

# WIND AT THE CORE

Driving India's Green Ambitions and  
International Influence

AUGUST 2025

mec+



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# About GWEC



The Global Wind Energy Council (GWEC) is the global trade association for the wind power industry. In 2025, GWEC will celebrate twenty years of advocating for the wind industry. Our mission is to ensure that wind power establishes itself as the answer to today's energy challenges, providing substantial environmental and economic benefits. We work closely with national governments, policymakers and international institutions to give them transparent information about the benefits and potential of wind power, enabling them to make informed decisions about national energy policies.

The members of GWEC represent over 1,500 companies, organisations and institutions in more than 80

countries. Our members are also all of the national wind industry trade associations, from both established and emerging markets, including the world's largest markets of the US, all the European markets, India and China.

GWEC is actively engaged with emerging markets to unlock their wind potential with proven successes in Latin America, Africa, India and also Southeast Asia. GWEC also works at the highest international political level to create a better policy environment for wind power. Working with the UNFCCC, REN21, the IEA, international financial institutions, the IPCC and IRENA, GWEC advocates for policies to help wind power reach its full potential in as wide a variety of markets as possible.

GWEC India was established in 2020 as a single advocacy and research body representing the entire value chain of India's wind industry. GWEC India works closely with government stakeholders, companies and adjacent technologies to accelerate the momentum around wind power development in India and support the country in achieving its ambitious renewable energy targets.

For further queries please visit [www.gwec.net](http://www.gwec.net) or contact francis.jayasurya@gwec.net.

# About MEC+

mec+

MEC+, also known as MEC Intelligence, is a specialist consulting firm focused on the wind and renewables sector for the last 14 years. MEC+ comprises a highly skilled team of consultants with a deep understanding of turbine technology, integration opportunities with battery, hydrogen, project supply chains in offshore and onshore wind, power market design, financing / bidding / PPA structuring and regulatory market.

MEC+ engages with asset owners and supply chain companies on their investment and growth decisions. The support provided extends from building business plans, identification and mitigation of risks, and managing innovation and sales processes at client organisations. In India, MEC+ has supported multiple acquisitions in the market on both supply chain and asset platforms. MEC+ also offers bidding support and strategy building for India.

MEC+ works with government entities to build a strong commercial understanding of areas related to wind power. Working with GWEC as a knowledge partner on India, MEC+ publishes the annual wind power market outlook and engages in multi-stakeholder discussions to promote wind power.

Our clients include the largest global wind OEMs, utilities, oil and gas companies, Supply chain players, Equity funds, and Independent Service Providers.

For further queries, please visit [www.mecintelligence.com](http://www.mecintelligence.com)

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# Foreword



I commend the Global Wind Energy Council for compiling this timely and insightful report. It reinforces the growing global relevance of India's clean energy journey and will be a valuable resource for all stakeholders in the wind energy sector.

India is executing one of the world's most ambitious energy transitions, not just to secure our own sustainable future, but to shape the global clean energy narrative. Under the visionary leadership of Prime Minister Narendra Modi, the renewable energy sector is poised for unprecedented growth. We have committed to installing 500 GW of non-fossil capacity by 2030, including 100 GW from wind, of which 30 GW will come from offshore projects.

India is not just building clean energy infrastructure, we are building the future. I am confident that this publication will contribute meaningfully to advancing our shared vision of a sustainable and energy-secure world.



**Shri Pralhad Joshi**

Ministry of Consumer Affairs  
Food & Public Distribution and  
Ministry of New &  
Renewable Energy (MNRE)  
Government of India

# Foreword



India has done transformative work in the area of renewable energy in the last 11 years. We have met our NDC targets before time and emerged as a leading country in deployment of renewable energy, manufacturing of equipment and developed excellent capabilities in technology. Policies and schemes framed by the

Government under the visionary leadership of Hon'ble Prime Minister Shri Narendra Modi have played a key role. This year India has become 3rd largest generator of electricity from wind and solar. Wind energy plays a leading role in providing round-the-clock power and therefore has to be supported fully. Technology has advanced in the last few years to harness more energy from available resources and manage energy in a better way with storage, scheduling and better grid management.

Penetration of renewable energy therefore now can be much more than what was initially considered possible. We must therefore, continue to support wind energy with full cooperation amongst all stakeholders including developers, manufacturers and technology providers along with the distribution companies and regulators.

I convey my good wishes to Global Wind Energy Council (GWEC).



**Shri Tarun Kapoor**

Adviser to PM  
Government of India

# Foreword

As we stand at the cusp of a new era in energy transition, it is imperative to recognise the pivotal role that Wind energy plays in shaping a sustainable future. The global shift towards renewable energy sources has been underpinned by technical innovations and economies of scale, translating into increasing cost competitiveness of renewable technologies. Wind and Solar PV are now commercially viable and sustainable, making them amongst the cheapest supply options in India. The stated target of 400GW of Wind energy capacities by 2047 under the Viksit Bharat initiative is a testament to the country's dedication to a greener tomorrow. The world is expecting 10% of global Wind supply chain to come from India and the time is right to drive the localisation of wind turbines from current 65% to at least 85% in a phased manner.

This report, "Wind at the Core: Driving India's Green Ambitions and International Influence" highlights the significant strides made by the sector

and the challenges that lie ahead. The journey towards a sustainable energy future is fraught with complexities, from policy mandates and grid stability to economic benefits and technological advancements. However, the potential rewards are immense. Given its complementarity with Solar power, Wind not only enhances the country's energy security and costs, but also impacts a large number of adjacent industries contributing to overall GDP, generates large amount of direct and indirect employment and optimizes utilization of the massive investments in the nations' grid infrastructure. Therefore, within the overall goal 500GW of RE by 2030, achieving 100GW of Wind is crucial in order to achieve a cost-efficient, affordable and secure energy mix for the country

At GWEC India, we have always believed in the power of innovation and collaboration. Our efforts to scale wind installations, increase localisation of wind turbines, and

support government policies are aligned with the vision of a Viksit and Atmanirbhar Bharat. The insights and recommendations presented in this report are a reflection of our collective expertise and dedication to advancing India's wind energy sector, and realising our Honourable Prime Minister's vision.

I am confident that this report will serve as a valuable resource for policymakers, industry stakeholders, and the broader community. Together, we can harness the power of wind to propel India towards its Net Zero goals.



**Girish Tanti**

Chairman, GWEC India and Vice  
Chairman Suzlon

# Foreword

The relentless quest for decarbonization and energy security drives the global adoption of renewable energy. As a signatory to Paris Accord, India is leading this movement with phenomenal strides by building a larger footprint with renewable energy that stands at approximately 44% in the country's energy mix. In accordance with updated Nationally Determined Contributions submitted to the United Nations Framework Convention on Climate Change, Government of India has committed to achieving 50% non-fossil based installed electricity capacity by 2030. Backed by prudent policy frameworks, increasing manufacturing capacities and strong public-private partnerships, India is marching ahead in its transition to clean energy.

The ambitious goal of achieving net-zero emissions by 2070 is also redefining India's energy landscape. As we pursue the national target of 500 GW of non-fossil capacity by 2030, Central Electricity Authority

recommends that 100 GW of this should come from wind for a balanced energy mix and making power affordable for consumers. Wind Energy also offers long-term energy affordability while strategically maximizing the value of the green corridor investments. In India, Wind Energy scaled 51 GW already with a consistent growth of 3.4 GW in FY25 and need to in the current fiscal year and need to build another 50 GW in coming 5 years.

The key drivers supporting this growth is a strong Govt. policy push of securing 10GW of tenders through wind & wind-linked hybrid tenders accounting for 11GW in 2024 alone. There is a surge in hybrid projects accounting for 50% of all RE tenders (including solar) in 2024. Another significant traction is being witnessed in private sector with 3GW of wind-related C&I (Commercial & Industrial) announced projects in 2024 and likely to add ~20GW by 2030 of the anticipated 50GW addition in coming 5 years. With return of large players

and positive response to hybrid tenders shows confidence in sector and improved investor sentiment.

Led by a domestic wind industry, the expansion resulted in a strong ecosystem, project operation capabilities and mature manufacturing base. With an enhanced focus on local manufacturing through "Atmanirbhar Bharat" initiatives of Govt. of India, the manufacturing ecosystem will become sustainable, robust & resilient as well. As India is positioned to become global wind manufacturing hub, the supply chain and procurement of Wind Turbine and its components need enhanced localization to deliver scale, cost-competitiveness, and quality. This needs to be done in a staggered manner and takes time to build a sustainable model for India becoming a global hub.

Moreover, the integration of grid-connected utility scale Energy Storage System and Green Hydrogen production have opened new avenues for the sector's advancement. Building



**RPV Prasad**

MD – Envision Energy India P Limited

upon these developments, the wind industry is optimistic about its pivotal role in helping India achieve its climate objectives.

Looking ahead will accelerate the progress of the wind energy sector. The recent tender for 1 GW offshore wind projects in Gujarat and Tamil Nadu with tariff support and other incentives promises the launch of the first project shortly, leveraging India's extensive 7,600km coastline. With Budget 2024-25, the Government of India is promoting establishment of renewable energy parks with policy initiatives and higher power evacuation capacities. On-going R&D advancements in large-scale battery storage aims to address the intermittent nature of renewable energy sources. In 2024, approximately 33 GWh of Energy Storage bids have been issued including 11 GWh BESS, 20 G0GWh PSP, with 219.1 MWh installed Battery Energy Storage System (BESS) capacity as of March 2024.

By fostering active collaboration between the government, industries, and academic institutions, we can accelerate the adoption of wind energy. The upcoming decade offers a pivotal window for the Indian wind

industry to translate intentions into tangible actions. Together, we can make significant strides toward reaching the milestone of net-zero emissions!

Envision Energy India has been supporting the India Outlook Report for the last three years. The report brings out the remarkable progress of the Indian wind sector, evolution of its role in India's energy transition, and helps inform all stakeholders to take it higher. India achieved record breaking installations last year & seen continued increase in installations over the last three years. These have been achieved notwithstanding ground challenges that reflects the dedication and determination of all industry stakeholders. I would like to thank the Government of India, State Governments, and fellow industry participants on their contributions to the sector.

I appreciate the efforts of GWEC for driving the RE advocacy globally and India in particular. Congratulations to GWEC India and the MEC team in releasing research report on ***"India Wind Energy Market Outlook 2024-2030,"*** which provides valuable insights into the wind energy landscape in India.



# Foreword

We are pleased to present the latest edition of the Indian Wind Outlook Report. The past year has witnessed a revival of momentum in India's wind sector, and while this report examines how this momentum can be sustained, it also takes a long-term perspective on the positioning of India's wind industry—both in terms of deployment and manufacturing capacity.

The wind sector has gained significant momentum over the last two years, with a notable revival of installations in FY 24-25. However, current deployment levels fall short of established targets and remain insufficient to meet India's ambitious renewable energy goals. This report addresses the targets set for the Indian wind market and reinforces the economic rationale behind them, highlighting that achieving these targets will reduce costs for consumers and minimize transmission system requirements needed to meet India's renewable energy objectives.

The current trajectory of 5 GW annual installations is inadequate to meet even the 2030 targets. To achieve the 2047 goal of 450 GW, India must scale up to 15 GW of annual installations. This scale-up is crucial not only for meeting climate commitments but also for strengthening India's manufacturing ecosystem and creating substantial employment opportunities.

India already possesses over 20 GW of turbine manufacturing capacity, serving both export and domestic markets. However, manufacturing costs in India remain at a premium, largely due to insufficient scale. Achieving greater scale will enhance the industry's competitiveness and improve India's self-reliance in local supply chains and technology development. Our analysis estimates that scaling annual installations from 5 GW to 15 GW could create more than 270,000 jobs across the wind sector, spanning manufacturing, asset development, and services.

We trust that the findings presented in this report will prove valuable to industry stakeholders, policymakers, and investors. We welcome your feedback and look forward to continued dialogue on advancing India's wind energy future.



**Sidharth Jain**

MD and Founder, MEC+

# Executive Summary

The global energy landscape is undergoing a profound transformation with renewable sources, particularly wind energy, at the forefront. This transition is driven by significant cost reductions, ambitious sustainability targets, supportive policies, and escalating demand. By 2030, renewables are expected to supply approximately 50% of global electricity, with wind capacity projected to exceed 2 TW, accounting for 20%-25% of the renewable energy mix.

