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Assessing the Development of **Wind Energy** in India

2025

Credits

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About Vasudha Foundation

Vasudha Foundation is a non-profit organisation set up in 2010. We believe in the conservation of Vasudha, which in Sanskrit means the Earth, the giver of wealth, with the objective of promoting sustainable consumption of its bounties. Our mission is to promote environment-friendly, socially just and sustainable models of energy by focusing on renewable energy and energy-efficient technologies as well as sustainable lifestyle solutions.

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1. Introduction

Globally, the transition to clean energy is accelerating to reduce emissions and mitigate the effects of climate change. At the forefront of this effort is the expansion of renewable energy (RE) to help decarbonise the electricity grid. India has witnessed a significant transformation in its energy sector, with installed RE capacity increasing from 58 GW in 2010-11 to 228.2 GW as of March 2025, making it the fourth-largest in the world in terms of installed RE capacity[1]. This expansion aligns with the country's ambitious target of achieving 500 GW from non-fossil sources by 2030[2].

Solar and wind energy dominate India's RE landscape, accounting for 61 percent and 29 percent of the total installed RE capacity (excluding large hydropower plants), respectively[1]. Unlike fossil fuel-based thermal power, RE sources are inherently intermittent, posing challenges related to grid stability and reliability. While conventional wind projects face intermittency and limitations in grid connectivity, hybrid wind projects commissioned under the Firm and Dispatchable Renewable Energy (FDRE) and Round-The-Clock (RTC) frameworks are emerging as preferred solutions to address these challenges.

India's total installed wind capacity has grown from 26.78 GW in 2015-16 to 50 GW in 2024-25 (as of March 2025). Year-on-year (YoY) additions have fluctuated due to policy changes, supply chain disruptions, and shifting investment trends. The highest annual wind capacity addition was recorded in 2016-17 (5.5 GW), as shown in Figure 1, driven by favourable tariffs and strong policy incentives. However, subsequent years saw a slowdown, particularly in 2017-18 (1.87 GW) and 2018-19 (1.48 GW), due to regulatory uncertainties and land acquisition challenges. However, the sector witnessed a recovery in recent years, with 3.25 GW added in 2023-24, indicating renewed momentum. As of 2024-25, 4.15 GW has been added, and further growth is expected by the end of the fiscal year.

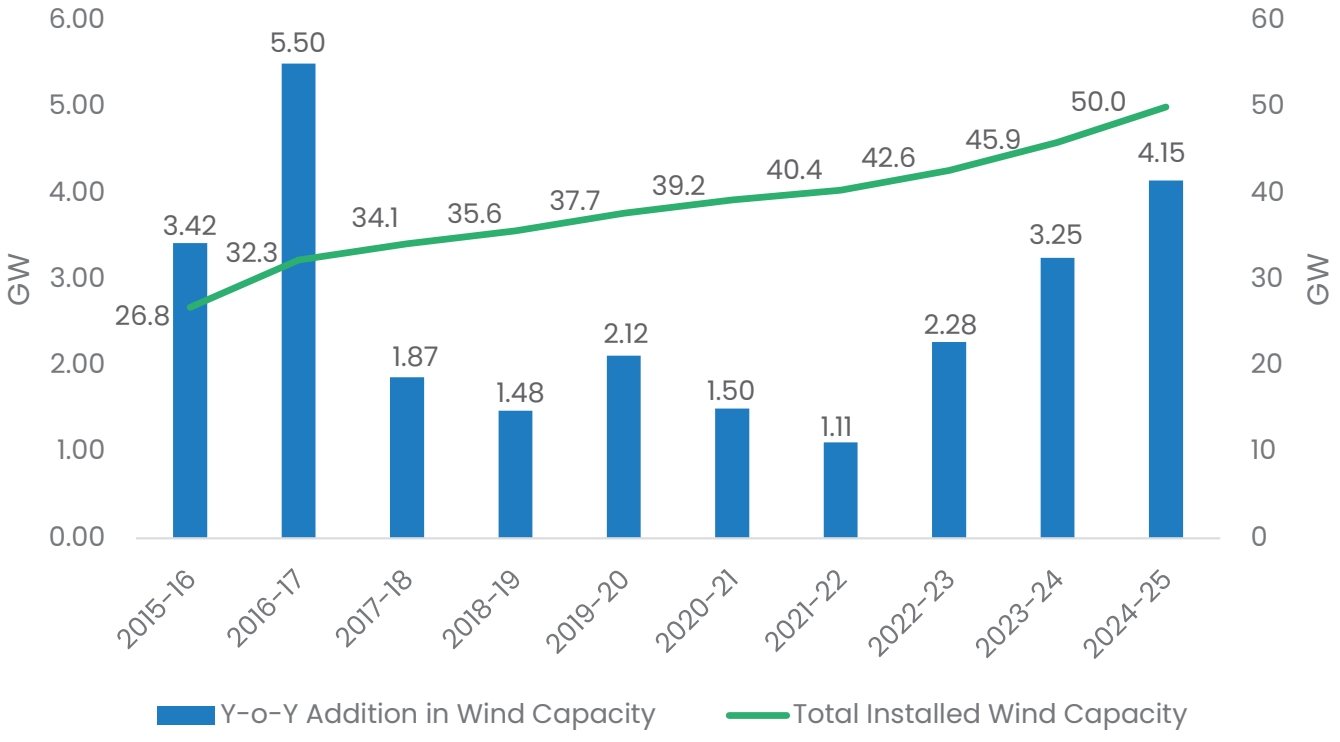

Figure 1: Year-on-year addition in wind capacity in India from 2015-16 to 2024-25

1 https://iced.niti.gov.in/
2 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2073038

Despite these positive developments, wind energy's annual capacity addition has lagged behind solar, largely due to higher capital costs, longer project development timelines, and site-specific constraints. However, with the increasing push for hybrid wind-solar projects and advancements in wind turbine technologies, the sector is expected to regain growth in the coming years. Figure 2 illustrates the wind energy potential that the country possesses, in terms of both onshore and offshore wind energy[3,4].

