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FOREIGN DIRECT INVESTMENT IN THE RENEWABLE ENERGY SECTOR

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Abstract

"Energy is fundamental to human survival and economic development, having long been a cornerstone of progress. The Brundtland Commission's 1987 report, *Our Common Future,* stressed the need for sustainable, reliable energy to ensure long-term development.[1339] However, conventional energy sources like coal, oil, and natural gas are depleting and significantly contribute to greenhouse gas emissions, posing serious environmental challenges."

[1339] "United Nations, *Our Common Future* (1987), World Commission on Environment and Development."

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India, with its rapidly growing energy needs, stands at a critical crossroads. "As the 3rd largest emitter of carbon dioxide—following the U.S. and China—India's dependence on fossil fuels heightens global climate concerns.[1340] Roughly 58% of the nation's energy is still derived from non-renewable sources, while 42% comes from renewables." Transitioning to clean energy is crucial to achieve sustainable development without compromising future generations' needs.

"India's Intended Nationally Determined Contributions (INDCs) under the 2015 Paris Agreement chart a roadmap for reducing emissions, with a global goal of limiting temperature rise to below 2°C."[1341] Meeting these commitments, however, requires strong political will, financial investments, and comprehensive policy support.

"India remains heavily reliant on imported crude oil and natural gas and continues to be a major coal consumer and producer. To counter this, the country has made notable advances in renewable energy, especially solar and wind. As of February 2023, over 64 GW of solar capacity had been installed, thanks to joint efforts by central and state authorities." Renewable energy is becoming increasingly affordable, creates employment, improves public health, and is particularly beneficial in remote regions without grid connectivity.

India initially targeted 175 GW of renewable energy by 2022—100 GW solar, 60 GW wind, 10 GW biomass, and 5 GW small hydro. While substantial progress has been made in solar and wind, the country now faces the more ambitious goal of achieving 500 GW by 2030. This path is riddled with challenges such as financial constraints, outdated technology, regulatory bottlenecks, and land acquisition difficulties.

"To navigate these challenges, India must attract domestic and foreign investment through investor-friendly policies, streamlined regulations, and supportive legal frameworks. Greater international cooperation and private sector involvement are also essential. With strategic planning and innovation, India can capitalise on its abundant renewable resources and position itself as a global leader in sustainable energy."

"The urgency is amplified by the country's population growth and industrial expansion. India's population is expected to reach 1.512 billion by 2030, with states like Uttar Pradesh and Maharashtra surpassing the populations of many countries.[1342] Between 2035 and 2040, India is projected to lead the world in energy demand growth."

"Despite coal and oil maintaining a large share in the energy mix, renewables have overtaken oil and gas to become India's second-largest energy source." Renewable energy consumption stood at 41 million tonnes of oil equivalent (mtoe) in 2020 and is expected to soar to 191 mtoe by 2035.[1343]

"Economic growth, rising incomes, urbanization, industrialization, and increasing use of appliances and electric vehicles are all driving energy demand. To meet this demand sustainably, expanding the renewable energy sector is imperative. By doing so, India can ensure energy security, drive economic growth, improve living standards, and contribute significantly to global climate goals."[1344]

Keywords: Foreign Direct Investment, Renewable Energy Infrastructure, Green Energy Financing, Sustainable Development, Clean Energy Policy, Energy Transition

Renewable Energy in India: Potential, Present Status, and Key Sectors

Renewable Energy Potential in India

India, being a tropical country, possesses immense potential for renewable energy, particularly solar power, owing to its abundant

[1340] "Global Carbon Atlas (2022)."
[1341] "UNFCCC, *India's INDC Submission* (2015)."
[1342] "Press Information Bureau (2021), India's Renewable Energy Roadmap."
[1343] "India Energy Security Scenarios 2047, NITI Aayog."
[1344] "IPCC Reports; World Resources Institute (WRI) India Reports."

sunlight and high solar irradiance.[1345] "The country's total renewable energy potential is estimated at around 1,096 GW. Alongside solar energy, advancements in technology have made it possible to tap into other sources like waste-to-energy (WTE), which is estimated to have a capacity of approximately 4.137 GW." Additionally, emerging energy sources such as geothermal, tidal, and wave energy remain largely untapped but show considerable promise—tidal and wave energy combined have an estimated potential of 48 to 69 GW, while geothermal energy offers around 10,600 MW.[1346]

"Rajasthan leads the country in renewable energy potential, particularly solar, due to its vast desert landscapes. Gujarat follows closely, with an estimated 122 GW potential, primarily driven by wind energy in areas like Kachchh and Kathiawar.[1347] The renewable energy sector in India is largely dominated by private investment, accounting for about 95% of the installed capacity, while contributions from state and central governments remain relatively small at 3% and 2%, respectively."[1348] Major private sector participants include companies such as Suzlon in wind energy, Tata Power in solar, and ReNew Power, which operates across both solar and wind segments.