India's energy transition is in alignment with these global trends, targeting 500 GW of non-fossil sources by 2030, including a crucial 100 GW from wind energy. This is pivotal for setting the nation on a path to achieve its Net Zero goal by 2070. Multiple studies indicate a much higher requirement for wind installations by 2030, driven by wind's complementary role to solar in producing Round the Clock (RTC) power, lowering costs and improving grid utilisation significantly. Moreover, increasing wind in the energy mix

can enhance the Capacity Utilisation Factor of RE assets, lead to more than 2.5x savings for customers compared to grid tariffs, and provide higher per unit profit to developers as wind's capture price is better aligned with peak demand hours. It also reduces transmission CAPEX by nearly 50% compared to solar plus storage hybrid projects due to less requirement for transmission.

Strong policy support, including Wind Renewable Purchase Obligations (RPO) and a mandated annual 10 GW wind project bidding, C&I decarbonization targets has driven consistent growth in domestic onshore wind capacity from about 40 GW in 2021 to approximately 52 GW in 2025 (as of 30th June), and has boosted wind turbine generator (WTG) manufacturing capacity from 12 GW to 20 GW between 2022 and 2024.

Despite focused initiatives, managing project timelines and preventing cancellations remain areas for

improvement. Key challenges include timely signing of Power Supply Agreements (PSAs), improved compliance with RPO by states, and effective management of grid construction schedules and commissioning processes. Addressing local execution obstacles is essential to streamline project development. Currently, India has achieved an installed capacity of 52 GW (as of 30th June), with projections indicating a potential increase to ~84 GW till 2030 if existing issues persist. However, addressing grid infrastructure concerns and improving RPO compliance could push installations to ~95 GW by 2030.

Clear policies and planning around RPO and grid development are crucial to achieving the ambitious 100 GW target. Elevating the localisation of wind turbine manufacturing to around 85% would align strongly with the Prime Minister's vision of achieving Viksit and Atmanirbhar Bharat.

India has ~20GW of manufacturing capacity. The country is competing on quality and costs in export but is not competing in local market. The major issues being scale, raw material and under investment in technology. Scaling annual wind installations to 8 GW could reduce costs by approximately 10%, create over 116,000 jobs, and boost local manufacturing content to at least 80%.

In conclusion, while the journey towards a sustainable energy future is complex, the potential rewards are immense. Wind energy offers a cost-effective, reliable, and environmentally friendly solution that can drive economic growth, create jobs, and enhance energy security. With the right mix of policies, planning, and execution, India can harness the power of wind to propel the nation towards a sustainable and prosperous future.

**Recommendations | Key focus areas include aligning wind energy with solar regulations, enhancing product quality standards, advancing wind project development with dedicated connectivity, and supporting OEMs as developers**

Theme	Recommendations
Level playing field with Solar	1 Uniformity in duty structure, incentives, resource allocation
Product Quality and Product Performance (taxonomy / standards)	2 Standards for certifications (pre-requisite for getting RLMM listing) need to be as per Indian climate and grid conditions requirements
	3 Standards for certifying that it's a manufacturing facility and not assembly line
	4 Third party certification for confirming that product as built is complying with original product certification as per RLMM
Dedicated connectivity for wind project development	5 Transmission capacities in and around Windy state should be planned keeping Wind resources as priority and not allowed to be blocked by Solar projects
	6 Give clear recommendation for all windy states of where the new dedicated grid facilities (at least for 150 GW) should be built for unlocking Wind potential
Recognizing Wind OEM as developer	7 Permit Wind OEM to apply and secure grid connectivity (without land/PPA) against allocation of demarcated areas for Wind development given by State government
Revitalizing large scale Wind Park	8 Update existing wind park policies to streamline land acquisition, simplify approvals, provide long-term incentives and support to accelerate development
Incentives for new technology in onshore turbines	9 All RE incentives, including PLI, should be equally accessible to both wind and solar, with allocations made on a proportional basis
	10 Just as solar benefits from broader export support, similar incentives should be extended to wind to strengthen domestic manufacturing and global competitiveness
	11 Clear definition of "Indian" R&D made onshore wind turbines and "New Technology"
	12 Draw parallels from other countries / industries for type of grants to be given for R&D, manufacturing and prototyping to accelerate the development of Indian-made onshore wind turbines

Theme	Recommendations
Incentives for offshore	13 Clear definition of “Indian” R&D made offshore wind turbines and “New Technology” and invest in training facilities
	14 Draw parallels from other countries / industries for type of grants to be given for R&D, manufacturing and prototyping to strengthen India’s domestic capabilities in offshore wind turbine development
	15 Create comprehensive list of clearances required for developers for offshore wind power
Repowering	16 Build mechanisms for offtake for repowering
Infra	17 Build clarity on the infra required and logistics planning to help improve the introduction of larger scale turbines in the country
Cybersecurity	18 Release of cyber security standards for Wind Turbines
Certification	19 Certification of products used in Grid inter-connection points
	20 Clarify guidelines for approval wind turbines on temperature derating issue – ensuring it is consistent and does not change going forward
Grid Compliance at CTU	21 Standardise CTU grid compliance process to commission projects; set 30-45 days deadline for CTU esp. hybrid
Address Financing and Taxation	22 GST rates on supply chain need to be kept at 12% with deemed rates to be as per contracts and export concessions should be continued to keep the competitiveness of industry high
	23 Improve access to finance by keeping wind eligible for carbon markets, REC multipliers for offshore wind



# Wind's Role in Energy Transition

## Global energy is in transition towards renewables, with wind energy continuing to play a major role in the energy transition

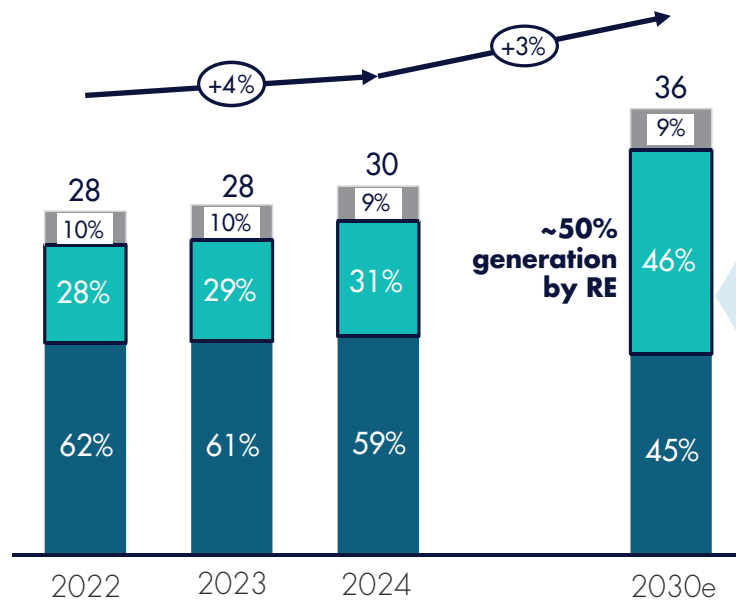
Global electricity generation  
10<sup>3</sup> TWh

Fossil RE Other Non-RE\*

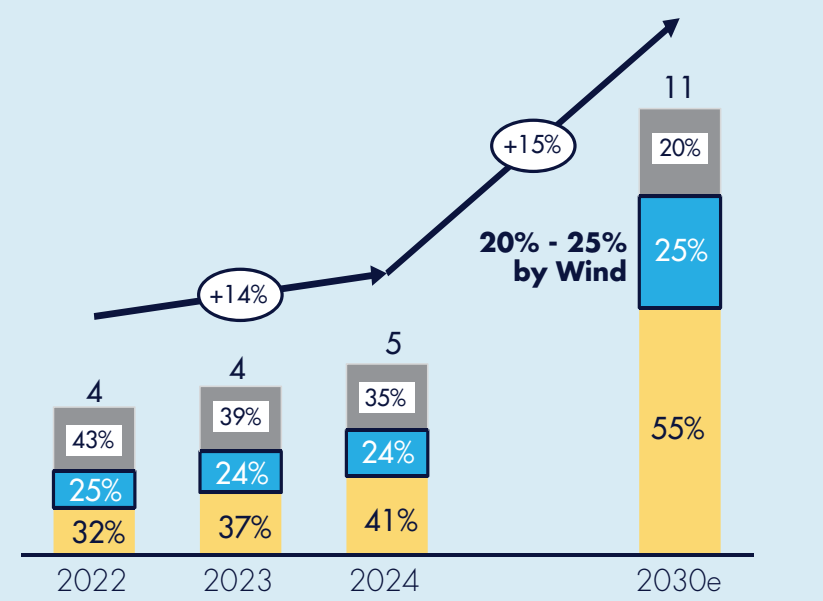
Global RE supply mix  
10<sup>3</sup> GW

Solar Wind Other RE \*\*

To achieve 36000 TWh of electricity generation, ~11000 GW of RE capacity is expected to be installed by 2030, with 2000\* GW - 2750\* GW projected to come from wind



- Driven by sustainability goals, policies, and rising demand, renewables are rapidly expanding and are projected to generate ~50% of global electricity by 2030, replacing fossil fuels

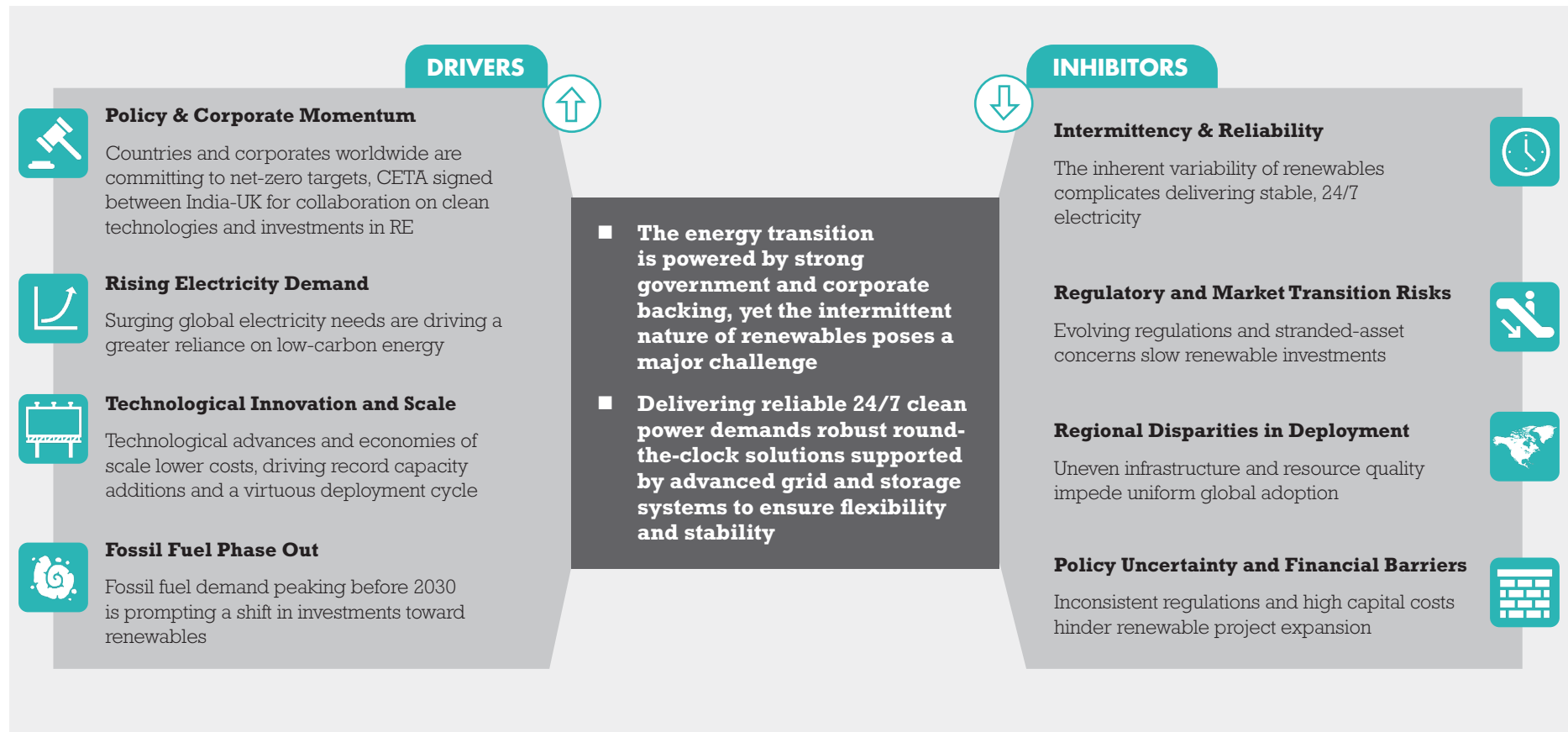


- Aligned with the growth in renewables, global wind capacity has risen from 900 GW in 2022 to 1100 GW in 2024 and is projected to reach 2700 GW by 2030, contributing 25% to the renewable energy mix