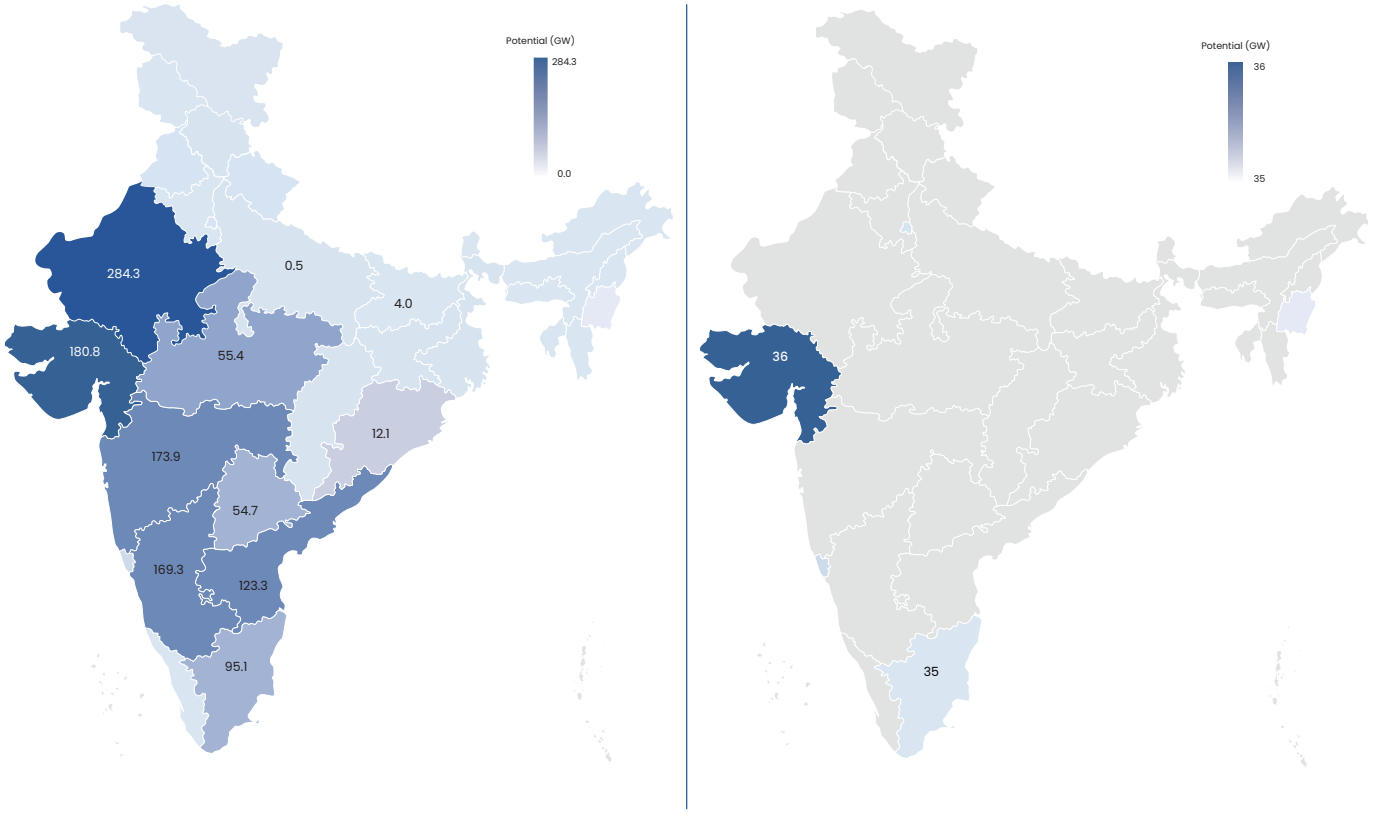

Figure 2: Onshore and offshore wind energy potential of India[5]

To take advantage of the more advanced and efficient Wind Turbine Generators (WTGs) developed over the years, the government has introduced a repowering policy for old installations. Under this policy, WTGs older than 15 years may be replaced- on commercial or voluntary grounds-with newer, more efficient WTGs, of a higher capacity[6]. As per the National Institute of Wind Energy (NIWE), India has an estimated wind repowering potential of 25.4 GW. Repowering may provide the necessary fillip to meet the projected electricity peak demand estimated by the Central Electricity Authority (CEA) till 2030, by enabling the country to achieve 100 GW of wind installed capacity by 2030, aligning with the national target.

As of March 2025, India's installed wind capacity stands at approximately 50 GW[7], compared to the forecasted requirement of 99.9 GW[8] as per the CEA's optimal generation mix by 2029-30. This gap underscores the need to analyse the wind ecosystem and identify existing challenges from the perspective of all relevant stakeholders. This report captures the issues highlighted by various government implementing agencies, wind developers, and Original Equipment Manufacturers (OEMs), including possible solutions, which shall lead to increased wind deployment. The report also captures a comprehensive study of the policy ecosystem across 10 states[9] selected for the study. These states encompass around 72 percent of the country's RE potential.

3 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1947133
4 https://mnre.gov.in/en/off-shore-wind/
5 https://iced.niti.gov.in/
6 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2022/12/202312071573748582.pdf
7 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2025/05/202505081659296923.pdf
8 https://cea.nic.in/wp-content/uploads/notification/2023/05/Optimal_mix_report_2029_30_Version_2.0__For_Uploading.pdf
9 States Studies- Andhra Pradesh, Gujarat, Rajasthan, Odisha, Tamil Nadu, Karnataka, Telangana, Uttar Pradesh, Maharashtra, Madhya Pradesh

2. Policy Landscape

As the urgency to combat climate change grows, effective policy and regulatory frameworks play a crucial role in accelerating the shift to cleaner energy. Clear guidelines, incentives, and stable regulations help de-risk investments, attracting both domestic and global players to drive RE adoption and progress toward net-zero Emissions. In fact, 84 percent of global utility-scale renewable capacity growth from 2024-2030 is expected to be policy-driven[10]. Well-defined policies not only set long-term targets but also build investor confidence by ensuring clarity in implementation.

