



THE GLOBAL DEVELOPMENT OF RENEWABLE ENERGY FOR A GREEN AND SUSTAINABLE FUTURE

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ABSTRACT

All nations have access to renewable energy sources, but their complete potential has yet to be realized. The International Renewable Energy Agency (IRENA) estimates that by 2050, 90 percent of the world's electricity could and should be generated from renewable sources.

Renewables offer a way out of import dependence, enabling countries to diversify their economies and protect themselves from the unpredictable price fluctuations of fossil fuels while driving inclusive economic growth, the creation of new jobs, and the alleviation of poverty. In India, research, development, demonstration, production, and application of a wide range of renewable energy technologies for use in various sectors have been vigorously pursued over the past twenty-five years.

The purpose of this paper is to present the current and historical experience of renewable energy in relation to consumption, investment, and employment opportunities globally, as well as to provide specific information about India. This paper also endeavors to summarize the availability, current status, significant achievements, and future potential of India's renewable energy sources.

KEYWORDS: Renewable energy, Co2 emissions, renewable energy employment and investments, renewable energy in India

INTRODUCTION

According to the International Energy Agency (2022), the current global energy crisis has increased the urgency to accelerate sustainable energy transitions and once again emphasized the significance of renewable energy. Pre-crisis policies result in faster development for renewable electricity, according to our updated forecast.

Despite having 80% of the world's population, developing countries consume only 30% of global commercial energy. As population and living standards rise and energy consumption rises, there is a growing awareness of the environmental impacts of energy and the need to expand access to energy in new ways. Renewable energy is moving from the margins to the Centre of sustainable development as its contribution to rural development, reduced health costs, energy independence, and climate change mitigation is increasingly acknowledged. Government, multilateral organizations, industry, and nongovernmental organizations (NGOs) pursuing energy, environment, and development agendas at the local, national, and global levels have increased their support for renewable energy. Moreover,

commercial markets for renewable energy are expanding, shifting investment patterns away from traditional government and international donor sources and towards a greater reliance on private companies and institutions.

Each renewable energy technology is in a distinct stage of research, development, and commercialization, and has varying current and projected future costs, industrial base, resource availability, and potential impact on greenhouse gas emissions (Anderson, 1997).

Renewable energy is a plentiful, well-established technology whose primary component is free. Eight nations hold 81% of the world's petroleum oil reserves, six countries hold 70% of the world's natural gas reserves, and eight countries hold 89% of the world's coal reserves. Over fifty percent of Asia, Africa, and Latin America import more than fifty percent of their commercial energy. The majority of these nations export commodities at low prices, but import energy at high prices, which drains their foreign exchange reserves. This issue is exacerbated by the fact that power generation in these nations is incessantly increasing (Bull, 2001).



Table - 1
Leading nations by consumption of renewable energy worldwide in 2021 (in exajoules)

Country	Global renewable energy consumption (in exajoules)
China	11.32
United States	7.48
Brazil	2.39
Germany	2.28
India	1.79
Japan	1.32
United Kingdom	1.24
Spain	0.97
Italy	0.76
France	0.74
Indonesia	0.63
Turkey	0.61
Australia	0.59
Canada	0.58
Sweden	0.49
Source: BP Statistical Review of World Energy 2022, page 43 https://www.bp.com/ [accessed May 1,2023] Figures exclude hydroelectricity, and are based on gross generation from renewable sources including wind, geothermal, solar, biomass and waste, and not accounting for cross-border electricity supply. Note: 1 exajoule = 1018 joule.	

China consumed 11.3 exajoules of renewable energy in 2021, more than any other country in the world. This measurement included renewable sources such as geothermal, wind, solar, biomass, and refuse, but did not account for international electricity trade.

After China, the United States was the second-largest consumer of renewable energy in the world. In addition, both nations consumed the highest total amount of primary energy. To reduce its reliance on imported energy sources, the United States strives for energy independence. In recent years, renewable energy production in the United States has exceeded consumption, and both have more than doubled since 1975.

India's position as a significant consumer of renewable energy is noteworthy.

Trend in global renewable energy investment and Employment Opportunities

China employs the most individuals in the renewable energy sector. Over 5.3 million renewable energy jobs (Table - 2) existed in the Asian country in 2021. Renewable energy has gained ground in China over the past few years, as the country seeks less emissions-intensive ways to support its expanding economy. India provides more than 0.8 million employments in the renewable energy industry.