Present Status of Renewable Energy in India

"India has emerged as a global leader in renewable energy due to its strong commitment to climate change mitigation and supportive institutional frameworks, particularly from the Ministry of New and Renewable Energy (MNRE)." A major policy shift from the feed-in tariff system to competitive bidding has significantly lowered solar power tariffs, with rates falling to a record low of ₹1.99 per unit.[1349] "Since 2014, the country's renewable energy capacity has surged by 99.3%, reaching 152 GW (including large hydro) by 2022. By January 2022, renewables accounted for 38.56% of the total installed energy capacity. Excluding large hydro, India had installed 105 GW of renewable capacity, ranking fourth globally in total renewable, wind, and solar installations."

Renewable energy development is unevenly distributed across India. Southern states like Karnataka and Tamil Nadu, and western states such as Gujarat, Maharashtra, and Rajasthan, dominate capacity deployment—contributing about 80% collectively. Northern, eastern, and northeastern regions have lagged in this growth.

Significant national initiatives have propelled this progress. The Green Energy Corridor enhances grid integration of renewables, while the National Hydrogen Energy Mission (launched in 2020) promotes green hydrogen development. Under its Paris Agreement commitments, India aims to create a 2.5–3 billion tonne carbon sink and reduce emissions intensity by 45% from 2005 levels by 2030.[1350] With $64 billion invested over five years, India is now the fastest-growing renewable energy market globally.[1351]

Solar Energy

Solar power has emerged as India's most dynamic renewable energy segment, growing from just 2.6 GW in 2013 to 50 GW by early 2022. "Government initiatives such as the Solar City Program and the development of major solar parks like Dholera (Gujarat), Pavagada (Karnataka), and Ananthpuramu (Andhra Pradesh) have bolstered growth. The Phase II Rooftop Solar Program targets 40 GW of rooftop installations, and the PM-KUSUM scheme aims to deploy 30.8 GW via solar pumps for farmers."[1352]

Despite setting a 100 GW solar target under the National Solar Mission by 2022, India reached

[1345] "MNRE, *Annual Report 2022–23*, Government of India"
[1346] "*Status Report on Ocean and Geothermal Energy in India*, 2021.""
[1347] "GEDA, *Wind Energy Potential Report*, 2022."
[1348] "CEEW (Council on Energy, Environment and Water), *Private Sector Investment Trends in Indian Renewables*, 2023."
[1349] "Mercom India, "India's Solar Tariffs Hit Record Low of ₹1.99/kWh in Gujarat Auction," December 2020"
[1350] "India's Updated NDC (Nationally Determined Contribution), August 2022, UNFCCC Submission."
[1351] "IBEF (India Brand Equity Foundation), *Renewable Energy Sector Report*, 2023."
[1352] "*Phase II Grid-Connected Rooftop Solar Program*, 2022"

only 63 GW by October 2022, largely due to COVID-19 disruptions. To support domestic manufacturing, the government has imposed safeguard duties on imported panels and launched a ₹19,500 crore Production-Linked Incentive (PLI) scheme. Challenges such as dust accumulation in solar parks are being tackled with robotic cleaners.

Wind Energy

India's wind sector is location-specific and dependent on precise resource assessment. The National Institute of Wind Energy (NIWE) operates nearly 900 monitoring stations. Onshore wind capacity has doubled from 21 GW in 2013–14 to 40 GW by 2022.[1353] Offshore wind holds promise, particularly in Gujarat and Tamil Nadu, due to better capacity utilization, though no projects have been launched yet. Only 20% of the 200 GW estimated wind potential has been utilized. Upgrading aging turbines has been recommended.

Small Hydro and Biogas

"Hydropower below 25 MW is classified as small hydro and managed by MNRE, while larger projects are overseen by the Ministry of Power." Small hydro projects are ideal for rural areas due to their low environmental impact. India exceeded its 5 GW small hydro target ahead of time.