Note: \*IEA Net Zero Scenario, GWEC forecast is 2000 GW, Non-RE includes Nuclear; \*\*Other RE includes Bioenergy, Hydropower, Geothermal, and Ocean power  
Source: World Energy outlook 2024; Renewables 2023; MEC+ analysis

## This energy transition is fueled by strong government and corporate support, but flexibility of RE remains a challenge due to its intermittent nature

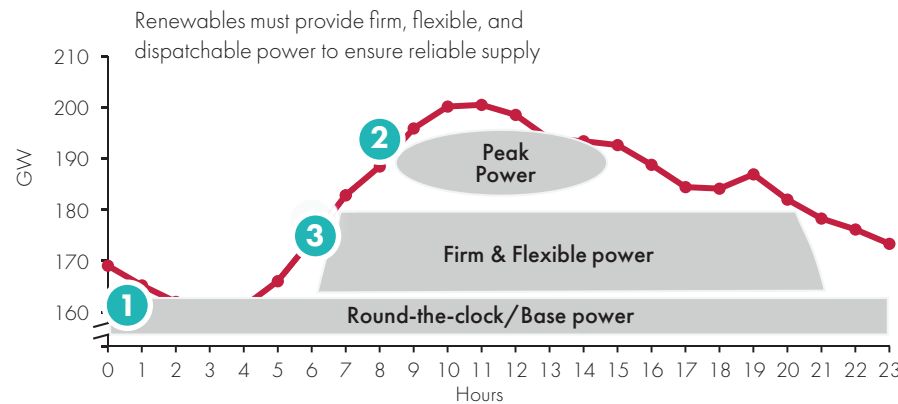
### Key drivers & inhibitors affecting role of RE in global energy transition



Source: World energy outlook(2024); MEC+ analysis

# A successful energy transition requires uninterrupted RE power, with wind energy playing a central role in enabling all 24x7 solutions

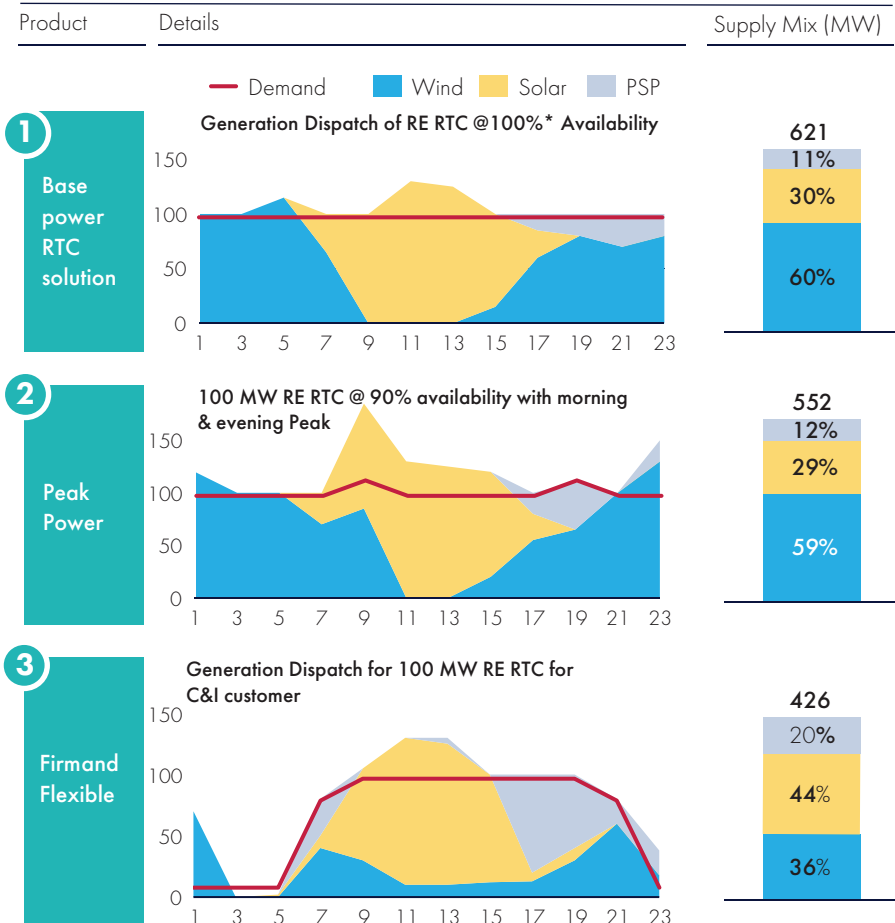
## Typical all India demand curve and supply planning



## Customer needs and RTC product

Customer needs and RTC product			
	1	2	3
	RTC or Base power	Peak Power	Firm and flexible RE
Need	24/7 supply for industries, data centers, and manufacturers using wind-solar-storage for cost-effective reliability	Power during high-demand periods (morning/evening) for utilities and commercial consumers	Flexible yet reliable power for industries and utilities to manage load fluctuations
Product	Continuous power supply, ensuring 100% availability for flat demand profiles	Targeted supply for morning and evening peaks	Quasi base power, operating 60-70% of the day to meet day-lean demands (5 AM to 11 PM)

## Product configurations and supply mix for 100 MW RE RTC



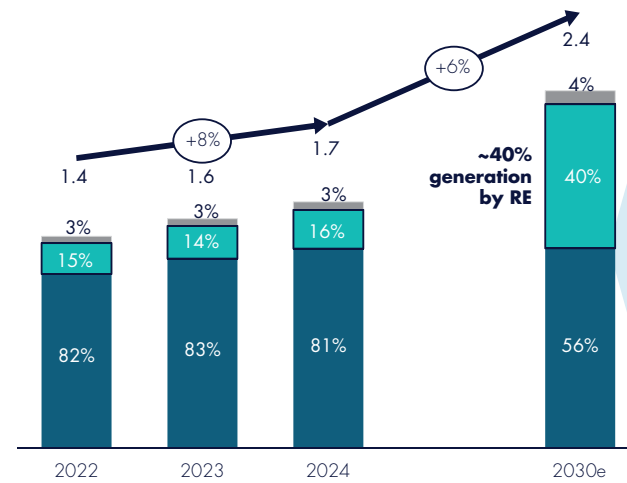
Note: \*RE RTC 100% represents an ideal case for power procurement leveraging the diversity and complementarity of both solar and wind

Source: ICED Dashboard; Techno-Economic Analysis of Renewable Energy Round the Clock (RE-RTC) Supply for Achieving India's 500 GW Non-Fossil Fuel Based Capacity Target by 2030 published by CEA; MEC+ analysis

## Aligned with global trends, India's clean energy shift places wind at the forefront, driving a significant share of the transition

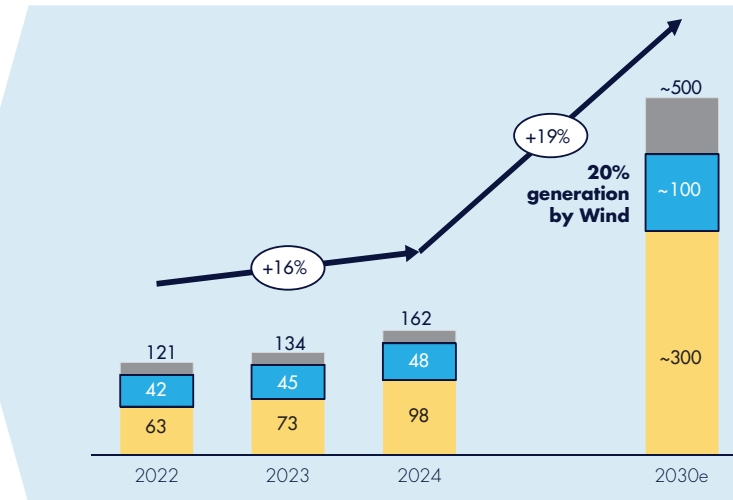
Indian electricity generation  
10<sup>3</sup> TWh

Fossil RE Other Non -RE\*



Indian RE supply mix  
GW

Solar Wind Other RE



To achieve ~2400 TWh of electricity generation, 500 GW is expected to be installed by 2030 from non fossil sources, of which 100 GW is projected to come from wind

- India has set a net zero target for 2070, with renewables projected to account for 40% of power generation by 2030
- Meanwhile, global regulations like the EU's CBAM are further driving decarbonization in hard-to-abate industries such as steel and cement, further accelerating the energy transition

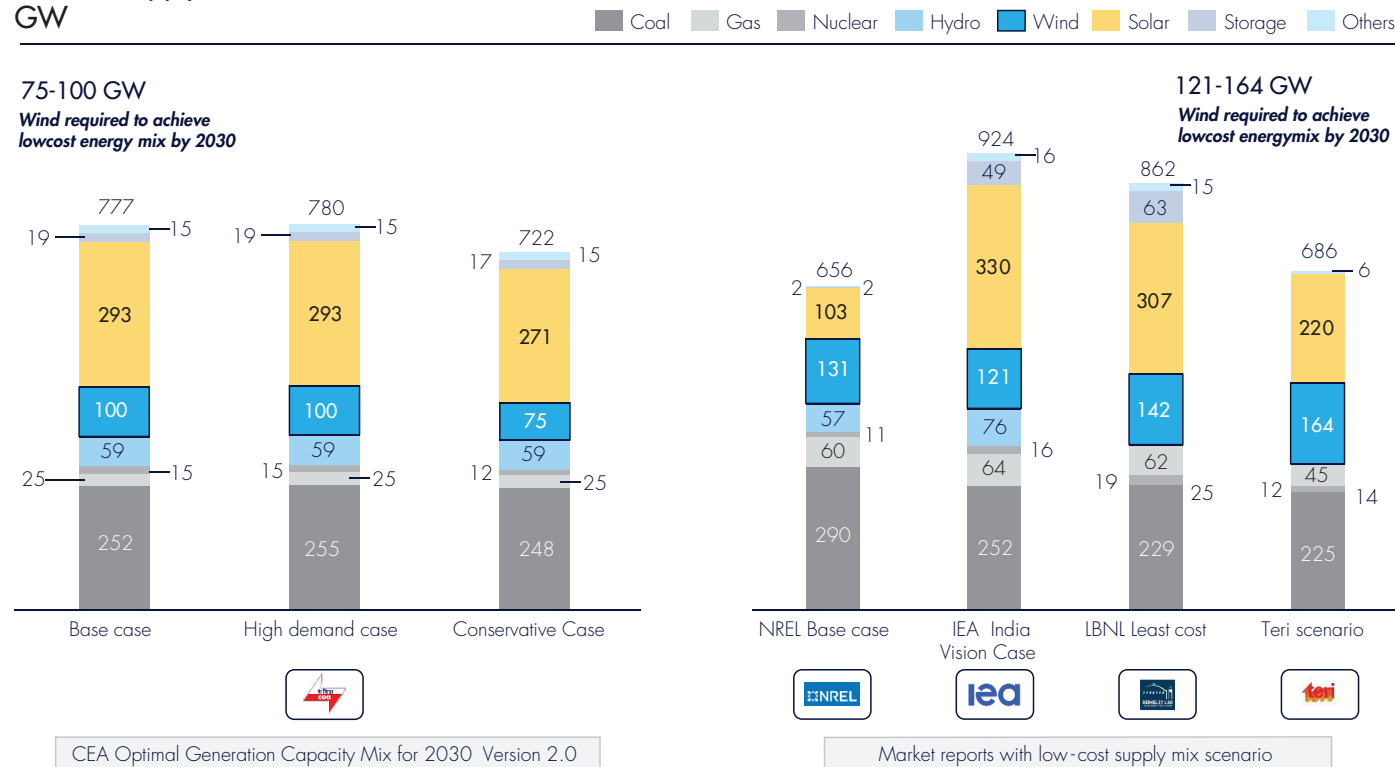
- Wind energy, contributing 30% of India's RE mix with 48 GW in 2024, is set to reach 100 GW by 2030, playing a critical role in energy transition
- Government policies such as tender mandates and wind RPO targets are accelerating wind capacity expansion and driving market growth

