise (GW/h)

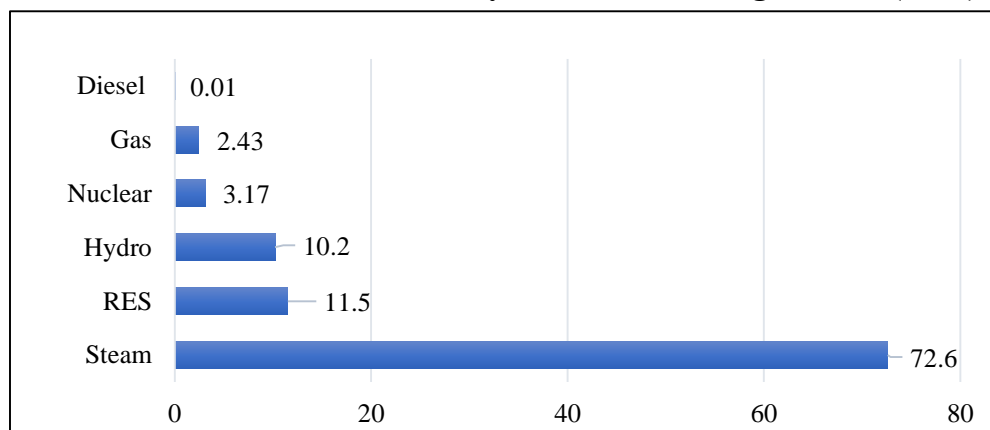
Year	Hydro	Thermal (including Steam, Gas & Diesel)	Nuclear	Renewable Energy Sources	Total
2012	130511.00	708427.00	32287.00	51226.00	922451.00
2013	113720.00	760454.00	32866.00	57449.00	964489.00
2014	134847.00	792054.00	34228.00	65520.00	1026649.00
2015	129244.00	877941.00	36102.00	61784.93	1165071.93
2016	121377.00	943013.00	37413.00	65781.00	1167584.00
2017	122377.56	993516.34	37915.87	81548.21	1235357.98
2018	126122.70	1037146.38	38346.12	101839.48	1303454.68
2019	134893.62	1072314.16	37812.60	126759.10	1371779.48
2020	155769.12	1042838.16	46472.45	138337.02	1383416.75
2021	150299.52	1032610.77	43029.08	147247.51	1373186.88
2022	151627.33	1114811.39	47112.06	170912.30	1484463.08

Source: Central Electricity Authority, All India Electricity Statistics

The data highlights the dominance of thermal energy sources, primarily fueled by steam, gas, and diesel, in the energy mix. Hydroelectric power's percentage of total energy capacity has remained relatively consistent over the years, ranging from around 9.83% to 14.15%. It is also exhibiting Thermal energy, which includes sources like coal, natural gas, and diesel, has been the dominant contributor to the energy mix, with a range of approximately 75.04% to 80.67%. Nuclear energy's percentage has been relatively stable, with a range of about 2.76% to 3.50%. The share of renewable energy sources has shown gradual growth over the years, ranging from around 5.32% to 11.57%.

Chart 1

All India Gross Electricity Generation during 2021-22 (in %)



Source: Central Electricity Authority, All India Electricity Statistics

The above chart it depicts that, in India a large portion of electricity is generated through steam i.e., 72.6% and Renewable energy is 11.5% at the end of 2021-22. The electricity generation through renewable energy contributing global climatic change and is increased to 233% from past 10 years. So far, total of 167.75 GW renewable energy capacity has been installed at the end of December 2022 in the country.

Journey towards Renewable Energy Sources (RES) in India

According to Pappas (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%). But at the end of 2022, the installed capacity of renewable sources of energy in India is 48.55GW of Solar, 40.03GW of wind, 4.83 GW of Small hydro, 46.51 GW of large hydro, 10.62 GW of Biopower and 6.78 GW of Nuclear power. Now India is the world's third largest producer of renewable energy sources with its 40% of its installed capacity from non-fossil fuel sources. The Indian Railways' ambitious Net Zero Emissions target for 2030 is expected to reduce emissions by an impressive 60 million tonnes annually. Additionally, the UJALA LED bulb campaign, is effectively curbing emissions by approximately 40 million tonnes each year.