"Biogas has significant rural potential, utilising agricultural and kitchen waste. Programs like NNBOMP, GOBAR-DHAN, and PM JIVAN promote their adoption.[1354] However, installation progress is slow—only 5 million plants out of a 12.3 million potential had been set up by 2021. Biogas and biofuels contribute to energy security, waste management, and rural development."

Legislative Framework for Renewable Energy in India

"India's original constitutional framework did not directly address renewable energy, as it was not a priority during the drafting of the Government of India Act, 1935 or the Constituent Assembly debates." However, the constitutional structure allows for its inclusion through various provisions. Under Article 246, legislative powers are divided between the Union and State governments.[1355] "Renewable energy falls under Entry 38 of the Concurrent List (Electricity), allowing both levels to legislate. In case of conflict, central laws prevail unless the state law receives Presidential assent."

"Environmental obligations under **Articles 48A** (Directive Principles) and **51A(g)** (Fundamental Duties) empower the state and citizens to protect the environment."[1356] These provisions support laws and policies promoting renewable energy. "Furthermore, under **Article 248(1)** and **Entry 97 of the Union List**, Parliament holds residual powers to legislate on matters not explicitly listed, including renewable energy." The **73rd and 74th Constitutional Amendments** also empower Panchayati Raj institutions and urban local bodies to participate in decentralised renewable energy initiatives, especially in rural and semi-urban areas.

Government Policy Initiatives

India has adopted a range of progressive policies and initiatives to promote renewable energy and sustainably meet its growing energy needs. "One such policy is the **National Offshore Wind Energy Policy (2015)**, which aims to tap into offshore wind potential within the country's territorial waters and Exclusive Economic Zone (EEZ)." The policy emphasises public-private partnerships and assigns the **National Institute of Wind Energy (NIWE)** as the nodal agency.[1357] "With over 7,500 km of coastline—especially along Tamil Nadu and Gujarat—India has an estimated 70 GW offshore wind capacity. Offshore wind turbines, significantly larger than onshore units, can generate higher-quality power, making them highly viable."

[1353] "*Wind Power Capacity in India*, 2022"
[1354] "Ministry of Rural Development, *Biogas Potential in Rural India*, 2021."
[1355] "Constitution of India, *Article 246: Distribution of Legislative Powers*, 1950"
[1356] "Constitution of India, *Article 48A: Environmental Protection*, 1976 (42nd Amendment)."
[1357] "*Wind Energy Policies and Schemes in India*."

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"The **National Policy on Biofuels (2018)** focuses on promoting various generations of biofuels by utilising biomass efficiently. It introduces strategies, funding mechanisms, and institutional support to advance self-reliance in clean energy." "The policy targets a 20% biofuel blend and establishes a **National Biofuel Coordination Committee**, chaired by the Prime Minister."[1358] India surpassed its 10 GW biomass target in 2022, reflecting strong early performance.

"To optimise land and grid infrastructure, the **National Wind-Solar Hybrid Policy (2018)** promotes hybrid systems, leveraging the complementary nature of solar and wind energy. The policy sets a target of 160 GW combined wind and solar capacity by 2022."[1359] "It includes technical and regulatory frameworks managed by the **Central Electricity Authority (CEA)** and **Central Electricity Regulatory Commission (CERC)**." Financial support and research incentives aim to encourage hybrid projects.

"With energy demand projected to rise faster than any other country, India has pledged to achieve **net-zero emissions by 2070** and source **50% of electricity from renewables by 2030**. As of 2023, India ranks **fourth globally in installed renewable capacity**, especially in wind and solar."[1360] Between FY2016 and FY2023, renewable capacity grew at a CAGR of 15.4%, reaching 125.15 GW, and is expected to double by 2026. A favourable investment climate and supportive policies have made India an attractive destination for clean energy investment.

"Globally, **China** leads in utility-scale renewables, with over 228 GW solar and 310 GW wind capacity—almost half of the world's total. State-owned enterprises, supportive policies, and robust supply chains drive its leadership, though coal still dominates its electricity mix. The **United States** excels in attracting foreign direct investment (FDI) in renewables, aided by tax incentives under the **Inflation Reduction Act** and strong state policies." Key FDI areas include solar, wind, hydrogen, and energy storage. Though regulatory hurdles and security reviews exist, sectors like offshore wind and green hydrogen offer strong potential.[1361]

"Germany is another global leader, known for pioneering wind and solar growth through the **Renewable Energy Sources Act (EEG)**. With 30,000 wind turbines and over 60 GW combined capacity, it also excels in solar power with 52 GW capacity as of 2020.[1362] Strong R&D backing and industrial innovation support this progress."