Table - 2
Global renewable energy employment in 2021 by country and major region (in 1,000s)

Country	Global renewable energy employment (In 1,000s)
China	5,368
Brazil	1,272
European Union	1,242
United States	923
India	863
Germany	352
Rest of Africa	235
Southern Africa	48
North Africa	24
International Renewable Energy Agency (IRENA) Renewable Energy and Jobs - Annual Review 2022, page 30 https://www.irena.org/media/Files/IRENA/Agency/Publication/2022/Sep/IRENA_Renewable_energy_and_jobs_2022.pdf [accessed May 1,2023]	



Globally, new investments in renewable energy reached approximately 495 billion U.S. dollars in 2022. This represented a 17 percent increase over the prior year. Over the past two decades, the quantity of global funding allocated to clean energy has steadily risen. (Table -3) In 2004, renewable energy investments totaled 32 billion dollars, and by 2022, they will have

reached a peak of 495 billion dollars. The substantial increase in investment funding indicates that the industry has significantly matured. Policy support for renewable sources, an expanding industry, and the emergence of publicly traded companies that own renewable energy assets have all contributed to the constant increase in clean energy investment.

Table - 3
Worldwide renewable energy investment from 2004 to 2022 (in billion U.S. dollars)

Year	Worldwide investment in renewable energy (in billion U.S. dollars)	Moving Average (5 Years)	5 Years CAGR
2004	32	-	-
2005	50	-	-
2006	79	-	-
2007	120	-	-
2008	155	87	37%
2009	152	111	25%
2010	213	144	22%
2011	266	181	17%
2012	241	205	9%
2013	211	217	7%
2014	262	239	4%
2015	301	256	3%
2016	285	260	3%
2017	315	275	8%
2018	285	290	2%
2019	319	301	1%
2020	363	313	5%
2021	423	341	6%
2022	495	377	12%

Source: Bloomberg NEF <https://about.bnef.com/blog/a-record-495-billion-invested-in-renewable-energy-in-2022/> [accessed May 1,2023]

CAGR – Compound Annual Growth Rate (Author's Calculation)

The CAGR formula is equal to $(\text{Ending Value}/\text{Beginning Value})^{1/(\text{No. of Periods})} - 1$.

The table – 3 exhibits the global energy companies with the highest revenue in fiscal year 2020-21. During the fiscal year of 2020-21, China Petroleum & Chemical Corporation generated more revenue than any other global energy company. The Chinese oil and gas refining colossus also known as Sinopec reported

revenue of 324.8 billion U.S. dollars. Saudi Arabian Oil Co, also known as Saudi Aramco, ranked third in terms of revenue, with 229,9 billion U.S. dollars, despite being the dominant energy company in terms of profits.

Table - 4
Global energy companies with the highest revenue (in millions of U.S. dollars) in fiscal year 2020-21

Revenue of leading global energy companies FY 2020-21	Revenue (in million U.S. dollars)
China Petroleum & Chemical Corp (China)	324,780
PetroChina Co (China)	298,385
Saudi Arabian Oil Co (Saudi Arabia)	229,891
Royal Dutch Shell (Netherlands)	180,543
BP (United Kingdom)	180,094
ExxonMobil (United States)	179,784
Total Energies (France)	119,704



Chevron (United States)	94,471
Gazprom (Russia)	86,471
Electricité de France (France)	82,190
Enel (Italy)	76,208
Lukoil (Russia)	75,330
EON (Germany)	73,371
Rosneft Oil Co (Russia)	70,063
Marathon Petroleum (United States)	69,897
ENEOS (Japan)	69,123
Engie (France)	66,378
Phillips 66 (United States)	64,171
Reliance Industries (India)	62,781
Uniper (Germany)	60,793
Source: S&P Global Platts The S&P Global Platts Top 250 Global Energy Company Rankings 2021 https://www.spglobal.com/commodityinsights/top250/rankings/2021 [accessed May 05,2023] Note: Figures reflect the most recent available reporting period as of October 2021. Includes electric utilities, multi utilities, integrated oil and gas, oil and gas exploration and production, oil and gas refining and marketing, and oil and gas storage and conveyance.	