Note: \*Other Non-RE includes nuclear energy

Source: CEA Dashboard; Installed capacity report published by CEA ; CEA Optimal Mix 2029 2030; MEC+ analysis

## 100 GW wind target also aligns with least-cost energy pathway assessments recommended by leading national and international agencies

Planned supply mix for 2030  
GW

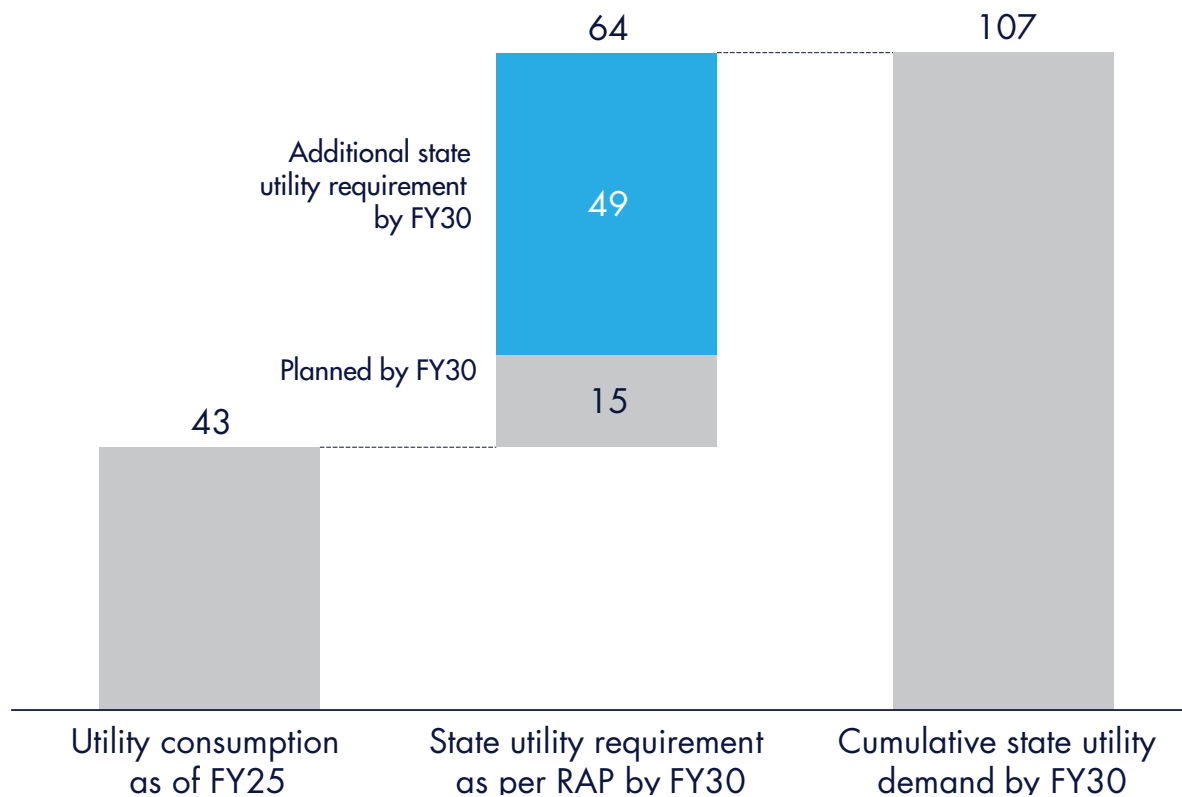


- Wind plays a significant role across all low-cost energy mix scenarios by Indian and International reports. According to CEA's report, 75-100 GW of wind capacity is essential for achieving the lowest-cost energy mix by 2030 under various demand scenarios
- Reports from organizations like NREL, IEA, WRI, and Lawrence Berkeley in their low-cost supply mix scenario align with CEA, suggesting that an even higher wind capacity (121-164 GW) is needed for a low-cost energy mix by 2030

Note: Others contain biomass, small hydro and pumped storage  
 Source: Least-Cost Pathway for India's Power System Investments through 2030 published by Berkeley Lab; Least-Cost Pathways for India's Electric Power Sector published by NREL; India Energy Outlook published by IEA; Report on Optimal Generation Mix 2030 by CEA; India's Electricity Transition Pathways to 2050 by TERI; MEC+ analysis

## The 100 GW target for wind power aligns with state utility resource adequacy plans through 2030, a consistency further supported by their growing recognition of wind's important role

Wind capacity comparison – installed vs planned vs estimated requirement  
GW



- CEA conducted studies to assess Resource Adequacy across States. The studies indicate that states need to adopt hybrid RE projects to meet their demand. Across states, it is estimated 107 GW of wind will be needed.
- Out of the total requirement, states have already commissioned and planned for 68GW. 64 GW additional wind is needed by FY 2030 to meet the RAP.
- Recent studies by CEA on Resource Adequacy on utilities indicate that 100 GW will be needed just for utilities to meet their load requirements.

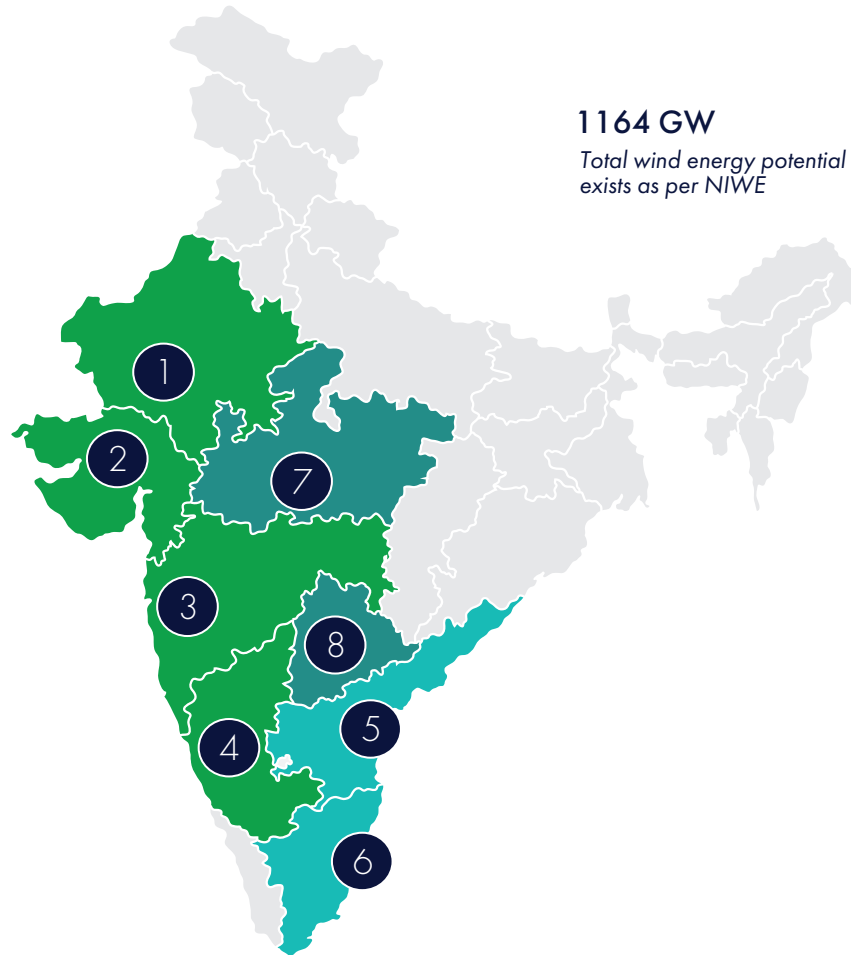
Note: Resource Adequacy Plan (RAP) outlines the projected supply mix—including wind, solar, DRE, hydro, flexible and hybrid resources—to ensure sufficient capacity for reliably meeting demand and minimizing anticipated unserved energy

Source: CEA RAP plan across states; MEC+ Analysis

**This requirement is a fraction of total potential of 1164 GW, with only 4.5% currently installed and another 6% identified for near-term development creating enormous room for scaling**

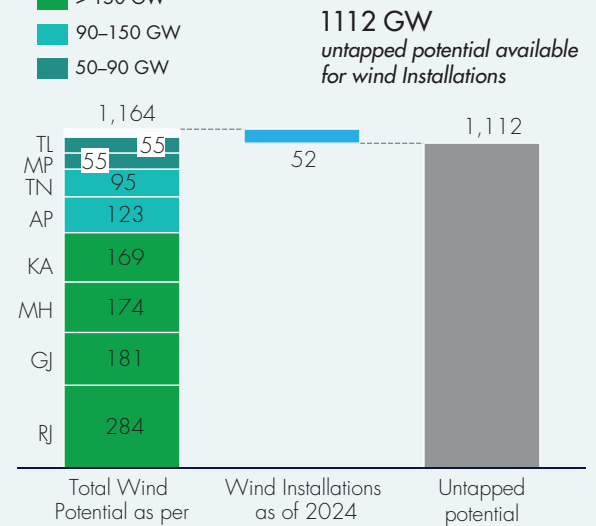
Wind Energy Potential in India at 150 m hub height  
GW

- > 150 GW
- 90-150 GW
- 50-90 GW



Wind Energy Potential in India at 150 m hub height  
GW

- > 150 GW
- 90-150 GW
- 50-90 GW

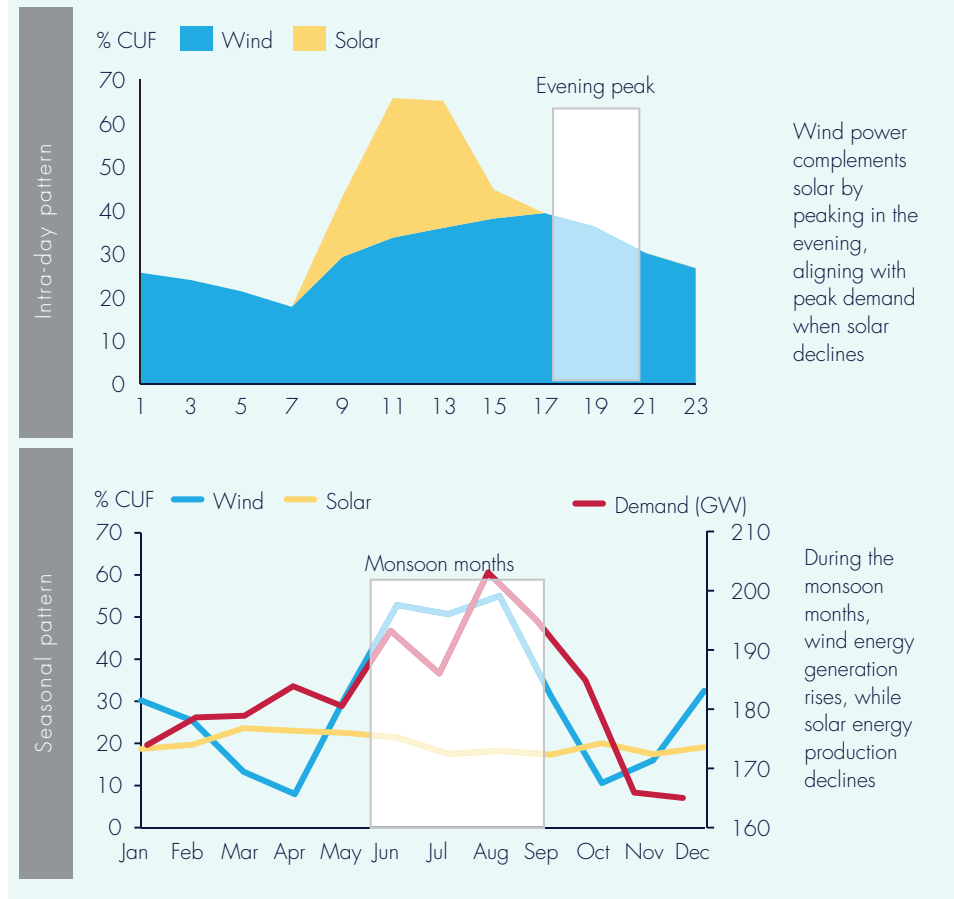


- India has a substantial wind energy potential of 1164 GW, primarily concentrated in eight states
- Rajasthan has the highest potential at 284 GW, followed by Gujarat with 180 GW
- With 48 GW of installed capacity, India still has 1112 GW of untapped wind energy potential