India's RE landscape has evolved through continuous policy adaptation at both the national and state levels. These reforms are now expanding to address accelerated wind capacity addition, ensuring smoother land acquisition and grid connectivity, leading to higher wind penetration, positioning the country to achieve its target of 50 percent cumulative electric power capacity from non-fossil fuel sources by 2030[11]. This section highlights key national-level policy and regulatory initiatives on wind energy, followed by a comparative analysis of policies across 10 Indian states[9] that together represent over 72 percent of the country's renewable energy potential.

2.1 National Level Initiatives

Table 1 captures the key national-level policy initiatives that have been introduced to promote utility wind projects. The initiatives have been described in terms of their objectives, key features, financial layout, expected impact, and implementation timeline.

Table 1: National level policy provisions for utility scale wind

Initiative	Objective	Key Features	Financial Support	Impact (Achieved/Expected)	Implementation Timeline
VGF for offshore wind energy[12]	Commission 1 GW of offshore wind energy projects	500 MW offshore wind projects off the coast of Gujarat and Tamil Nadu, respectively	Financial outlay of INR 7,453 crore (including INR 600 crore for logistics)[13]	Generate 3.72 billion units per year. 2.98 million tons of CO^2 equivalent emission for a period of 25 years	Since 2024
National Repowering & Life Extension Policy for Wind Power Projects	Optimise India's wind energy capacity by repowering or refurbishing older WTGs	Developers should consider repowering or refurbishment after 15 years of WTG life	N/A	NIWE has estimated the repowering potential to be 25.40 GW[14]	Since 2023
Offshore Wind Energy Lease Rules[15]	To regulate the leasing mechanism of offshore areas towards the development of offshore wind energy projects	No entity shall install offshore wind energy projects or offshore transmission projects, except under a lease granted under these rules	N/A	SECI has floated RfS for the allocation of seabed lease rights for 4,000 MW offshore wind power projects[16]	Since 2023

10 https://iea.blob.core.windows.net/assets/17033b62-07a5-4144-8dd0-651cdb6caa24/Renewables2024.pdf
11 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2073038#:~:text=The%20solar%20photovoltaic%20(PV)%20sector,the%20end%20of%20the%20year.
12 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/09/20240912108998762 6.pdf
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14 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/12/20231213187429622 9.pdf
15 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/12/20231220821688 0.pdf
16 https://www.seci.co.in/Upload/Tender/SECI000137-5687983-RfSforallocationofSeabedLeaseRights-4000MWOffshoreWindProject.pdf

Initiative	Objective	Key Features	Financial Support	Impact (Achieved/Expected)	Implementation Timeline
RE tendering trajectory	Tendering of 10 GW[17] of wind projects every year from FY 2023-24 to FY 2027-28	Selection of 4 renewable energy implementing agencies (REIA) for tendering, namely, SECI, NTPC, NHPC and SJVN Bids for trajectory may consist of vanilla solar, vanilla wind, solar-wind hybrid, round-the-clock renewable energy power	N/A	In FY 2023-24, 69 GW[18] of RE capacity was tendered	Since 2023
TBCB Guidelines[19]	Procurement of RE in a transparent, competitive, and cost-effective manner	Transparent L1 price discovery via competitive bidding. Promotes competition and efficiency in the power sector	N/A	N/A	Since 2023
Green Energy Open Access Rules[20]	Enable buyers to procure RE from any state	Open access for consumers with 100 kW+ demand	N/A	90.4% growth in open access capacity, reaching 18.7 GW in FY24 [21]	Since 2022
CCDC for wind equipment[22]	Reduce import costs for wind energy developers	Concessional customs duty for certified wind equipment manufacturers	Duty exemption for components under RLMM	Lowers project costs, boosts domestic wind turbine manufacturing	Since 2017
Revised List of Models & Manufacturers (RLMM)[23]	RLMM ensures that only certified and tested wind turbine models from credible manufacturers are listed	RLMM sets a benchmark for WTG quality and performance across the industry. RLMM certification is necessary for developers to commission a wind project in India	N/A	N/A	Since 2016

17 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/10/2023100514851421 30.pdf
18 Vasudha Analysis
19 https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/08/2024051519772656 80.pdf
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21 https://ieefa.org/sites/default/files/2024-12/Impact%20of%20Green%20Energy%20Open%20Acess_Dec2024.pdf
22 https://ccdcwind.gov.in/ccdc.html
23 https://mnre.gov.in/en/wind-manufacturing/

2.2 State Policy Provisions

2.2.1 Utility-scale Wind

State-level support for utility-scale wind energy in India presents a varied picture, with some leading states setting firm deployment targets and structured implementation pathways, states have set firm deployment targets and structured implementation pathways, others remain vague or non-committal. Andhra Pradesh, Madhya Pradesh, and Karnataka stand out for defined wind capacity targets (ranging from 4 GW to 26 GW), strong land facilitation mechanisms, and well-articulated banking, evacuation, and financial incentives.

States like Gujarat, despite lacking an explicit MW target, are leveraging their substantial wind potential through supportive frameworks such as streamlined land access and a unified clearance portal. Rajasthan, meanwhile, integrates wind energy into its broader 90 GW RE goal, providing robust support through enhanced transmission infrastructure, land leasing provisions, and fiscal incentives-making it an attractive destination for wind developers.

Telangana and Odisha offer encouraging provisions like deemed non-agricultural land status and partial banking flexibility However, they fall short in establishing robust institutional frameworks or setting clear capacity targets. Maharashtra, Tamil Nadu, and Uttar Pradesh, in contrast, do not present a detailed wind policy framework in the current cycle. Tamil Nadu also lacks a wind policy framework, which is surprising given its historically strong wind performance.

In terms of developer ease, single-window clearance mechanisms are operational or planned in most proactive states (e.g., Andhra Pradesh, Karnataka, Rajasthan, and Telangana), suggesting growing administrative efficiency. However, a lack of uniformity across states - particularly in grid infrastructure planning and standardised incentives - continues to hinder the scalability of utility-scale wind projects across India.