"India's renewable rise is supported by flagship initiatives like the **International Solar Alliance (ISA)** and **One Sun One World One Grid (OSOWOG)**."[1363] It ranked third in the 2021 **Renewable Energy Country Attractiveness Index (RECAI)**. "Companies like **Adani Green Energy Limited (AGEL)** play a key role, attracting global investors and focusing on large-scale solar, wind, and hybrid projects. Despite facing financial and regulatory challenges, AGEL remains integral to India's green energy ambitions. Its growth mirrors India's larger goal of becoming a global renewable energy hub while balancing development with sustainability."

Conclusion

"India, now the world's 5th largest economy, is swiftly expanding its renewable energy sector to promote sustainable growth, enhance energy independence, and address climate change. With a renewable energy potential of approximately 1,096 GW, the country has introduced key programs such as the National Solar Mission, PM-KUSUM, the Solar Park Scheme, and the Production Linked Incentive (PLI) Scheme to harness solar, wind, biomass, and hydropower resources." "Between 2017–18

[1358] "*National Policy on Biofuels*, 2018."
[1359] "*National Wind-Solar Hybrid Policy*, 2018."
[1360] "*Renewable Energy Capacity in India*, 2023."
[1361] "U.S. Department of Energy, *Foreign Direct Investment in U.S. Renewable Energy*, 2022."
[1362] "German Energy Agency (dena), *Germany's Renewable Energy Capacity and Development*, 2020."
[1363] "International Solar Alliance (ISA), *One Sun One World One Grid Initiative*, 2020."

and 2022, India's installed renewable energy capacity more than doubled from 70 GW to 152 GW. This enabled the nation to meet its Paris COP21 commitment—sourcing 40% of its electricity from non-fossil fuels—eight years ahead of the 2030 target. At COP26, India further elevated its renewable energy goals by pledging to reach 500 GW of capacity by 2030 and unveiling the "One Sun, One World, One Grid" initiative to promote global cooperation in solar power distribution."

Despite this progress, India's renewable sector faces multiple challenges: regulatory ambiguities, financial strain on DISCOMs, inadequate transmission infrastructure, over-reliance on imported solar equipment, and insufficient R&D. "To overcome these, stronger policies and enforcement are needed, including establishing Renewable Energy Certificates (RECs) to promote market growth. Regulatory frameworks should be strengthened by empowering State Electricity Regulatory Commissions (SERCs) and ensuring strict Renewable Purchase Obligation (RPO) compliance across states".

"Financially, the sector requires better budget allocations, targeted incentives for private investment, and integration into priority lending sectors to ease credit access. Programs like UDAY have failed to fully resolve DISCOM financial distress, suggesting a need for renewed financial interventions". Incentives like tax and interest rebates for individuals installing renewable systems could further drive adoption.

"Infrastructure development must accelerate. Power Grid Corporation of India (PGCIL) should receive greater funding to expand transmission capacity through Green Energy Corridors, and collaboration between State Transmission Utilities (STUs) and developers must be strengthened". To reduce dependence on Chinese imports, the Make in India initiative should prioritize domestic solar module manufacturing, coupled with increased R&D funding and industry-academia partnerships for innovation.

Skill development is also crucial. New educational and research institutions must train the workforce to meet the sector's growing needs, creating employment opportunities and ensuring efficient project execution. Local bodies like municipalities and panchayats should be empowered and incentivized to promote renewable projects, fulfilling their constitutional roles and boosting community-level awareness and acceptance.

"Hybrid energy projects integrating solar, wind, and battery storage must be prioritized under a strengthened Wind-Solar Hybrid Policy to address land and transmission challenges effectively. Investment summits and facilitation events should be organized to attract domestic and international investors".

"Overall, renewable energy is key to India's long-term energy strategy. While fossil fuels will remain essential for decades, their finite nature highlights the urgency of transitioning to sustainable sources. India's proactive steps, such as the International Solar Alliance (ISA) and ambitious INDC targets, position it as one of the fastest-growing and most attractive renewable energy markets globally." However, achieving its vision for sustainable, inclusive growth will depend on overcoming existing challenges through coordinated policy action, strategic investments, technological innovation, and grassroots participation. This paper highlights that transitioning to renewable energy is India's only viable path toward meeting its rising energy demands while ensuring environmental sustainability.