Note: RJ – Rajasthan, GJ – Gujarat, MH – Maharashtra, KA – Karnataka, AP – Andhra Pradesh, TN – Tamil Nadu, MP – Madhya Pradesh, TL - Telangana  
Source: India's Wind Potential at 150m; NIWE; Global Wind Atlas; MEC+ analysis

# Acceleration of wind will drive benefits across stakeholders

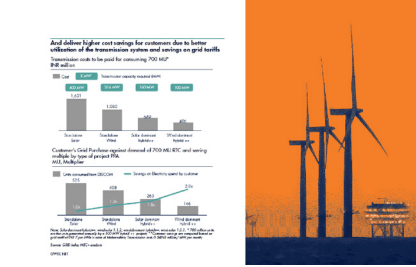
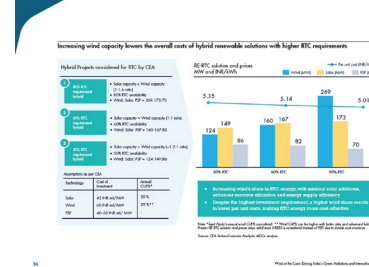
Complementarity of wind and solar is seen across the day and during seasons



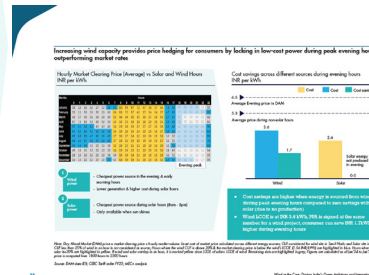
Note: Wind enabled solutions refer to standalone wind and hybrids where wind component is more than 50%; For intra-day and seasonal patterns, CUF considered for wind site in Tamil Nadu and solar site in Gujarat  
Source: Wind turbine OEMs annual reports; MEC+ analysis

## Driving benefits across the ecosystem

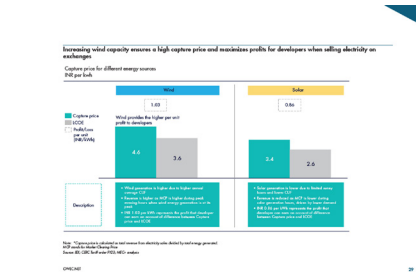
1. Lowers **LCOE** for hybrid power
2. **Cost savings** for customers



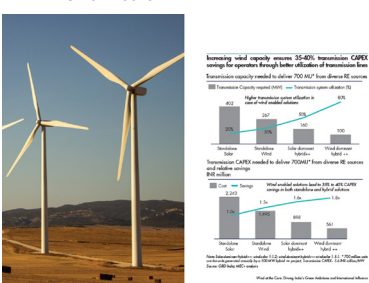
3. Provides **price hedging** for consumers



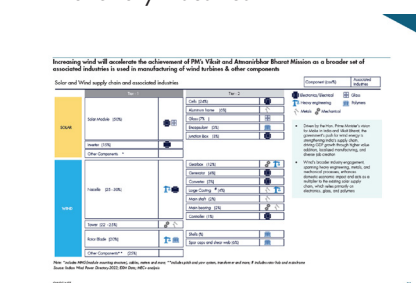
4. High **capture price** for developers for RE produced



5. Operator **cost savings** on transmission



6. Stimulates **economic growth** in ancillary industries



# Increasing wind capacity lowers the overall costs of hybrid renewable solutions with higher RTC requirements

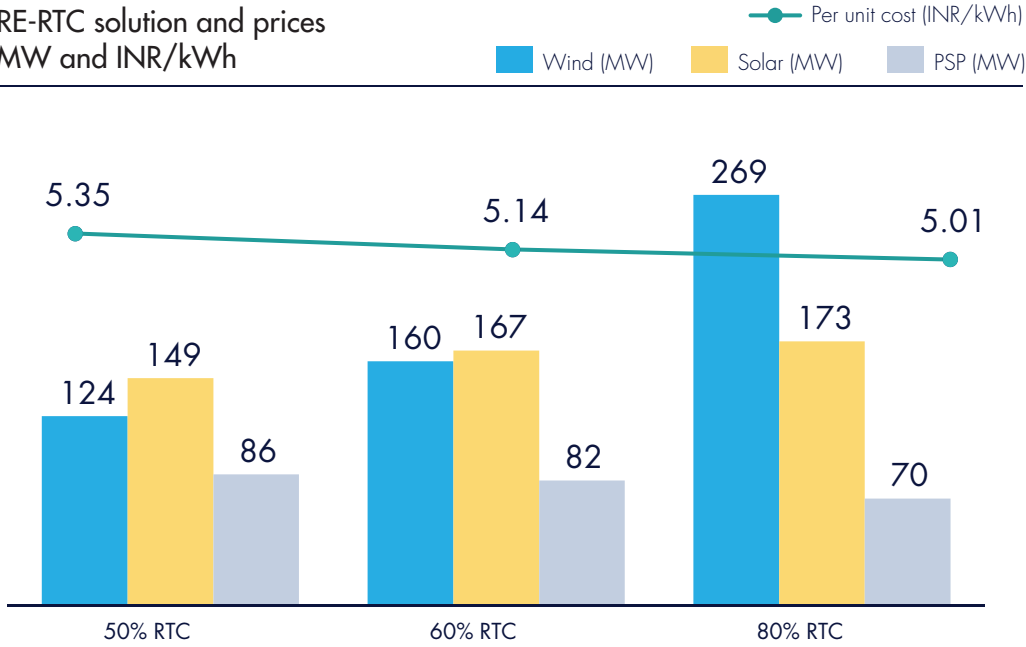
## Hybrid Projects considered for RTC by CEA

- 1** 80% RTC requirement hybrid
  - Solar capacity < Wind capacity (1:1.6 ratio)
  - 80% RTC availability
  - Wind: Solar: PSP = 269:173:70
- 2** 60% RTC requirement hybrid
  - Solar capacity ≈ Wind capacity (1:1 ratio)
  - 60% RTC availability
  - Wind: Solar: PSP = 160:167:82
- 3** 50% RTC requirement hybrid
  - Solar capacity > Wind capacity (~1.2:1 ratio)
  - 50% RTC availability
  - Wind: Solar: PSP = 124:149:86

Assumptions as per CEA

Technology	Cost of Investment	Annual CUF%*
Solar	45 INR mil/MW	20 %
Wind	60 INR mil/MW	29 %**
PSP	40-60 INR mil/ MW	-

RE-RTC solution and prices MW and INR/kWh



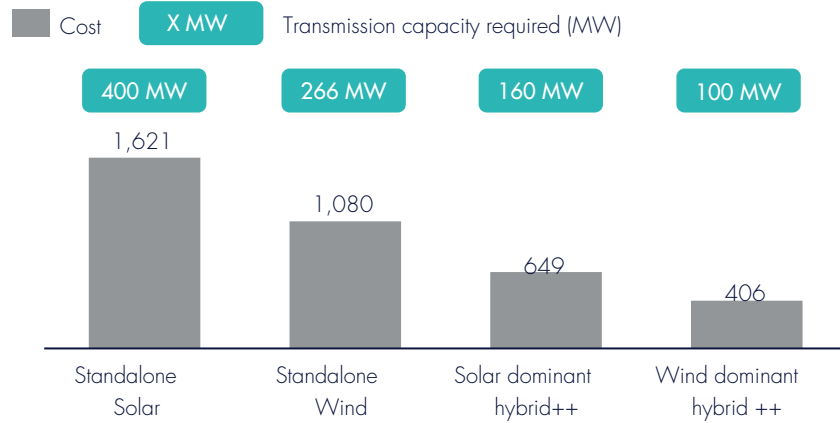
- Increasing wind's share in RTC energy, with minimal solar additions, enhances resource utilization and energy supply efficiency
- Despite the highest investment requirement, a higher wind share results in lower per unit costs, making RTC energy more cost-effective

Note: \*Tamil Nadu's annual wind CUF% considered; \*\* Wind CUF% can be higher with better sites and advanced turbines; Present RE RTC solution and prices stays valid even if BESS is considered instead of PSP, due to similar cost structures

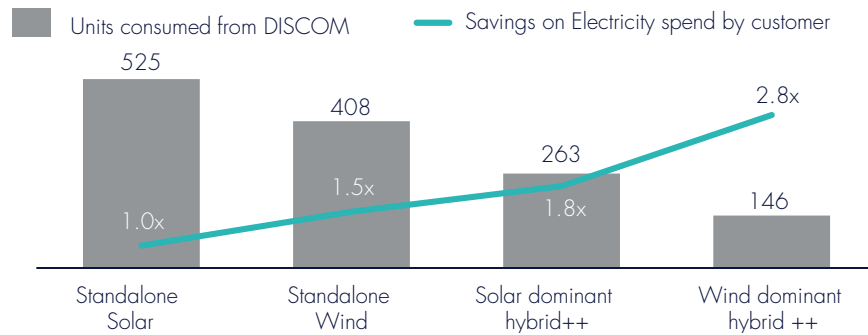
Source: CEA Techno-Economic Analysis; MEC+ analysis

## And deliver higher cost savings for customers due to better utilization of the transmission system and savings on grid tariffs

Transmission costs to be paid for consuming 700 MU\*  
INR million



Customer's Grid Purchase against demand of 700 MU RTC and saving multiple by type of project PPA  
MU, Multiplier



Note: Solar-dominant hybrid++: wind-solar 1:1.2; wind-dominant hybrid++: wind-solar 1.5:1. \* 700 million units are the units generated annually by a 100 MW hybrid ++ project; \*\*Customer savings are computed based on grid tariff of INR 7 per kWh in state of Maharashtra; Transmission cost- 0.34INR million/ MW per month;

Source: GRID India; MEC+ analysis

GWEC.NET



## Increasing wind capacity provides price hedging for consumers by locking in low-cost power during peak evening hours, outperforming market rates

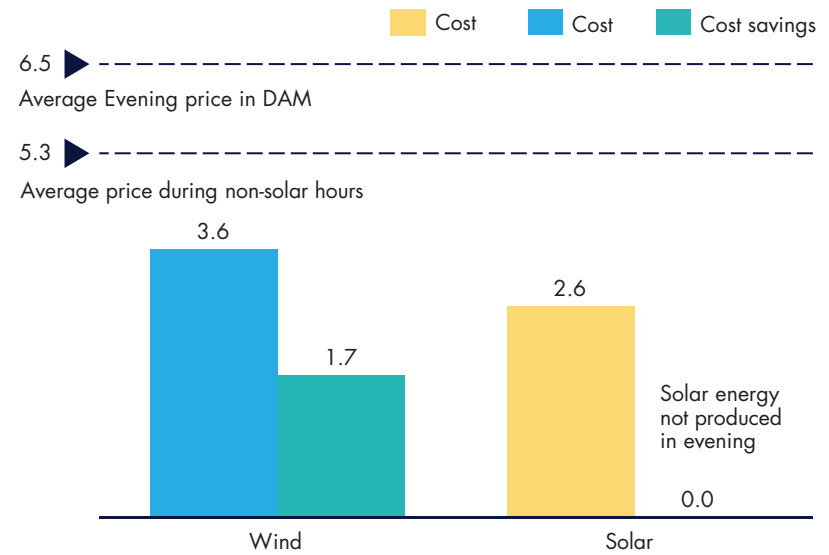
Hourly Market Clearing Price (Average) vs Solar and Wind Hours  
INR per kWh