To accelerate wind deployment in high-potential states, it is essential to establish clearer targets, standardised procedures, and dedicated land and transmission facilitation must become the norm rather than the exception. Table 2 details the various provisions provided in the state policies aimed at creating a conducive environment for the wind energy development.

Table 2: State policy provisions for utility-scale wind

Category	Utility-scale Wind						
Parameter	Deployment Target (MW)	Land Acquisition Support	Grid Evacuation Infrastructure	Power Evacuation and Banking Support	Incentives for Developers	Business Model	Single Window Clearance Mechanism
Andhra Pradesh	26 GW of wind energy capacity by 2030	Land to be facilitated through district-level committees; government land to be allotted as per guidelines; single-window support mentioned	Coordination with APTRANSCO, STUs for strengthening transmission infrastructure; ISTS/STU evacuation encouraged	Banking allowed with yearly settlement and up to 30% banking; APTRANSCO/APSPDCL involved in power evacuation infrastructure facilitation	Exemptions on electricity duty, 100% stamp duty reimbursement, SGST reimbursements, and incentives for early commissioning	Open access, third-party sale, and captive consumption models are permitted	State Nodal Agency New & Renewable Energy Development Corporation of Andhra Pradesh (NREDCAP) to act as single window facilitator
Gujarat	No specific target. The state acknowledges a wind potential of 143 GW	Waste land may be allocated for wind energy installations	Developer must build a dedicated evacuation line to the STU substation; common lines for clusters are encouraged	Same provisions as solar	Bank guarantee and wheeling agreements required; electricity duty governed by the relevant Act	Captive, third-party, and DISCOM sales allowed	Unified web portal managed by GEDA
Karnataka	4,000 MW (4 GW) of wind power targeted by 2027	Land to be identified by KREDL in coordination with district authorities; use of government land encouraged; lease options available through KIADB and land banks	Policy emphasises strengthening of transmission infrastructure; KPTCL and ESCOMs to develop evacuation in coordination with developers	Evacuation at a voltage level suitable for the system strength; banking of energy allowed up to 15% for captive/third-party use, subject to KERC regulations	Exemption from electricity tax for captive consumption; stamp duty and registration concessions on land leases and loans; deemed NA (non-agricultural) conversion	Encourages IPP, Captive, and Third-Party sale models; policy also encourages hybrid projects (wind + solar)	KREDL is the nodal agency providing single-window facilitation for all RE projects, including wind
Madhya Pradesh	10,000 MW target set for wind power by 2029–30.	Projects may be set up on private or government land; permission for land use as per the MP Land Revenue Code; no specific land facilitation cell	Projects must be connected to the STU/CTU network; MPPTCL is responsible for grid infrastructure development	Energy banking allowed up to 30% of monthly injection for captive/third-party sale with a 2% banking charge	100% exemption from electricity duty for 10 years; land premium exemption for public land; VAT and GST-related reimbursements not mentioned	Open access, captive, and third-party sales permitted; hybrid projects also encouraged	Policy mentions "Ease of Doing Business" cell under NREDC-MP for all RE projects, including wind, facilitating single-window approvals

Category	Utility-scale Wind						
Parameter	Deployment Target (MW)	Land Acquisition Support	Grid Evacuation Infrastructure	Power Evacuation and Banking Support	Incentives for Developers	Business Model	Single Window Clearance Mechanism
Maharashtra	2500 MW	Non-agricultural land status will be applicable for project lands acquired for project development.	N/A	N/A	N/A	N/A	N/A
Odisha	N/A	The Nodal Agency may allot such identified sites to the public/ private sector, with each entity getting a maximum capacity of 50 MW, on a first-come-first-serve basis, up to a cumulative capacity of 500 MW	N/A	The unutilised banked energy shall be considered as a deemed purchase by GRIDCO/DISCOMs at the power purchase cost, as may be determined by OERC. The payment for the deemed purchase of unutilied banked energy shall be capped at a certain percentage of the total banked energy during the month. Any unutilised banked energy beyond that shall be treated as free power to GRIDCO.	N/A	N/A	Nodal agency shall provide a single window facility for approval of all RE projects in the state
Rajasthan	No separate MW target for wind; included in overall 90 GW RE target	Government land allotment support via RREC for eligible developers; policy encourages private land leasing as well.	Green Energy Corridor (GEC) development supported; Rajasthan Vidyut Prasaran Nigam Limited (RVPNL) and DISCOMs to augment transmission	Banking allowed up to 30% of energy injected annually with carry-forward for one year	Exemption from transmission and wheeling charges for projects commissioned within the policy period; stamp duty waiver; electricity duty exemption for captive/ third-party	Captive, third-party sale, and merchant models are permitted	Rajasthan Renewable Energy Corporation Limited (RRECL) acts as the nodal agency for approvals

Category	Utility-scale Wind						
Parameter	Deployment Target (MW)	Land Acquisition Support	Grid Evacuation Infrastructure	Power Evacuation and Banking Support	Incentives for Developers	Business Model	Single Window Clearance Mechanism
Tamil Nadu	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Telangana	No specific target. Overall wind target- 3805 MW by FY30 and 4528 MW by FY35	1. Deemed non-agricultural status will be accorded for the land utilised for the development of projects. 2. The ceiling limit as per the Land Ceiling Act will not be applicable for any land acquisition for wind power projects 3. 100% eimbursement of stamp duty will be given for land purchased to set up wind projects	1. Power will be evacuated at the appropriate voltage level at the interconnection point of TGTRANSCO/ TGDISCOMs, and evacuation up to the interconnection point will be the sole responsibility of the developer for the projects. 2. TGTRANSCO/ TGDISCOMs will process the proposals for the technical feasibility within 14 days of receipt of the application from the solar power project developer	Banking charge = 8% The permitted quantum of banked energy by Green Energy Open Access consumer shall be at least 30% of the total monthly electricity consumption from the distribution licensee by the consumer	1. Supervision charges levied by TGTRANSCO/ TGDISCOMs will be reimbursed to the project developer. 2. 100% net SGST reimbursement will be given for fixed capital investment incurred for wind power projects developed by women SHGs/Vos. (50% for all other projects)	N/A	Nodal agency will facilitate the developer in obtaining requisite clearances through TG-iPASS/any other single window clearance facility provided by the government for setting up projects
Uttar Pradesh	N/A	N/A	N/A	N/A	N/A	N/A	N/A

2.2.2 Repowering Wind Projects

While India has a large number of ageing wind turbines with suboptimal performance, most state policies are yet to respond to the opportunity offered by repowering of wind energy projects. Among the ten states compared, only Tamil Nadu has introduced a clear framework with performance improvement benchmarks and mandates for repowering wind turbines older than 20 years. Its inclusion of Wind Repowering Project Aggregators (WRPAs), siting relaxations, and Power Purchase Agreement (PPA) extensions marks a progressive step toward structured repowering.

