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Beyond Megawatts: Wind Energy and Just Transitions

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NOVEMBER 2025

Discussion Paper

Beyond Megawatts: **Wind Energy and Just** **Transitions**

II ABSTRACT

India's rapid renewable energy (RE) transition, including the focus on solar and wind energy, is widely celebrated as a pathway toward low-carbon growth and energy security. The wind sector in India holds enormous untapped potential for energy transition. As government policies now focus on this growth potential, some challenges and constraints need to be considered. This paper raises critical questions about which interests must be prioritized, and at what cost. The present RE frameworks in India often bypass environmental impact assessments (EIA) for wind projects, creating significant gaps in accountability. These omissions risk overlooking the social, ecological, and livelihood concerns of communities directly impacted by land acquisition and project development. This paper examines the intersection of wind energy policy looking at current and future policy and practice, environmental governance, and social justice in India's wind sector.

II INTRODUCTION

India announced its net-zero target for 2070 at the 26th United Nations Climate Change conference, 2021 (COP26), strengthening India's commitment to climate action and just energy transitions. With 45 years to its decarbonization goal, the energy sector in India has continued to progress towards rapid transformation to support clean energy.

Additionally, India has also set a national commitment to decarbonize nearly 50% of its energy by 2030, taking its non-fossil energy capacity to 500 GW (Shankar et al, 2022). As one of the world's fastest-growing economies with rapidly increasing demands for electricity, India faces dual challenges of meeting energy needs while reducing its dependence on fossil fuels, especially with surmounting international pressure on the matter. On a global scale, India has led efforts in expanding its non-fossil fuel capacity, but significant challenges remain in meeting the targets set forth. With five years till the target year, India's growth trajectory, decentralization efforts, RE capacity, and challenges within the sector can be analyzed to think of alternate pathways

Currently, India's installed renewable energy capacity is over 237.49 GW as of 2025 (MNRE, 2025). India's diverse renewable energy portfolio includes small and large hydro power, biomass power, waste-to-energy, bio power, ground-mounted, hybrid, and off-grid solar and wind power (MNRE, 2025).

Wind energy has emerged as a cornerstone of India's renewable energy portfolio as it offers scalable and increasingly cost-competitive electricity. In the last few decades, India has built a robust domestic manufacturing base and favorable policy frameworks to assist the grid-connectivity for wind energy. This paper will take a look at India's wind energy sector, its capacity and potential to support energy transition, its evolution and policy, offshore wind, as well as challenges and opportunities for human-centric wind transition, especially for remote areas in the country.

I INDIA'S WIND CAPACITY AND UNTAPPED POTENTIAL

Wind energy contributes significantly to India's installed capacity for renewable energy. From a total of 234.49 GW of installed renewable energy in 2025, wind has a large share of 52.14 GW, making it the second-largest clean energy source for the country, following solar energy (PIB, 2024).

Sector	Cumulative Achievements (till 31.03.2014)	2014-15	2023-24	2024-25 (01.04.2024 – 31.12.2024)	Cumulative Achievements (till 31.12.2024)
Wind Power	21,042.58	2,311.77	3,253.38	2,276.65	48,163.16
Solar Power	2,821.91	1,171.62	15,033.24	16,051.10	97,864.72
Small Hydro Power	3,803.68	251.68	58.95	97.3	5,100.55
Biomass (Bagasse) Cogeneration	7,419.23	295.67	0	372.86	9,806.42
Biomass (Non-bagasse) Cogeneration	531.82	60.05	107.34	0	921.79
Waste to Power	90.58	0	1.6	0	249.74
Waste to Energy (Off-grid)	139.79	9.71	30.17	34.13	370.2
Total	35,849.59	4,100.50	18,484.68	18,832.04	162,476.58

Source: [PIB \(2025\), Energy Security in India](#) (Values in MW).

Despite its growing renewable energy capacity, India remains heavily reliant on thermal power to meet its ever-increasing energy demand. This dependence is further compounded by the challenges of intermittency associated with renewable energy, particularly solar energy. Since natural resources such as the sun and wind are affected by environmental, seasonal, and cyclic changes (Shah, 2024), the issue of energy storage has become pertinent to support renewable energy in times when it is not readily available. Particularly, solar energy faces a considerable challenge in meeting demand during non-solar hours, when sunlight is unavailable. To meet demand during these hours, there is an increasing push for wind power to operate as a complementary source alongside solar. By harnessing the strengths of both technologies, wind and solar together can provide a more balanced and reliable supply of renewable energy¹, forming a crucial pillar for achieving a smooth and sustainable energy transition.