Months	Hours																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
January	3.0	2.8	2.6	2.6	2.7	3.3	6.1	9.3	10.0	9.9	9.7	7.2	4.7	3.6	3.7	4.4	7.4	9.6	9.8	9.4	7.0	4.4	3.4	3.3
February	3.3	3.1	3.0	2.9	3.0	3.5	6.0	8.8	8.5	7.2	5.7	4.2	3.7	3.4	3.4	3.7	4.7	6.5	7.7	8.2	6.1	4.6	3.7	3.5
March	4.3	3.7	3.5	3.4	3.4	3.8	4.3	5.2	4.4	4.0	3.5	3.3	3.0	2.7	3.0	3.3	3.7	3.7	4.7	5.7	4.5	4.4	4.2	4.2
April	8.7	7.3	6.0	5.3	4.9	5.0	5.3	4.3	3.5	3.3	3.0	2.8	2.6	2.5	2.9	3.4	3.9	4.2	5.0	7.0	6.4	7.8	8.5	9.1
May	9.7	8.1	5.4	4.3	4.3	4.3	4.2	3.4	2.9	2.8	2.8	2.7	2.7	2.7	3.5	3.8	4.2	4.0	4.6	7.8	8.9	9.6	9.9	9.9
June	9.7	8.3	6.6	5.3	5.4	5.0	5.0	3.6	2.8	2.6	2.5	2.4	2.5	2.5	3.4	3.7	3.9	3.9	4.2	7.4	9.1	9.8	10.0	10.0
July	8.5	6.8	5.0	4.7	4.5	3.8	4.7	3.7	3.0	2.7	2.4	2.2	2.0	2.0	2.5	3.0	3.2	3.3	4.1	8.4	9.5	9.8	9.9	9.9
August	5.8	4.5	3.7	3.6	3.7	3.4	4.2	3.7	2.8	2.5	2.3	2.0	1.9	1.8	2.2	2.7	3.1	3.2	4.2	8.1	8.7	8.8	8.4	7.6
September	5.0	4.0	3.6	3.3	3.3	3.3	3.8	3.2	2.6	2.3	2.1	2.1	1.9	1.8	2.4	2.9	3.2	3.9	5.8	9.1	8.4	8.3	7.3	6.8
October	4.9	3.8	3.5	3.3	3.2	3.3	3.5	3.4	2.9	2.6	2.2	2.1	2.0	2.0	2.5	3.0	3.4	4.9	8.1	7.1	5.9	5.8	5.5	5.4
November	2.8	2.6	2.6	2.6	2.6	2.8	3.4	3.9	3.5	3.0	2.4	2.1	1.9	1.8	2.3	2.8	3.6	7.2	8.1	4.2	3.6	3.3	3.0	2.9
December	2.4	2.3	2.2	2.2	2.3	2.8	3.7	6.2	6.9	5.9	3.9	3.1	2.8	2.5	2.8	3.2	4.2	8.3	9.0	4.9	3.5	3.1	2.7	2.6

Evening peak

- 1** Wind power
  - Cheapest power source in the evening & early morning hours
  - Lower generation & higher cost during solar hours
- 2** Solar power
  - Cheapest power source during solar hours (8am - 3pm)
  - Only available when sun shines

Cost savings across different sources during evening hours  
INR per kWh



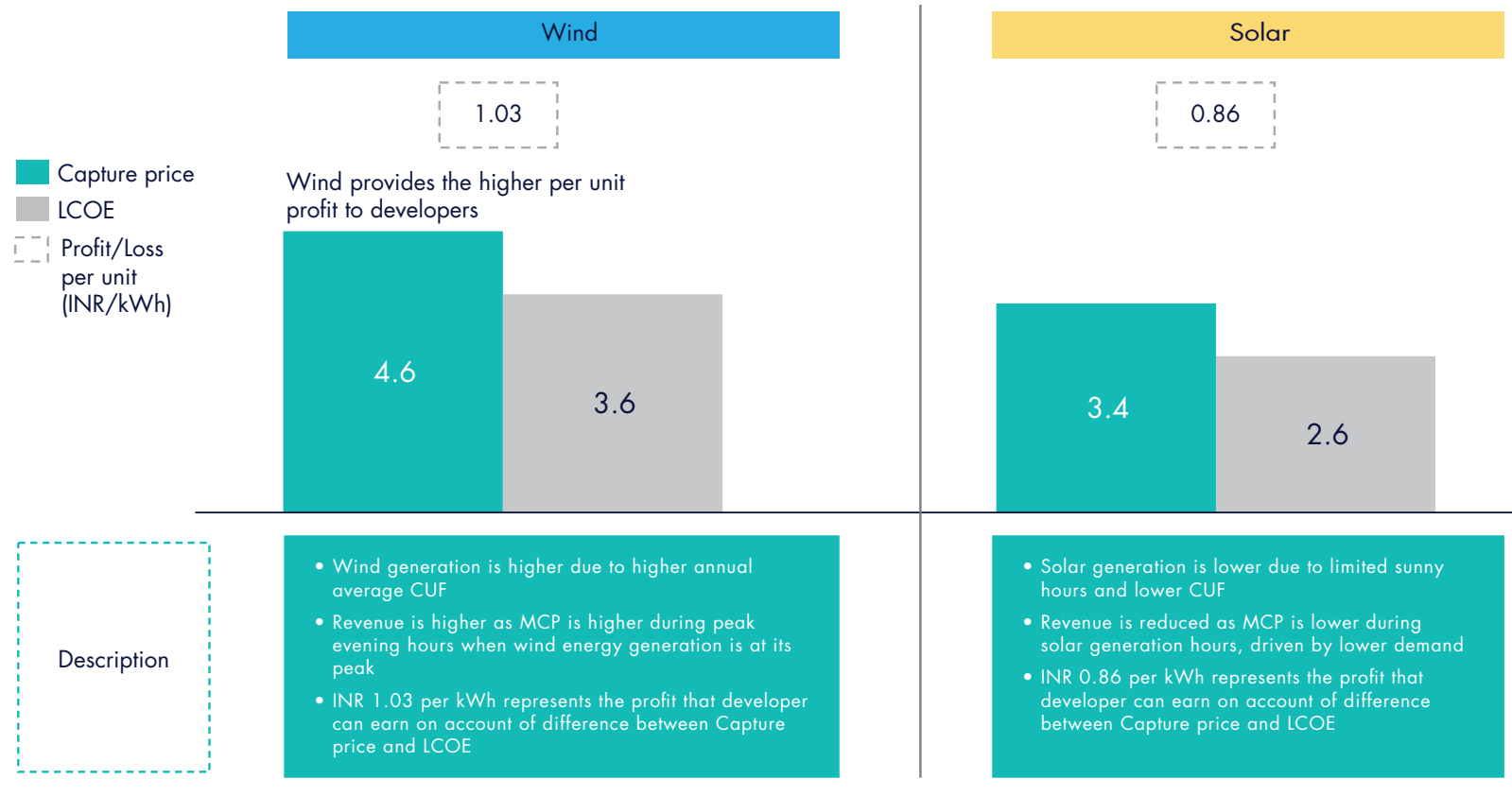
- Cost savings are higher when energy is sourced from wind during peak evening hours compared to zero savings with solar (due to no production)
- Wind LCOE is at INR 3.6 kWh, PPA is signed at the same number for a wind project, consumer can save INR 1.7kWh or higher during evening hours

Note: Day Ahead Market (DAM) price = market clearing price x hourly market volume. Least cost of market price calculated across different energy sources; CUF considered for wind site in Tamil Nadu and Solar site in Gujarat, CUF less than 20% of wind in an hour is not considered as source; Hours where the wind CUF is above 20% & the market clearing price is below the wind's LCOE (3.56 INR/kWh) are highlighted in blue. Hours where CUF of solar is >20% are highlighted in yellow. If wind and solar overlap in an hour, it is marked yellow since LCOE of solar < LCOE of wind. Remaining slots are highlighted in grey; Figures are calculated as of Jan'24 to Jan'25; Evening price is computed from 1800 hours to 2200 hours

Source: DAM data IEX; CERC Tariff order FY23; MEC+ analysis

## Increasing wind capacity ensures a high capture price and maximizes profits for developers when selling electricity on exchanges

Capture price for different energy sources  
INR per kwh



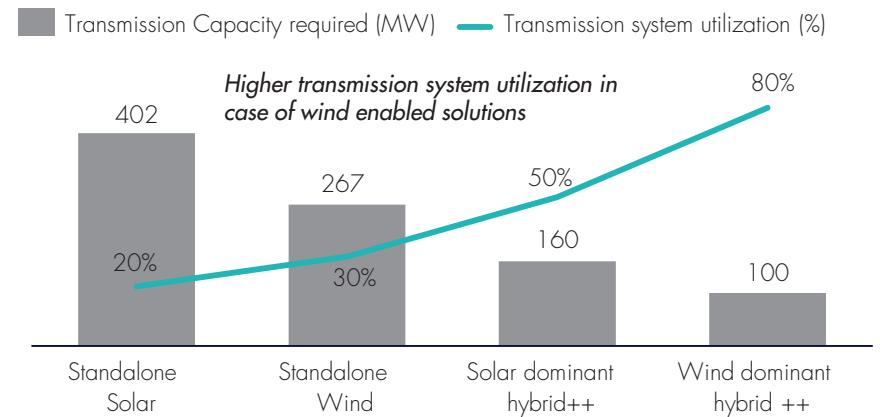
Note: \*Capture price is calculated as total revenue from electricity sales divided by total energy generated.  
MCP stands for Market Clearing Price

Source: IEX; CERC Tariff order FY23; MEC+ analysis

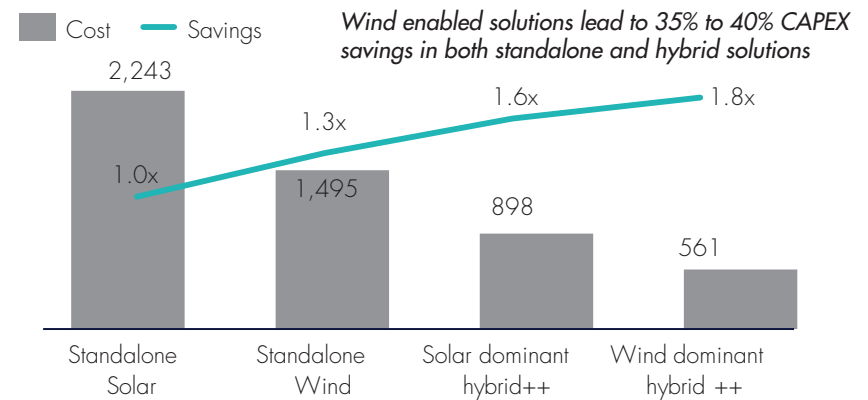


## Increasing wind capacity ensures 35-40% transmission CAPEX savings for operators through better utilization of transmission lines

Transmission capacity needed to deliver 700 MU\* from diverse RE sources






















Transmission CAPEX needed to deliver 700MU\* from diverse RE sources and relative savings  
INR million



Note: Solar-dominant hybrid++: wind-solar 1:1.2; wind-dominant hybrid++: wind-solar 1.5:1. \* 700 million units are the units generated annually by a 100 MW hybrid ++ project; Transmission CAPEX - 5.6 INR million/MW  
Source: GRID India; MEC+ analysis

## Increasing wind will accelerate the achievement of PM's Viksit and Atmanirbhar Bharat Mission as a broader set of associated industries is used in manufacturing of wind turbines & other components