Gujarat also mandates repowering wind turbines older than 25 years and offers some continuity on Power Purchase Agreements (PPAs), but like most other states, it lacks detailed support for infrastructure or land aggregation. Karnataka, Rajasthan, and Andhra Pradesh mention repowering within broader RE facilitation frameworks but do not provide specific targets, incentives, or dedicated institutional support. Rajasthan does encourage land aggregation and infrastructure upgrades on a case-by-case basis, while Karnataka allows the reuse of existing evacuation networks where feasible.

States like Madhya Pradesh, Telangana, and Odisha have minimal to no dedicated focus on repowering, despite having considerable older capacity. Most states, except Tamil Nadu, fail to offer state-specific financial or regulatory incentives that could make repowering more attractive.

Overall, despite growing national emphasis on repowering to optimise land and grid resources, policy response remains fragmented and non-committal. For this segment to mature, states must introduce clear repowering targets, dedicated incentives, streamlined land aggregation provisions, and grid augmentation support tailored to the unique challenges of retrofitting ageing wind assets. Table 3 details the various provisions created by the states for the repowering of wind projects in the states.

Table 3: State policy provisions for wind repowering project

Category	Wind Repowering Project					
Parameter	Repowering Target (MW)	Power evacuation infrastructure	Land consolidation/ aggregation support	State subsidy or additional incentives	Infrastructure development (wider access roads, etc.)	Single-window clearance
Andhra Pradesh	No specific MW target mentioned for repowering	Not specifically addressed under repowering, but covered under general wind evacuation infrastructure facilitation	Not mentioned in the context of repowering specifically	Not explicitly stated for repowering projects	No specific provisions for access roads or repowering-related infrastructure	General single-window clearance mechanism by NREDCAP applies, but not specifically addressed for repowering
Gujarat	Mandatory repowering required after 25 years; partial/full repowering allowed	Augmentation allowed; connectivity extensions only on repowering	Developers must surrender unused land post-decommissioning	Existing PPA terms honoured for old capacity; DISCOM may procure additional power through competitive bids	Responsibility lies with the developer; not specified in detail	Enabled under the unified portal and SNA processes
Karnataka	No specific MW target is mentioned for repowering in the policy	Developers can use existing evacuation infrastructure if feasible; otherwise, it is to be upgraded by KPTCL/ESCOMs as required	No explicit provision is mentioned for land aggregation specific to repowering	No separate incentives are specified for repowering projects beyond general RE project benefits	No specific mention for repowering-related infrastructure upgrades like roads	Repowering projects to be facilitated through KREDL's single-window clearance system, like other RE projects
Madhya Pradesh	No separate MW target for repowering projects is specified	No distinct provision for repowering; general evacuation infrastructure rules apply	Not explicitly mentioned for repowering projects	No additional incentives specified for repowering	No mention of dedicated infrastructure (e.g., roads) for repowering projects	General single-window clearance through NREDC-MP applies

Category	Wind Repowering Project					
Parameter	Repowering Target (MW)	Power evacuation infrastructure	Land consolidation/ aggregation support	State subsidy or additional incentives	Infrastructure development (wider access roads, etc.)	Single-window clearance
Maharashtra	N/A	N/A	N/A	N/A	N/A	N/A
Odisha	N/A	N/A	N/A	N/A	N/A	N/A
Rajasthan	No specific MW target mentioned	Existing infrastructure is to be augmented wherever feasible for repowering	Policy encourages the aggregation of fragmented land holdings for repowering	No special state subsidy or additional incentive specifically for repowering	Facilitation of infrastructure (roads, etc.) on a case-by-case basis, but no special provision	RREC will facilitate repowering project clearances as the nodal agency
Tamil Nadu	No aggregate target given, but mandatory for WEGs >20 years old; repowering must improve generation by 1.25× (standalone or aggregated)	The developer must assess pre-feasibility and bear all costs related to augmentation	Aggregated repowering allowed through WRPA (Wind Repowering Project Aggregator) via SPV/JV; no specific land consolidation support	No financial subsidy, but incentives include banking support, siting relaxations, permission for wind-solar hybrid, and PPA extensions	The developer is responsible for all infrastructure augmentation, not supported by the state	Yes, approvals are processed through the SNA (TNGECL) portal
Telangana	No specific target. Overall wind target- 3805 MW by FY30 and 4528 MW by FY35	1. Power will be evacuated at the appropriate voltage level at the interconnection point of TGTRANSCO/ TGDISCOMs, and evacuation up to the interconnection point will be the sole responsibility of the developer for the projects 2. TGTRANSCO/ TGDISCOMs will process the proposals for the technical feasibility within 14 days of receipt of the application from the solar power project developer	1. Deemed non-agricultural status will be accorded for the land utilised for the development of projects 2. The ceiling limit as per the Land Ceiling Act will not be applicable for any land acquisition for wind power projects 3. 100% reimbursement of stamp duty will be given for land purchased to set up wind projects	1. 100% exemption of electricity duty for MSMEs for 8 years from COD 2. Projects are exempt from obtaining any NOC/ consent for establishment under pollution control laws from the Telangana Pollution Control Board	No mention of dedicated infrastructure (e.g., roads) for repowering projects	Nodal agency will facilitate the developer in obtaining requisite clearances through TG-iPASS/ any other single window clearance facility provided by the government for setting up projects
Uttar Pradesh	N/A	N/A	N/A	N/A	N/A	N/A

2.2.3 Small-scale Rooftop Wind

Across the ten states reviewed, policy attention to small-scale rooftop wind is minimal, with most states either completely omitting the segment or offering only token references. Gujarat stands out as the only state to acknowledge the segment, permitting rooftop wind systems under net/gross metering, and offering access through GEDA's portal. However, even here, specific financial incentives or a detailed business model for wider uptake are missing.