Renewable Energy Status in India

According to the Indian Brand Equity Foundation's Renewable Energy Industry Report (2023), India's ambitious renewable energy goals are transforming its power sector. A growing population and widespread rural electrification contribute to the demand for energy to power households, businesses, and communities. Pollution levels will decrease as villages attain self-sufficiency through the use of renewable energy. As the government focuses on electric vehicles, green hydrogen, and solar equipment production, the renewable energy sector in India is expected to flourish in 2022, with 15 billion dollars likely invested this year.

It is anticipated that by 2040, approximately 49% of total electricity will be generated by renewable energy, as more efficient batteries will be used to store electricity, resulting in a 66% decrease in the cost of solar energy compared to the current cost. India will save Rs. 54,000 crores (\$8.43 billion) annually by replacing coal with renewable energy. Between 2020 and 2025, it is anticipated that approximately 15,000 MW of wind-solar hybrid capacity will be added. The table below describes the leading foreign investors in renewable energy and renewable energy agencies in India.

Table – 5
Top foreign investors and Agencies for Renewable Energy

Top Foreign Investors Towards Renewable Energy	Agencies for Renewable Energy
• Enercon (Germany) • Vestas (Denmark) • Applied Materials (US) • Asian Development Bank • Enel (Italy) • Gamesa (Spain) • Orix (Japan) • Nordex (Germany) • Mudajaya (Malaysia)	• Ministry of New and Renewable Energy (MNRE) • National Institute of Solar Energy (NISE) • National Institute of Wind Energy (NIWE) • Sardar Swaran Singh National Institute of Bio-Energy • Skill Council for Green Jobs • Solar Energy Corporation of India (SECI)
Source: compiled from Indian Brand Equity Foundation - Renewable Energy Industry Report (2023) https://www.ibef.org/industry/renewable-energy [Accessed May 8,2023]	

In the future decades, India's energy demand is anticipated to increase more than that of any other nation due to its sheer size and enormous growth and development potential. Therefore, it is essential that the majority of this new energy demand be met by renewable, low-carbon sources. India's announcement that it

intends to achieve net-zero carbon emissions by 2070 and satisfy 50 percent of its electricity demand from renewable sources by 2030 is a watershed moment in the global fight against climate change.



The renewable energy market in India is the fourth most alluring in the globe. As of 2020, India ranked fourth in wind power, fifth in solar power, and fourth in installed capacity of renewable energy. Installed renewable power generation capacity

increased at a compound annual growth rate of 15.92% between FY16 and FY22. India is the fastest-growing market for renewable electricity, and new capacity additions are expected to double by 2026.

Table - 6
Renewable energy capacity in India from 2009 to 2022

Year	Renewable Energy Capacity (In Megawatts)	Changes in Percent (%)
2009	48,304	-
2010	52,259	8%
2011	58,053	11%
2012	60,460	4%
2013	63,589	5%
2014	71,889	13%
2015	78,579	9%
2016	90,411	15%
2017	105,253	16%
2018	118,195	12%
2019	128,428	9%
2020	134,455	5%
2021	147,122	9%
2022	162,963	11%

Source: International Renewable Energy Agency (IRENA) - Renewable Energy Capacity Statistics 2023, page 2

Note: Figures are compiled from several editions of this report.

https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Mar/IRENA_RE_Capacity_Statistics_2023.pdf?rev=b357baf054584e589c8ab635140d0596 [accessed May 1,2023]

In 2022, India had approximately 163 gigawatts of renewable energy capacity. This was an increase from approximately 134.4 gigawatts in 2020 and the highest value for the period under consideration.

CONCLUSION

Governments around the globe have a great deal of trust in renewable energy as a crucial technology for mitigating energy-related environmental issues, especially CO₂ emissions. India has set a goal of reducing the carbon intensity of its economy by less than 45 percent by the end of the decade, achieving 50 percent cumulative electric power installed from renewable sources by 2030, and achieving net-zero carbon emissions by 2070. (India, 2023)

To make renewable energy technology a global public benefit, i.e., accessible to all, not just the wealthy, it will be necessary to eliminate obstacles to knowledge sharing and technological transfer, such as intellectual property rights restrictions. Essential technologies such as battery storage systems enable the storage and release of renewable energy, such as solar and wind, when individuals, communities, and businesses require electricity. (UNO, 2022) According to Secretary-General António Guterres, "renewables are the only path to real energy security, stable power prices, and sustainable employment opportunities." In recent years, the world and India have increasingly adopted renewable energy techniques and taken

measures to reduce carbon emissions, purify the air, and ensure a more sustainable future.

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