### Solar and Wind supply chain and associated industries

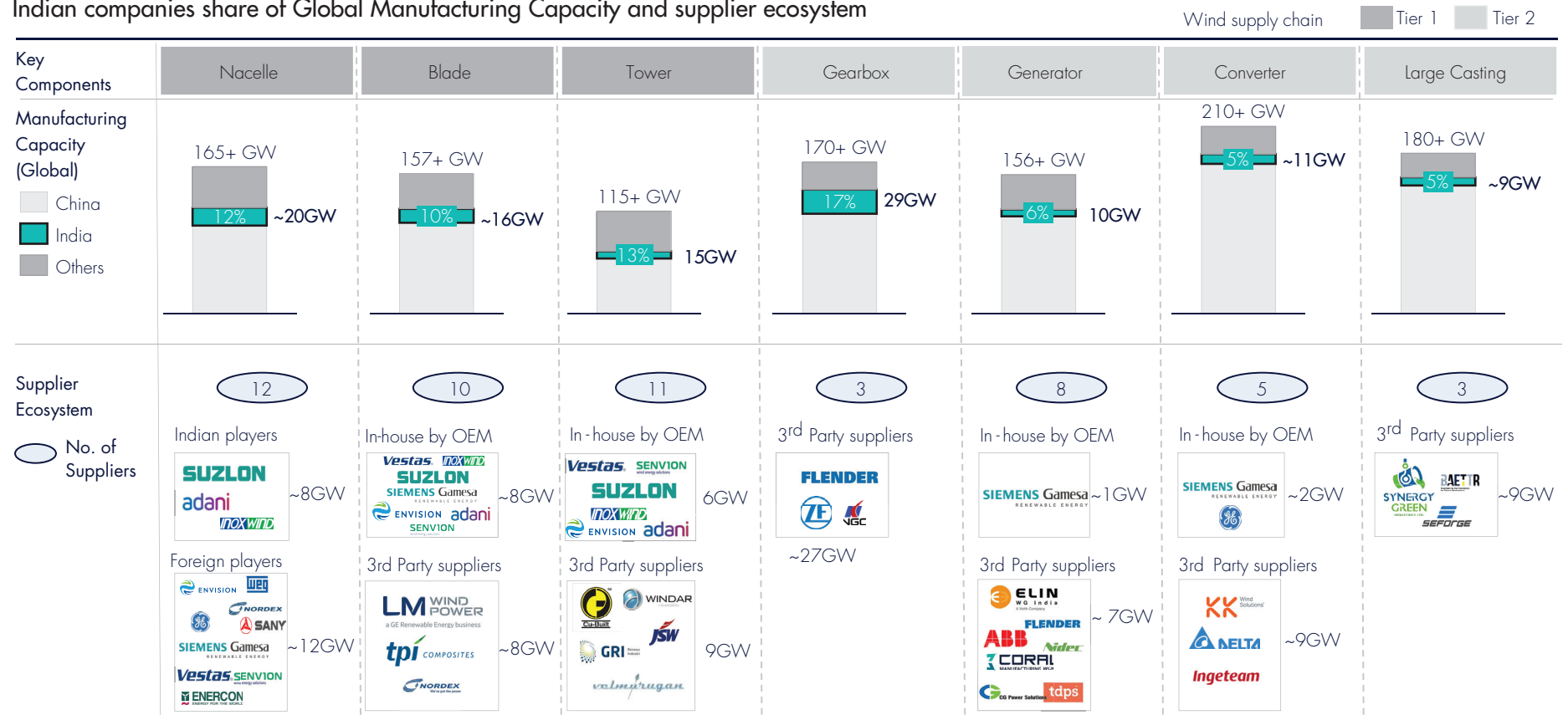
	Tier - 1	Tier - 2	Component (cost%)	Associated Industries
SOLAR	Solar Module (50%) 	Cells (24%) 	Electronics/Electrical	Glass
		Aluminum frame (6%) 	Heavy engineering	Polymers
		Glass (7%) 	Metals	Mechanical
		Encapsulant (3%) 		
	Inverter (15%) 	Junction Box (3%) 		
	Other Components *			
WIND	Nacelle (25 - 30%) 	Gearbox (12%) 		
		Generator (4%) 		
		Converter (3%) 		
		Large Casting # (4%) 		
		Main shaft (2%) 		
		Main bearing (2%) 		
		Controller (1%) 		
	Tower (22 - 25%) 			
	Rotor Blade (20%) 	Shells (9%) 		
	Other Components** (25%)	Spar caps and shear web (6%) 		

- Driven by the Hon. Prime Minister's vision for Make in India and Viksit Bharat, the government's push for wind energy is strengthening India's supply chain, driving GDP growth through higher value addition, localized manufacturing, and diverse job creation
- Wind's broader industry engagement, spanning heavy engineering, metals, and mechanical processes, enhances domestic economic impact and acts as a multiplier to the existing solar supply chain, which relies primarily on electronics, glass, and polymers

Note: \*includes MMS (module mounting structure), cables, meters and more; \*\*includes pitch and yaw system, transformer and more; # includes rotor hub and main-frame  
Source: Indian Wind Power Directory-2023; EXIM Data; MEC+ analysis

## And increasing the wind capacity in India allows the existing vibrant supplier ecosystem of wind players in India to expand and create strong global exports

Indian companies share of Global Manufacturing Capacity and supplier ecosystem



India has established itself as a global manufacturing hub for WTG components, with a strong supplier network and expanding capacities across key Tier 1 (nacelle, blade, tower) and Tier 2 (gearbox, generator, converter, casting) segments, ensuring global competitiveness, reinforcing its global competitiveness

Source: MNRE; Global Wind Atlas; GWEC Mission Critical; Company website; MEC+ analysis

A photograph of a wind farm at sunset. The sky is a mix of deep blue and orange, with several birds flying in the upper right. The foreground is a field of green grass. A dark teal horizontal band is overlaid across the middle of the image, containing the text "India's Wind Outlook".

# India's Wind Outlook

## Strong government policy support has been driving consistent expansion in domestic onshore wind installations over past years

Major central policy announcements over past years and their impact

	Jun 21	Jun 22...	Mar 23...	Feb 24...	Aug 25...
Policy/ market mechanism	ISTS charge waiver extension	Bidding Trajectory for RE Projects	Wind RPO	Modification to Tariff Based Comp. Bidding	Revised Procedure for URET
Features of policies/ market mechanisms	<ul style="list-style-type: none"> <li>ISTS charges waiver for RE projects was extended until 30 June 2025</li> <li>Projects commissioned by this date will enjoy a 25-year exemption from ISTS charges</li> </ul>	<ul style="list-style-type: none"> <li>Annual issue of 10 GW wind tenders and appointment of additional REIAs</li> <li>Aims to maintain a steady pipeline of new projects for continuous growth in the wind energy sector</li> </ul>	<ul style="list-style-type: none"> <li>Gradually increases wind energy targets from 0.67% in 2025 to 3.48% by 2030</li> <li>Imposes penalties on DISCOMs and captive consumers for non-compliance</li> </ul>	<ul style="list-style-type: none"> <li>Streamlines procurement for RE projects with storage, enabling location specific bids, stricter CUF compliance, faster PPA signing, and introduced insurance surety bonds</li> </ul>	<ul style="list-style-type: none"> <li>URET withdrawn due to substantial renewable energy capacity awaiting power sales agreement (PSA) signing and to expedite the deployment of RE</li> </ul>

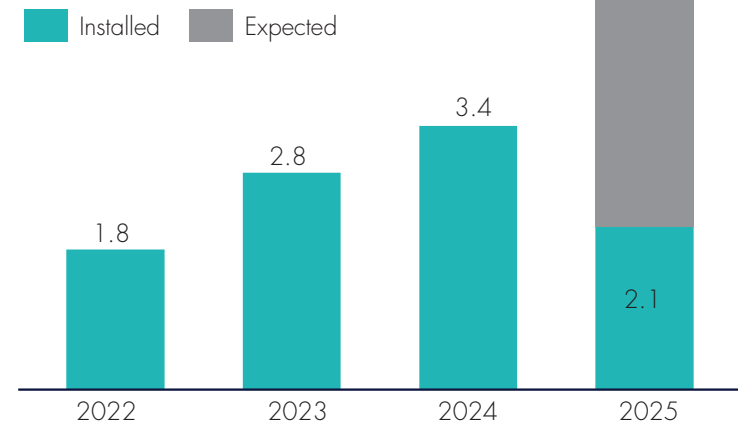
### Impact of policy/market mechanism on wind and hybrid installations

Scale of installations	Jun' 2025	FY 2028	FY 2030	Until next amendment	FY 2028
Duration of impact	Jun' 2025	FY 2028	FY 2030	Until next amendment	FY 2028

Note: RPO – Renewable Purchase Obligation; URET – Uniform Renewable Energy Tariff; GEOA – Green Energy Open Access; RE – Renewable Energy; PPA – Power Purchase Agreement; SCOD – Scheduled Commercial Operation Date  
 Source: ISTS waiver; Wind RPO; Tariff bidding update; 500 GW target by 2030; URET; CY – Calendar Year. MEC+ analysis

### Installations from Jan'22-Jun'25 (CY) GW

Market activity has intensified in recent years, with installations gaining momentum



- Government Policies like Wind RPO and mandatory tenders for wind projects boosted wind energy installations in India from about 40 GW in 2021 to approximately 48GW in 2024
- A significant growth of 8 GW in installations over the past three years highlights the recovery in demand for renewable energy post-COVID-19

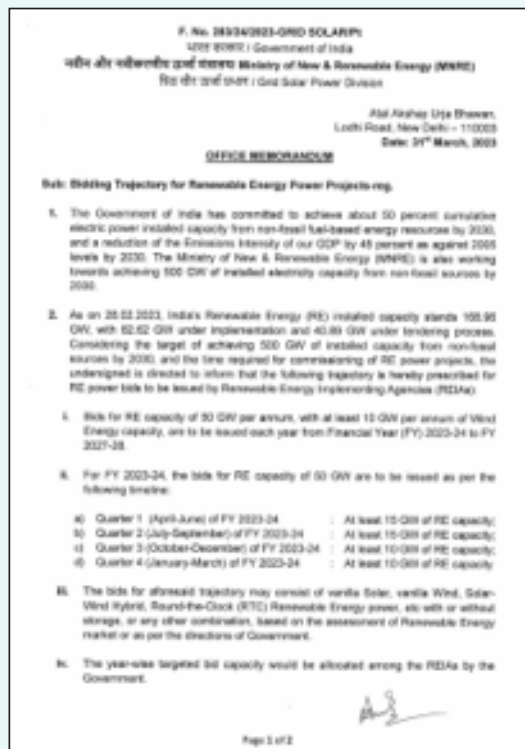
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Source: ISTS waiver; Wind RPO; Tariff bidding update; 500 GW target by 2030; URET; CY – Calendar Year. MEC+ analysis

## MNRE's 10 GW annual bidding trajectory since 2023 has significantly boosted tender activity, surpassing issued targets

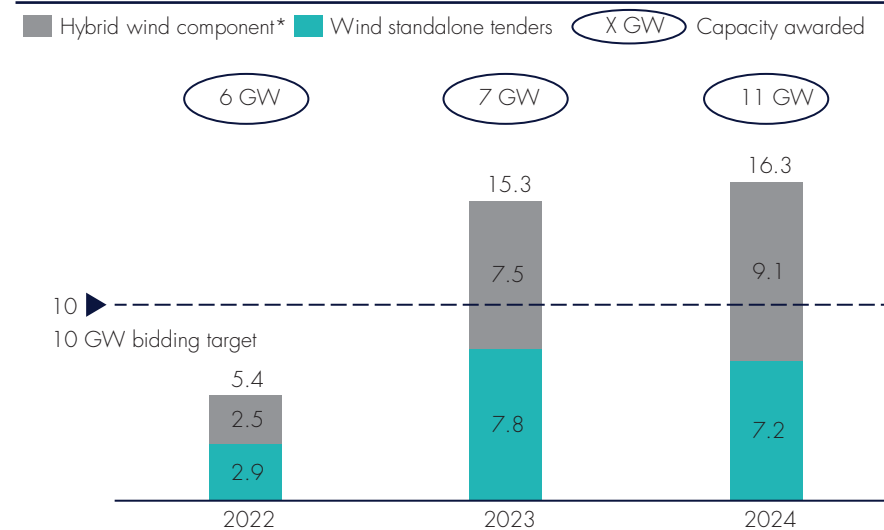
Bidding trajectory for renewable energy projects

MNRE; Bidding Trajectory for Renewable Energy Power Projects, Mar'2023



The MNRE has set an annual bidding target of 50 GW for renewable capacity until FY 2028, with at least **10 GW** reserved for wind projects through exclusive tenders