Emerging research indicates that wind energy has the potential to fill these gaps. Studies, including a recent report by Ember based on the Central Electricity Authority (CEA), highlight how wind power generation patterns can often complement solar output during periods when sunlight can be limited. The report states that in India, wind power often peaks during the night and early hours of the day, providing solutions to fill gaps of intermittency to a certain level (Shah, 2024).

At the Global Wind Day, the Union Minister of New and Renewable Energy addressed three key issues for the wind sector, underlining the need to combine wind, solar, and storage, competitive tariffs, and domestic manufacturing (MNRE, 2025). Furthermore, he highlighted the intention to explore India's potential for wind energy by focusing on new states, including Madhya Pradesh,

¹ . These complementary energy sources can fill the gap for daily cyclic issues; however, it is still important to note that without efficient storage solutions, renewable energy intermittency challenges remain.

Telangana, and Odisha. Additionally, the government is launching projects for offshore wind with 4GW of leasing areas in Gujarat and Tamil Nadu, modernizing the grid and integrating wind into round-the-clock and firm green power strategies (MNRE, 2025). These targets share a broader vision to place wind energy at the core of India's growing promise of renewable energy. Expanding India's wind capacity to meet its targets can ease the transition process, especially in combination with solar energy, battery storage, and an expanding portfolio of renewable energy sources.

II MARKET, MANUFACTURING AND POLICY LANDSCAPE

The onshore wind has continued to be the backbone of the sector in India. The wind sector in India has achieved significant growth through private sector investment since the 1990s², as well as favorable policies for manufacturing (Shankar et al, 2022), which have put India on the map as a global competitor for wind turbines.

The initial growth of wind energy was rapid, before a market focus shift to solar. However, government policies, even back in the 1990s and early 2000s, give insight into how market conditions can promote growth within the sector. In 1994, the government introduced a tax-saving mechanism for wind energy projects with a depreciation rate of 100%, which came to be known as accelerated depreciation (AD) (Shankar et al, 2022). Although the AD tax benefit was available to other renewable energy sources as well, the primary beneficiary was the wind sector due to the maturity of the technology, resource availability, and the pre-existing experience (Sud et al, 2015).

In 2002, the depreciation rate was reduced to 80 per cent before the scheme was withdrawn in 2012. A parallel scheme to the AD was also announced in 2009, which came to be known as the Generation-Based Incentive (GBI) to attract larger independent power producers and foreign direct investment to the sector, opening the market to those beyond the AD scheme (Sud et al, 2015). After 2018-19, the depreciation value for wind energy installed on or before March 31, 2012 is 40 per cent (CBDT, n.d.), ²⁰Although most literature and reports on the early wind policy instruments characterize the AD scheme as a failure. The failure of the policy is often cited as being its tax-driven deployment, the prevalence of underperforming assets, as well as fragmented ownership structures. The absence of long-term operational incentives is often seen as evidence that the policy underdelivered on its primary objectives. While all these shortcomings are substantial, however, it may be more accurate to understand these outcomes as policy and market gaps rather than outright failures.

The AD scheme achieved parts of what it was designed to do as a policy, which was to stimulate the early investment in a nascent sector and put India on the path to unlock its wind capacity. In the subsequent years, a change in the renewable energy landscape and investment patterns led to increased government support and efforts to alternate sources of energy.

In the initial stages of India's policy for renewable energy, the push for wind power, resulted from rising fuel prices and the 1970s oil crisis, even though the initial investment for wind projects was quite huge, comprising 60-70% of the initial cost (Sharma & Sinha, 2019). This gained momentum further during 1994-1996, when private sector investments in the wind energy sector significantly expanded the market. Development for grid connectivity under the 7th and 8th wind energy market,

2. The government of India began working on wind energy from the 1980s to the early 1990s, influenced by the 1970s energy crisis. The Department of Nonconventional Sources began research and development in the renewable energy sector, and wind energy saw growth from 41MW to 968 MW installed capacity in just 4 years between 1992 to 1998; (Sharma, 2019)

as well as the Indian Renewable Energy Development Agency, for financial aid, created more financing flows.