With a commitment to the Paris Agreement and the UN Sustainable Development Goals, India has made significant and ambitious targets towards renewable energy sources. As part of its Intended Nationally Determined Contributions under the Paris Agreement, India pledged to achieve 40% of its total installed capacity from non-fossil fuel sources like, solar, wind, hydro, and other renewable energy by 2030. India launched the Jawaharlal Nehru National Solar Mission in 2010 with the goal of deploying 20,000 megawatts (MW) of grid-connected solar power by 2022. The Indian government has also launched the National Wind Energy Mission to harness the potential of wind power and it aims to achieve a capacity of 60,000 MW of wind power installations by 2022.

In a COP-26 (2021) India presented five nectar elements (*Panchamrit*) of India's climate change. They are, to reach 500GW non-fossil energy capacity by 2030 and utilises 50% of country's energy requirements from renewable energy by 2030. To Reduce the total projected carbon emissions by 1 billion tonnes from 2021 to 2030, Reduction of the carbon intensity of the economy by 45% by 2030 and achieving the target of net zero emissions by 2070.¹ India is actively working on developing Green Energy Corridors to facilitate the transmission of renewable energy from resource-rich regions to high-demand areas to improve the integration of renewable energy into the national grid and also recognized the potential of offshore wind energy and is working on policies and regulations to support the development of offshore wind projects along its vast coastline (Kumar & Majid, 2020)². As part of its renewable energy efforts, India is also focusing on promoting electric mobility and has set ambitious targets for the adoption of electric vehicles (EVs) to reduce emissions from the transportation sector (Tavana et.al.,2023).³

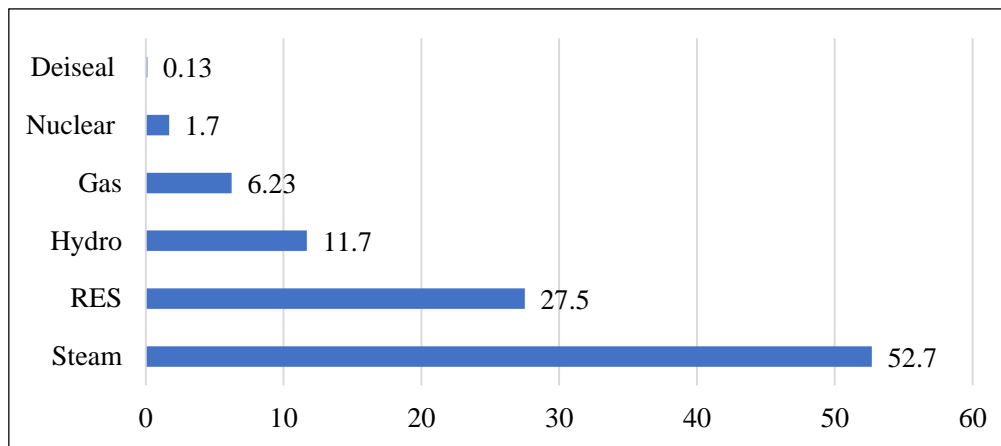
¹ Pib.gov.in

² Kumar. J & Majid (2020). Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities. *Energy, Sustainability and Society*

³ Taghizad-Tavana K, Alizadeh A, Ghanbari-Ghalehjoughi M, Nojavan S. A, (2023). Comprehensive Review of Electric Vehicles in Energy Systems: Integration with Renewable Energy Sources, Charging Levels, Different Types, and Standards. *Energies*. 16(2):63. <https://doi.org/10.3390/en16020630>

Chart 2

Installed Electricity Generation Capacity 2021-22 (in %)



Source: Central Electricity Authority, All India Electricity Statistics

In India, a largest share of installed electricity generation capacity at the end of 2021-22 is dominated by steam-based electricity generation i.e., 52.7%. The contribution of Renewable Energy Sources like, wind, solar and geo thermal energy is 27.5%. there is a significant contribution of hydro electricity generation and natural gas-based electricity generation is 6.23% and 1.7% respectively. there is a minimal contribution of deiseal based electricity generation i.e., 0.13% and it is used as a backup power sources.