States like Karnataka, Madhya Pradesh, Telangana, and Andhra Pradesh make no mention of rooftop wind in their RE frameworks, and Tamil Nadu, Odisha, Maharashtra, Uttar Pradesh, and Rajasthan similarly offer no policy provisions. The absence of consumer support, dedicated incentives, or business models reflects a lack of strategic vision for harnessing decentralised wind potential, despite rooftop wind's relevance for urban and semi-urban areas with high wind speeds.

To unlock this untapped segment, states need to integrate rooftop wind into broader distributed energy frameworks, provide clear technical standards, and align incentives with those offered for rooftop solar.

Table 4: State policy provisions for small-scale wind rooftop projects

Category	Small-scale Wind Rooftop Projects				
Parameter	**Mention of Segment**	**Single-window Clearance**	**Support for Consumer**	**Financial Assistance**	**Business Model**
Andhra Pradesh	Not mentioned — there is no reference to small-scale or rooftop wind energy systems in the policy	Not applicable	Not applicable	Not applicable	Not applicable
Gujarat	Mentioned; allowed on rooftop premises with net/gross metering	Available via the GEDA portal	Eligible under central/state schemes	Not specifically detailed	Captive use or gross metering for sale to DISCOM
Karnataka	Not explicitly mentioned in the policy	Not specified for rooftop wind	No dedicated support is mentioned	No state financial assistance or schemes identified.	Not defined for rooftop wind
Madhya Pradesh	Not mentioned in the policy	Not applicable/not mentioned	Not applicable/not mentioned	Not applicable/ not mentioned	Not applicable/ not mentioned
Maharashtra	N/A	N/A	N/A	N/A	N/A
Odisha	N/A	N/A	N/A	N/A	N/A
Rajasthan	N/A	N/A	N/A	N/A	N/A
Tamil Nadu	N/A	N/A	N/A	N/A	N/A
Telangana	Not mentioned in the policy	N/A	N/A	N/A	N/A
Uttar Pradesh	N/A	N/A	N/A	N/A	N/A

3. Wind Energy Value Chain

To understand the challenges and find targeted solutions that persist in wind project implementation, it is necessary to take stock of the various stakeholders participating in the ecosystem. As depicted below in Figure 3, we observe that three primary categories of stakeholders influence wind project implementation.

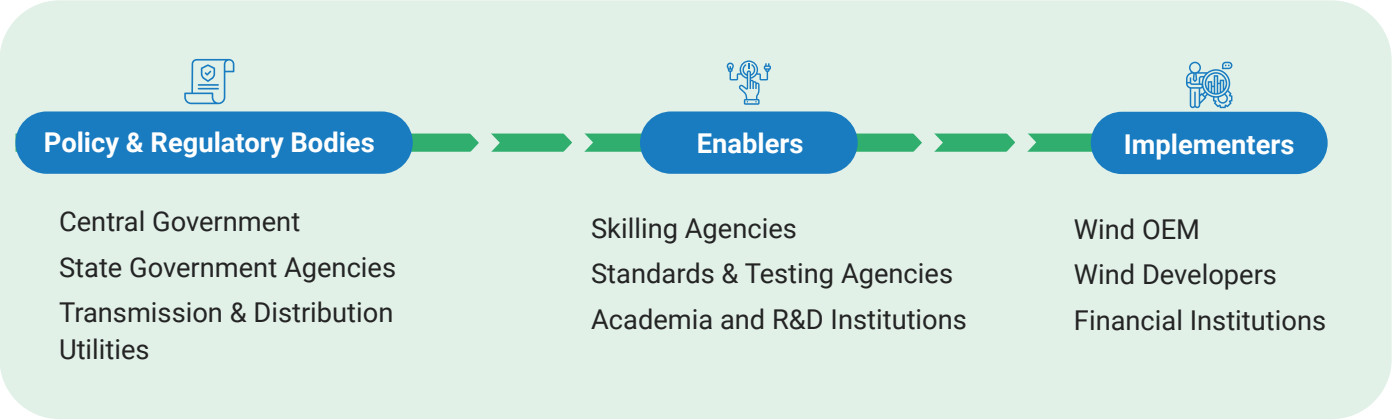

Figure 3 : Wind energy ecosystem stakeholders

3.1 Policy and Regulatory Bodies

As detailed in the previous chapter, a stable policy and regulatory framework is of utmost importance for de-risking utility-scale wind projects, driving more investment into the sector, ensuring smoother implementation of the projects, and thereby leading to faster adoption in the country's energy mix. There are three major stakeholder groups concerning policy and regulatory affairs:

» **Central Government Bodies**
The Central Government Bodies play an important role in formulating India's policy and regulatory frameworks. The centre is expected to draw guidelines, launch subsidies, and release mandates, nationwide, for the states to gain guidance and make their state-wise policies for the implementation of wind projects. Schemes and policies, as discussed in the above section, are created by the central bodies keeping the interest of the project developers/consumers in mind. The central authorities, such as Solar Energy Corporation of India (SECI) and other Renewable Energy Implementation Agencies (REIAs), are also responsible for project tendering and implementation on a national scale. The central government agencies approached for this study include the Ministry of New and Renewable Energy (MNRE) and the Solar Energy Corporation of India (SECI).

» **State Government Agencies**
State agencies oversee the entire project lifecycle, from tendering to commissioning. Their responsibilities include potential assessment, forecasting future demand, formulating state-specific wind policies, allocating land for projects, introducing state-level subsidies, and managing project tendering and implementation in alignment with projected demand. The state government agencies considered as part of this study are shown in Annexure-1.