The first setback to the wind energy sector came through the new Electricity Act in 2003, which was more market-oriented when generation-based incentives (GBI), as opposed to capacity addition, were introduced in 2009. Although sectors including solar flourished under the reverse auctions to drive down solar tariffs, the wind sector did not present a favourable sector to lower tariffs due to the increase in steel and other components (Sati et al., 2022).

However, wind energy continues to be a favorable market for domestic manufacturing, more so now that India is set to significantly decrease its reliance on imports and secure supply chains. According to the World Wind Energy Association, India ranks fifth among the largest markets for new wind capacity, behind China³, Germany, the United States, and Brazil. There has been an increase in wind-solar hybrid tenders in India in recent years (Shah, 2024). Wind-solar hybrid projects are being used to combine the strengths of both technologies, generating more energy throughout the day than standalone wind or solar projects. This higher generation and better use of infrastructure can reduce overall costs, leading to lower tariffs than vanilla wind projects.

In a move to support domestic markets, the MNRE has introduced new norms under the ALMM (wind) systems, requiring key components, such as the blades, towers, generators, etc., to be sourced from approved domestic supplies, and mandating domestic data storage for wind turbine operations (Reuter, 2025). The directive also further prohibits the real-time operational data transfer abroad, and requires operational control and research and development centers to be located in India (Reuters, 2025).

This will mark a strategic shift for India as it focuses on self-reliance in renewable energy, especially among increasing geopolitical tensions and trade wars. While this policy may not be an explicit response to specific international tensions, it aligns with broader trends of countries seeking greater control over their critical infrastructure. By bolstering domestic manufacturing capabilities, India aims to reduce dependence on foreign suppliers. While this puts India in a stronger position internationally, it also carries the potential risk of driving down future investments.

I TRICHY: INDIA'S ENERGY EQUIPMENT HUB

Trichy or Tiruchirappalli, as it is officially known, is a city in the east-central part of the state of Tamil Nadu. Among the growing demand for wind turbines and local manufacturing, Trichy has been dubbed India's energy equipment and fabrication capital (Karthik, 2025). It has received this position due to its high manufacturing capabilities, producing more than 50% of the components that are required for wind turbines, including towers and blades. The industries here are focused on domestic manufacturing to meet the strong demand for wind turbines, and have created employment opportunities for the youth in the region. Apart from being a booming IT hub, the wind turbine blade producers in Trichy have also generated employment, currently employing over 3,500 people either directly or indirectly (Karthik, 2025).

Although the success of Trichy is aspirational, it is not simply a story to revere. More than a regional success story, it is a lesson to broaden India's domestic manufacturing and self-sufficiency goals. The rise of Trichy as an energy equipment hub was enabled by a mix of

3. China has surpassed its 500'000 MW milestone in 2024 and had an installed capacity of 561'492 MW at the end of the year 2024; WWEA, 2025.

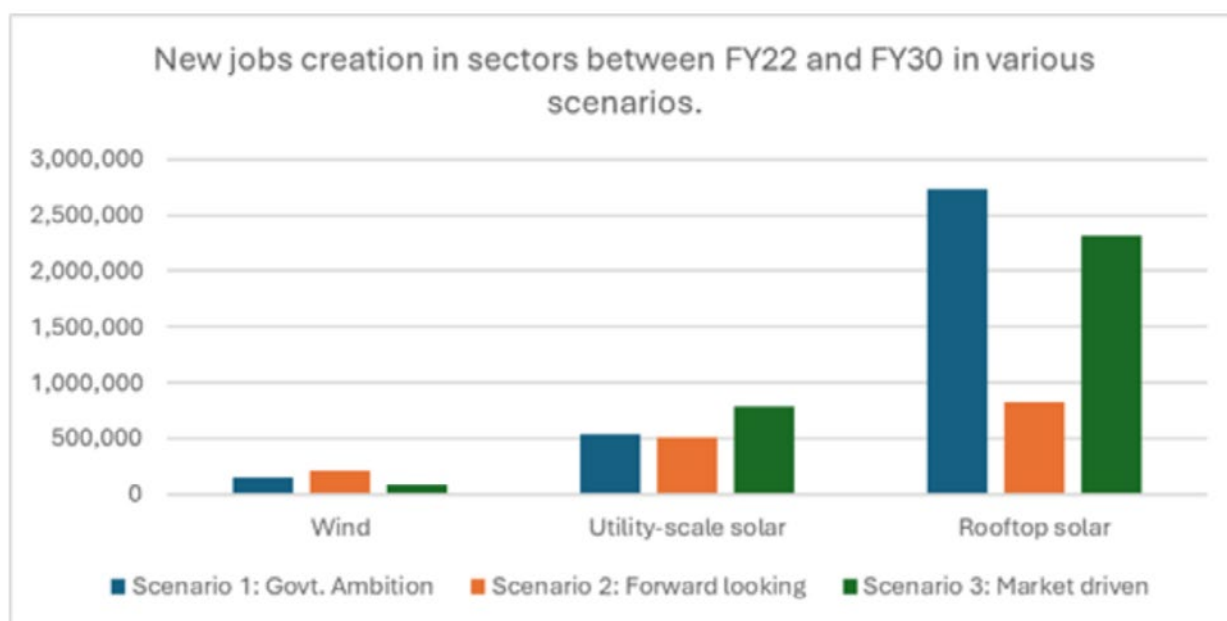
state-level industrial policies, infrastructure development, and the presence of early turbine manufacturers that attracted a value chain of smaller suppliers. This relies on the importance of creating local ecosystems that truly promote the idea of self-sufficiency in a sustainable way.