Table 2

Growth of Installed Capacity of Renewable Energy Sources Over 10 years

Year	Small Hydro Power	Wind Power	Bio-Power	Solar Power	Total
2012	3410.52	16896.60	3255.01	941.31	24503.44
2013	3643.17	18484.99	3727.11	1686.44	27541.71
2014	3803.68	21042.58	7059.81	2631.93	34988.00
2015	4055.36	23354.35	7805.48	3743.97	38,959.16
2016	4273.47	26777.40	8110.33	6262.85	45924.04
2017	4379.86	32279.77	8295.78	12288.83	57244.23
2018	4485.81	34046.00	8839.10	21651.48	69022.39
2019	4593.15	35625.97	9241.80	28180.71	77641.63
2020	4683.16	37693.75	10022.95	34622.82	87027.68
2021	4786.81	39247.05	10314.56	40085.37	94433.79
2022	4848.90	40357.58	10628.36	53996.54	109885.38

Source: Central Electricity Authority, All India Electricity Statistics

The above table depicts the installed capacity of Small Hydro Power has been gradually increasing over the years but the percentage of total installed capacity of Small Hydro Power has been consistently decreasing over the years. It started at around 13.92% in 2012 and decreased to about 4.41% in 2022. Wind Power has maintained a significant share of the total installed capacity, ranging from around 36.77% in 2022 to 68.87% in 2012. While it decreased in relative percentage, it remained a dominant source throughout the years. Solar Power has shown remarkable growth, starting at 3.84% in 2012 and reaching 49.15% in 2022. It's clear that there has been a shift towards more solar and wind energy, likely due to advancements in technology, decreasing costs, and increasing emphasis on cleaner energy options. The data suggested that, a continued shift towards renewable energy sources, particularly solar and wind power. This trend might continue as technology improves and the world places greater emphasis on clear energy.

Role of Renewable Energy in Sustainable Development of India

Renewable energy holds a vital role and immense importance in driving sustainable development in India. As a rapidly growing economy with surging energy demands, the country faces challenges like energy security, environmental degradation, and climate change. Embracing renewable sources, such as solar, wind, and hydroelectric power, offers a multi-faceted solution. It curbs greenhouse gas emissions, lessens reliance on fossil fuels, and enhances energy self-reliance. Renewable energy fosters economic growth by creating jobs, stimulating innovation, and attracting investments. Moreover, it aids rural electrification, improves air quality, and ensures equitable energy access, particularly benefiting marginalized communities. By integrating renewables, India can pave the way for a greener, more inclusive, and sustainable future.

Suggestions and Conclusion

In the context of India's pursuit of sustainable development, the adoption of renewable energy sources emerges as a strategic necessity with wide-ranging ramifications. Several crucial recommendations can steer this transformative journey. To begin with, it is imperative to meticulously devise and consistently update policy frameworks that establish a stable and conducive environment for investments in renewable energy. Secondly, strengthening research and development endeavours is essential for enhancing the efficiency, affordability, and scalability of renewable technologies. Thirdly, comprehensive energy planning, coupled with robust grid infrastructure and effective energy storage solutions, can guarantee a dependable and uninterrupted supply of clean energy. Furthermore, fostering collaborations among governmental entities, industry stakeholders, and international partners can facilitate the transfer of technology, exchange of knowledge, and mobilization of resources. Lastly, an unwavering commitment to promoting fair energy access across different socio-economic segments will play a pivotal role in unlocking the complete potential of the socio-economic advantages offered by renewable energy.

In conclusion, the convergence of these recommendations not only serves as the foundation for India's aspirations of sustainable development but also paves the path towards a more ecologically conscious and prosperous future that harmonizes economic growth with environmental stewardship.

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