» **Transmission and Distribution Utilities**

Transmission and distribution utilities play a crucial role in shaping the RE landscape of the country. As the custodians of the electricity grid, they are responsible for the efficient evacuation of power from wind plants and providing off-taker guarantees to wind projects. Reliable power facilitated through wind projects helps Distribution Companies (DISCOMs) reduce their dependence on fossil fuels, enabling them to procure green energy from wind projects for supply to both domestic and commercial consumers in their regions. Annexure-2 captures the list of stakeholders operating at the state level and considered for our study.

3.2 Enablers

While policy and regulatory bodies create a favourable environment for the development of wind projects, the continued growth of the wind sector also depends on a skilled workforce, ongoing research into new technologies, and robust testing processes to ensure the quality of power. The organisations that offer skilling programmes for the workforce and those involved in the research and development of emerging wind technologies have been identified, as shown in Annexure-3.

3.3 Implementers

While policy-making organisations and enablers lay the foundation for the future of RE in India and work towards developing a skilled workforce, the role of implementers is crucial in turning the country's RE potential into reality through wind project deployment. For the requirements of this study, participation was sought from institutions captured in Annexure-4.

4. Stakeholder Insights

For gaining a holistic view of the wind ecosystem in India, in-person interactions with various stakeholders of the wind ecosystem were conducted. The stakeholders belonged to various facets of the ecosystem, as described in the previous section. These interactions played a crucial role in helping us identify the gaps that exist in the ecosystem and identify the solutions that may be deployed to counteract the same, leading to an accelerated deployment of wind projects.

4.1 Overview of Key Challenges Identified

4.1.1 Onshore Wind

- **Issues in Repowering of Old Wind Turbines:** In 2022, MNRE came out with guidelines for the repowering of old WTGs . Under the guidelines, it is recommended that the wind turbine generators under 2 MW should be decommissioned and replaced with higher capacity WTGs. As per the National Institute of Wind Energy (NIWE), the country has a repowering potential of 25.4 GW. However, with no clear guidelines for decommissioning a wind farm, multiple stakeholders involved for a single site and repowering being capital intensive, repowering saw reluctance from the developers. Hence, restricting India from realising its wind potential. In 2023, MNRE revised the guidelines and came out with a National Repowering & Life Extension Policy for old WTGs.
- **Waiving off of Concessional Custom Duty Exemption Certificate (CCDC):** In 2017, the Ministry of Finance introduced the Concessional Custom Duty Exemption Certificate (CCDC) for wind turbine manufacturing with an aim to boost domestic manufacturing of wind turbines . Under the exemption, turbine manufacturers could import raw materials/parts for WTGs at a concessional customs duty, hence bringing down the cost of WTGs. However, in 2023, the ministry has stated that the provision shall only be extended till March 2025 . WTG manufacturers predict that the cost of WTG shall increase rapidly once the concession is revoked, ultimately driving up the project cost.
- **Land Allotment:** India has an onshore wind potential of 1,164 GW at 150 m hub height and to realise this potential, MNRE has appointed REIAs to issue 10 GW of wind farm tenders annually through 2030. However, developers face multiple issues with regard to land procurement for the projects, such as:
  - Multiple stakeholders for a single parcel of land.
  - Connectivity unavailable/owned by a different developer at a high CUF site.
  - State's reluctance to allot land for ISTS projects instead of state tenders.
- **Unstable Auctioning Strategy:** Wind energy in India has seen 3 different auctioning strategies over the years. Initially, the government came out with a feed-in-tariff-based auctioning strategy, wherein the regulatory body fixed a feed-in-tariff and the wind developers had no role in the same. In 2017, the government came out with a reverse auction strategy for wind energy, which led the developers to bid aggressively for the projects. This move helped the government drive down the tariff for wind energy. However, due to the developers bidding in a competitive manner, projects were often under-bid at unrealistic prices, leading to non-feasibility. In 2021, the auctioning strategy was changed to competitive bidding (L1 tariff), considering the under-bidding taking place in reverse auction. Currently,

the auctioning strategy has again been changed to reverse auction. Such frequent changes in the auctioning strategy leads to a lack of interest from business investors for wind energy underscoring the need for a better and long-term auctioning strategy.

- **Difficulties in Land Acquisition:** Acquiring land for wind power projects remains a major bottleneck due to unclear ownership, fragmented land parcels, and bureaucratic hurdles in approvals. Developers face long delays, increasing project timelines and costs.
- **Connectivity and Grid Bottlenecks:** Grid infrastructure constraints, including substation unavailability and delayed finalisation of substation locations, create significant obstacles to project execution. This leads to higher costs and inefficiencies in power evacuation.

4.1.2 Offshore Wind

- **Lack of Expertise in Offshore Wind Projects:** Offshore wind energy is a new technology for India that requires the use of higher capacity wind turbines, floating platforms, floating substation and transmission infrastructure along with upgradation of port facilities. With the country having no experience in the same, developers are sceptical about the technology implementation and its success as compared to other RE technologies.
- **High Tariff even with VGF would Lead to Off-taker Unavailability:** Due to the high capital required for setting up an offshore wind farm, the LCOE achieved for the technology is high. Even though the government is offering Viability Gap Funding (VGF) for offshore wind projects, developers remain sceptical about the tariffs becoming competitive. As a result, there are concerns about the availability of offtakers, since other renewable energy technologies supply electricity to DISCOMs and consumers at significantly lower tariffs.
- **States Determining their own Ceiling Tariff for Offshore Wind Projects:** While the developers indicate a high tariff for offshore wind energy, even after aid from VGF, few states have already defined their ceiling rates, along with indicating off-take guarantees. However, the determined tariff is very low and may be unachievable, which further lowers confidence in project developers, given that offshore wind energy is a completely new technology for India.
- **Absence of Skilled Workforce for Offshore Wind Farms:** Offshore wind energy technology is still in its early stages in India and, as a result, lacks a sufficiently skilled workforce. This challenge is further compounded by the absence of dedicated training or skilling programmes for offshore wind. There is a need to train personnel in key areas such as offshore wind resource assessment, floater technologies, mooring systems, and related technical skills.
- **Stakeholder Apprehension Towards New Technologies**: There is reluctance among stakeholders to adopt offshore wind technology, given the availability of land-based wind and solar options that offer comparable capacity utilization factors (CUF) at lower costs.
- **Environmental and Social Impact Concerns:** Offshore wind projects can disrupt marine ecosystems and affect local communities dependent on coastal resources. Comprehensive environmental and social impact assessments are essential to address these concerns.