I EXPANDING WORKFORCE AND SOCIOECONOMIC ASPECTS

With India being one of the top countries for wind energy in the world, employment in the sector has also become instrumental to its success. The renewable energy sector in general, in India, has hit a significant milestone when it was found to have created an estimated 1.02 million jobs until 2023 (PIB, 2024). According to a report by the International Renewable Energy Agency and the International Labor Organization (ILO), the wind sector alone employed approximately 52,000 people⁴ in 2023, with around 40% in operations and maintenance and 35% in construction and installation.

While this number may not be significant compared to the population in India, it does create another ripple effect. The sector not only creates employment but also creates opportunities for localized systems of employment and technical training for young people outside of modern urban centers.

Wind-solar hybrid projects and other RE projects also open the potential for rural/off-grid clean energy deployment and mini-grid solutions. Mini-grid projects have the potential to create new jobs in India's rural areas, which go beyond the agricultural sector.



Source: India's Expanding Clean Energy Workforce: Opportunities in the Solar and Wind Energy Sectors, NRDC, 2022.

Even though the wind sector has great potential for employment generation, it has grown relatively slowly compared to other RE sectors. This is partially due to the temporary nature of jobs, the concentration of wind-energy generation in some states, and skill gaps. The 'Vayumitra Skill Development Program', a flagship program from the MNRE and is implemented by the National Institute of Wind Energy in Chennai, is a training program aimed at creating skilled manpower for

4. Most people employed in the sector are also young professionals with nearly 55 per cent of the workforce between the ages of 26 and 35 years of age, which makes the sector a future-focused employer; PTI, Business Standard, 2025.

the wind energy sector. The program aimed to train nearly 5010 participants during the period between 2021 to 2024 in O&M Mechanical, Electrical Tech, and Site Surveyor roles (NWE, 2025). These policies not only promote technological training but also create pathways for young people in remote areas where wind farms are located to find employment opportunities that may otherwise be rare. However, these programs can benefit from adopting more accessibility, building more gender-focused skilling courses (Tyagi, 2023), and focusing on creating opportunities for those from marginalized backgrounds.

II OFFSHORE WIND: INDIA'S NEXT FRONTIER

Driven by our ambitious climate targets, India is expanding its development of sustainable offshore wind capacity. Offshore wind can unlock big potential in diversifying India's energy mix and fill dependency gaps.

Offshore wind energy can facilitate India's progress to its net-zero ambitions. Across the world, installations have reached a total capacity of 75.2 GW (Bhardwaj & Shah, 2025). The utilization of wind turbines in large water bodies enables more efficient usage as the wind velocity is higher and more dependable in offshore locations (Desalegn, 2023). The MNRE has forwarded its strategy for the development of offshore wind along India's coastline and, in partnership with the UK, has announced a UK-India Wind taskforce in a shared vision for the development of RE technology for both nations and advancing offshore wind ecosystems, supply chains, and financing models (PIB Delhi, 2025).

Additionally, offshore wind can address some of the limitations that onshore wind faces, such as land constraints, including land use conflicts, and also further increase the reliability of power generation. It can also further unlock the potential of coastal hubs, giving coastal communities new opportunities for socio-economic benefit through technical training and skills.

However, several challenges and costs must be assessed. Research indicates that offshore wind power systems tend to have a higher carbon footprint than onshore installations⁵. Additionally, they involve substantially higher upfront development costs, though the government has allocated an initial budget of INR 7,453 crore for its new offshore wind tender, targeting up to 4 GW of capacity. The development of offshore wind turbines can also impact marine biodiversity, impacting the ecosystems and the livelihoods of specific coastal & fishing communities.

For this purpose, the government must first invest in research & development of low-carbon offshore wind technologies by using lightweight materials, etc., and at the same time conduct comprehensive environmental impact assessments that focus on marine ecosystems and coastal biodiversity.

II HUMAN CENTRIC WIND TRANSITION FOR REMOTE AREAS

For a truly sustainable energy transition for India, planning must consider human well-being and ecological integrity alongside technological progress. Wind energy, whether onshore or offshore, has immense potential to serve as a cornerstone for this transition. Land conflicts present a major bottleneck for setting up new installations, even in cases where the land ownership issues don't

5. This carbon footprint is still relatively less than traditional energy generation/ thermal power, yet it is important to consider the net-zero targets and offsetting mechanisms for the future.

emerge directly, such as for wastelands. The conflict is often between project development and social uses of land for road access or cattle grazing (Mallya et al, 2024).

The expansion depends heavily on land policies, but these vary widely across states and often lack consistency. Most states allow land use conversion for RE projects, but approvals and fees are still required, except in a few cases where exemptions exist. States such as Tamil Nadu do not mention a land conversion policy for solar energy, while others, such as Haryana and Jharkhand, offer partial or full waivers, respectively (Mallya et al., 2024). Another significant challenge is the limited options for setting new installations. Studies by CEEW find that areas with population density less than 250 people per square kilometer only account for 29% onshore wind potential. However, streamlined land acquisition, which puts communities at the center, can promote community buy-in.

Equally important are mechanisms to ensure environmental stewardship and minimizing the harm to non-human species for our own developmental standards to fight climate change. Offshore wind projects threaten to disturb marine biodiversity, create noise pollution for delicate marine habitats, and pollute the ocean water at various development stages of the project. There has also been apprehension about the cost of these wind energy projects on mangroves and the coral reefs. These can further affect the lives of nearly 15 million people in India who draw their livelihoods from fishing and fish-related activities. (Sarangi, 2022).

This points to obvious concerns for the lack of stringent measures to conduct environmental and social impact assessments for RE projects in India. While there exists a strong framework for large infrastructure projects and coal, hydro projects, etc., solar and wind projects are often exempt from the requirements of the EIAs, although land conversion and forest clearances may trigger other forms of approval requirements. With the expansion of the renewable energy sector in India, these concerns are growing even more. This absence points to an obvious regulatory and ethical issue. In effect, RE policies are designed for investors and developers rather than for people and places. This undermines the very spirit and broader goals of a “just energy transition”.

II CONCLUSION

India stands at a pivotal juncture in energy transition as a developing country. Wind and solar power are cornerstones of the growing renewable energy portfolio of the country, with untapped growth potential. New policies and government support have the answers to unlock this potential over the next few decades to reach India's net-zero targets.

Yet, the expansion of renewable energy is not without deep socio-economic and environmental challenges, some of which have not been given due focus and consideration in this rapid move towards renewable energy. However, a human-centric and environmentally conscious approach must become central to India's renewable energy trajectory.

For the near future, this means expanding renewable energy in a way that places communities, ecosystems, and justice at the heart of the transition, and not as afterthoughts. The communities that are at the center of climate justice, economic opportunity, and transition are key to finding solutions that are equitable and sustainable. Ensuring transparent land allocation, embedding environmental and social safeguards, supporting local job creation, and encouraging participatory decision-making are not only aspirational but pertinent to avoid reproducing extractive models of development under a green banner. Ultimately, the success of India's renewable energy future may be reflected in gigawatts installed, but it must always be measured in the lives it has the potential to shape. Clean energy transitions also must account for whether they can deliver a truly just and sustainable transition, one that reduces emissions while also respecting livelihoods, protecting ecosystems, and fostering shared prosperity.

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