4.2 Recommended Solutions

4.2.1 Onshore Wind

- Designate specific land zones for wind/hybrid projects, with dedicated grid connectivity to streamline the development process.
- A dedicated green energy corridor should be developed for efficient power evacuation from the repowering projects coming up in the country.
- Enhance the grid interconnection infrastructure to support larger wind farms and ensure seamless integration with the power grid.
- Implement stable, long-term auction plans with realistic tariffs to provide certainty to developers and encourage investment in wind projects.
- Upgrade grid infrastructure at already commissioned wind sites, allowing developers to apply for incremental connectivity as older wind turbines are decommissioned.
- Introduce separate tariffs for repowered projects to make repowering economically viable and incentivise developers to replace outdated turbines with more efficient ones.
- Developing a uniform national framework will streamline procedures, reduce complexities, and promote large-scale renewable energy deployment. Going forward, REIAs should initiate the tendering process only after securing firm demand from utilities or other consumers, ensuring a more efficient and predictable project development timeline.
- Conduct resource adequacy studies at state level to identify future demand growth and how it will be met, allowing for better planning of transmission infrastructure to ensure maximum reliability and efficient energy delivery.

4.2.2 Offshore Wind

- Offering additional VGF for offshore wind projects will help bridge the financing gap, making these projects more attractive to developers by reducing the initial investment burden.
- A clear, long-term roadmap from MNRE will provide strategic direction, set targets, and outline regulatory frameworks to support offshore wind development in India.
- Attracting foreign investment and facilitating technology transfer will enable India to access advanced offshore wind technologies, build expertise, and accelerate the development of this sector.
- Promoting the local manufacturing of essential offshore wind components, such as floaters and high-capacity wind turbines, will reduce reliance on imports, lower costs, and strengthen India's offshore wind capabilities.
- Establishing specialised ports, vessels, and maintenance infrastructure for offshore wind installations will address logistical challenges and ensure the timely deployment of projects.
- To address concerns, conducting detailed environmental and social impact assessments for offshore wind farms and involving local communities in the planning process can mitigate opposition and ensure sustainability.

Annexure-1

State authorities stakeholder mapping

State	State Nodal Agency
Andhra Pradesh	New & Renewable Energy Development Corporation of Andhra Pradesh Ltd
Gujarat	Gujarat Energy Development Agency
Karnataka	Karnataka Renewable Energy Development Limited
Madhya Pradesh	Madhya Pradesh Urja Vikas Nigam Ltd
Maharashtra	Maharashtra Energy Development Agency
Odisha	Odisha Renewable Energy Development Agency
Rajasthan	Rajasthan Renewable Energy Corporation Limited
Tamil Nadu	Tamil Nadu Green Energy Corporation Ltd
Telangana	Telangana Renewable Energy Development Corporation
Uttar Pradesh	Uttar Pradesh New and Renewable Energy Development Agency

Annexure-2

State distribution utility and state transmission utility stakeholder mapping

State Distribution Utility and State Transmission Utility Stakeholder Mapping		
State	Organisation Type	Organisation Name
Andhra Pradesh	State Distribution Utility	Andhra Pradesh Southern Power Distribution Company Ltd.
	State Transmission Utility	Transmission Corporation of Andhra Pradesh
Gujarat	State Distribution Utility	Gujarat Urja Vikas Nigam Limited
	State Transmission Utility	Gujarat Energy Transmission Corporation Limited
Karnataka	State Distribution Utility	Chamundeshwari Electricity Supply Corporation Limited
	State Transmission Utility	Karnataka Power Transmission Corporation Limited
Madhya Pradesh	State Distribution Utility	MP Paschim Kshetra Vidyut Vitran Company Limited
	State Transmission Utility	Madhya Pradesh Power Transmission Company Ltd.
Maharashtra	State Distribution Utility	Maharashtra State Electricity Distribution Company Ltd.
	State Transmission Utility	Maharashtra State Electricity Transmission Company Limited

State Distribution Utility and State Transmission Utility Stakeholder Mapping		
State	Organisation Type	Organisation Name
Odisha	State Distribution Utility	TP Central Odisha Distribution Limited
	State Transmission Utility	Odisha Power Transmission Corporation Limited
Rajasthan	State Distribution Utility	Jaipur Vidyut Vitran Nigam Limited
	State Transmission Utility	Rajasthan Rajya Vidyut Prasaran Nigam Limited
Tamil Nadu	State Distribution Utility	Tamil Nadu Power Distribution Corporation Ltd
	State Transmission Utility	Tamil Nadu Transmission Corporation Limited
Telangana	State Distribution Utility	Telangana State Northern Power Distribution Company Ltd
	State Transmission Utility	Transmission Corporation of Telangana Limited
Uttar Pradesh	State Distribution Utility	Noida Power Company Limited
	State Transmission Utility	UP Power Transmission Corporation Limited

Annexure-3

Wind enablers stakeholder mapping

Wind Stakeholder Mapping	
Skilling Agencies	Skill Council on Green Jobs
	National Institute of Solar Energy
Standards and Testing Agencies	TUV SUD
	Bureau Veritas
Research and Development and Academia	National Institute of Solar Energy

Annexure-4

Wind implementers' stakeholder mapping

Wind Implementers' Stakeholder Mapping	
Utility Wind OEM	Vestas
Utility Wind Developer	Axis Energy
	Windplus
Financial Institutions	ADB
	World Bank

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