Standalone wind & hybrid – Total tenders announced & capacity awarded GW

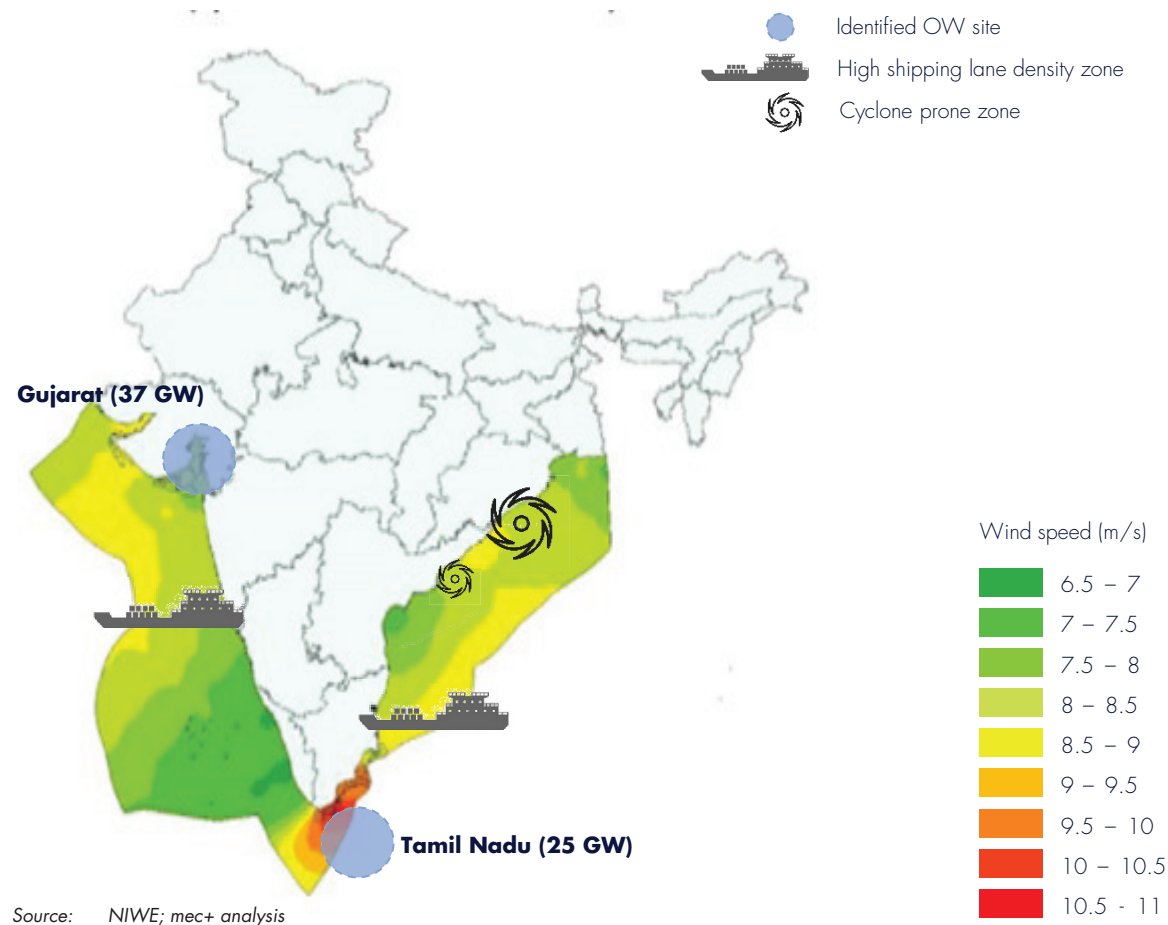


- India has successfully achieved and exceeded the 10 GW bidding target set by MNRE for 2023 and 2024, following the release of the trajectory in March 2023
- A significant portion of the tendered capacity has been awarded, with 11 GW of projects awarded in 2024

Note: \*Assuming a 1:2 ratio of wind to solar, based on the proportion of wind in hybrid projects awarded in 2024  
Source: MNRE Bidding Trajectory; SECI tender result announcement; MEC+ auction database; MEC+ Analysis

## Government has actively targeted offshore wind in India, identifying high-potential coastal regions with an estimated capacity of 62 GW

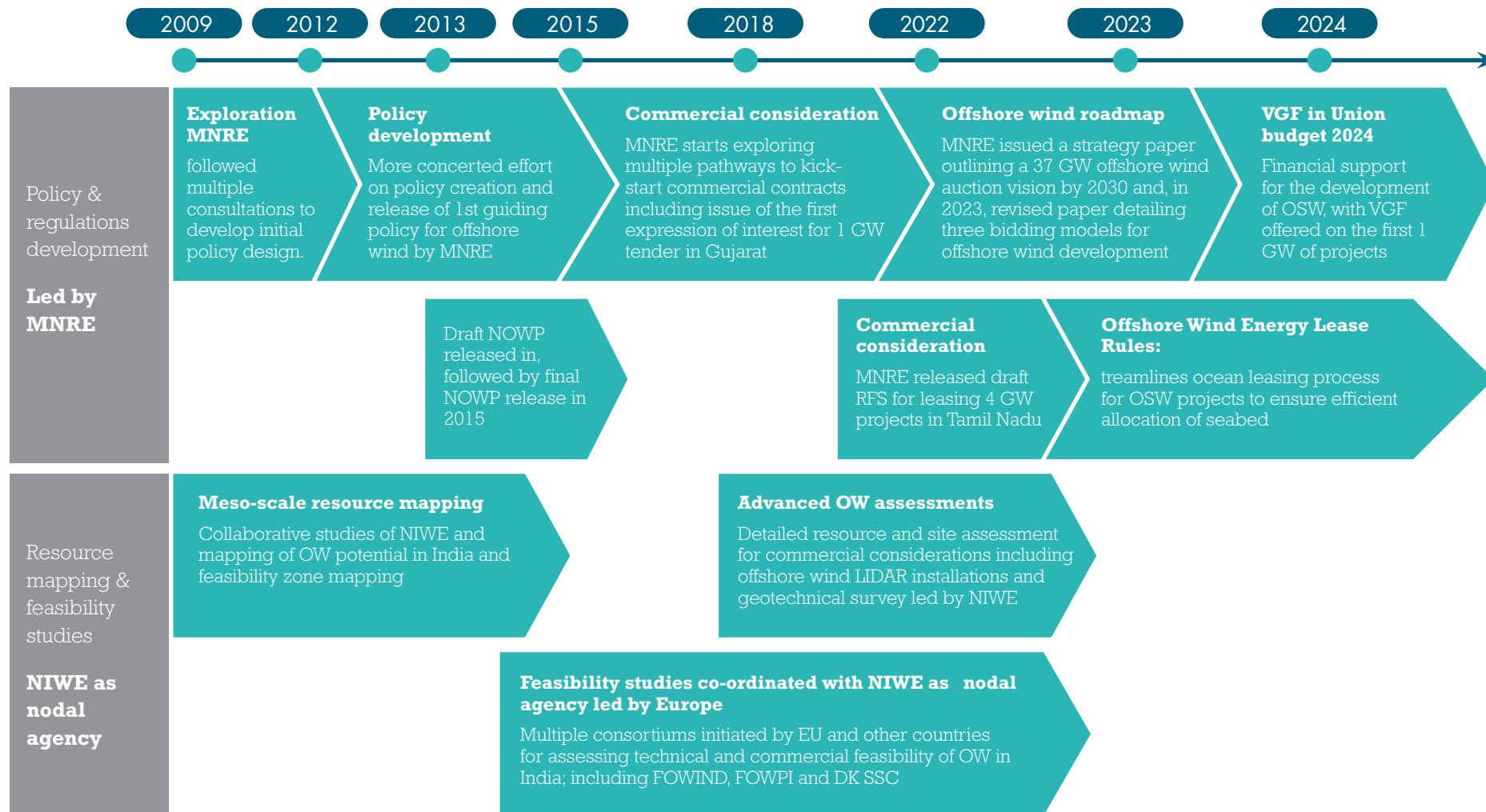
### India Offshore Wind Resource and potential



- India has long coastline of about **7600 kms** spread across states of Gujarat, Maharashtra, Karnataka, Kerala, Andhra Pradesh and Odisha
- **2 states Gujarat and Tamil Nadu** are identified for OW development based on technical potential of ~62 GW as per recent studies by NIWE
  - Tamil Nadu sites: Selected as best wind resources
  - Gujarat sites : Selected due to offshore activity and moderate wind resources
- Good wind zones in Maharashtra, Odisha and Tamil Nadu east coasts , however:
  - Odisha is restricted due to high cyclone activity in the area
  - Maharashtra and east cost of Tamil Nadu is restricted by high shipping activity

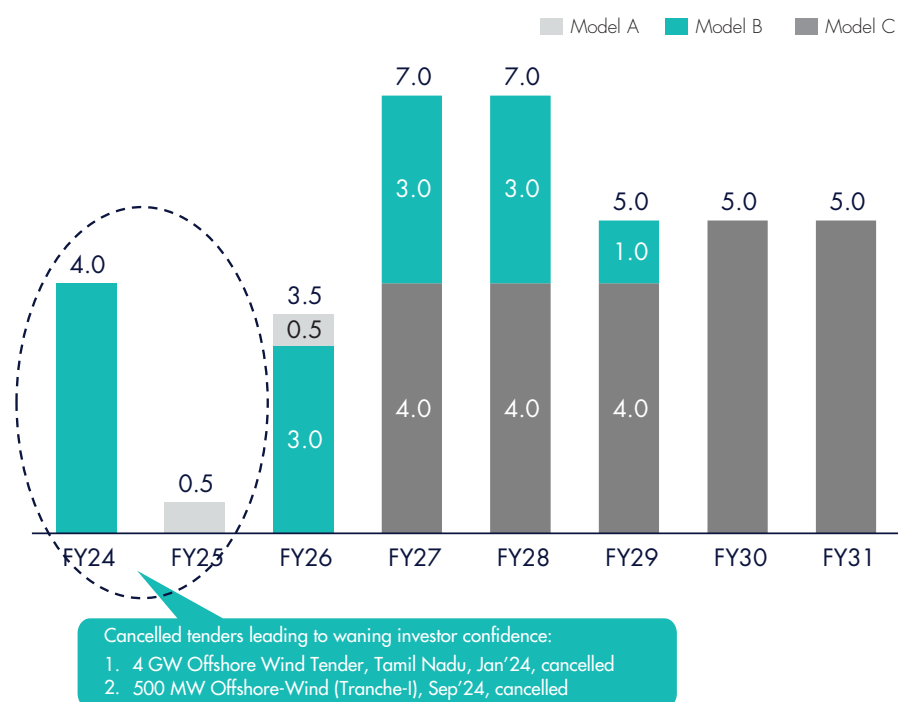
## MNRE and NIWE have been at the forefront of offshore wind development in India, driving progress through proactive initiatives and fostering international collaborations to support the sector's growth

Timeline of OW activities



## Offshore wind development advanced with 4.5 GW of tenders issued, although infrastructure challenges have slowed market participation

### Offshore wind bidding trajectory



Note: \*Uniform Renewable Energy Tariff, VGF- Viability Gap Funding. \*Model A: PPA and exclusive lease award based on quoted tariff or VGF bid, with identified zones and completed studies. Model B: Exclusive lease award based on lease fee bids for captive/open access sales, with zones identified but studies to be done by the developer. Model C: Non-exclusive lease award on a 'first-come-first-serve' basis for surveys, with no zone identification or studies completed

Source : MNRE Strategy paper on OW development; MEC+ analysis

### Offshore wind challenges and expected progress



#### Bidding issues

4.5 GW tenders issued in 2024, but the bidding process has been delayed due to low market activity & insufficient existing infrastructure



#### Lack of adequate port infra

- Inadequate port infrastructure and limited on-site assembly and manufacturing facilities constrain offshore wind deployment
- Shortage of specialized vessels for OSW component transport



#### Regional Disparities in Deployment

- OSW projects are capital-intensive, and with government support limited to the first 1 GW, developers face significant financing challenges
- Estimated tariffs of ₹10.5/kWh in Gujarat and ₹9.6/kWh in Tamil Nadu are significantly higher than the current grid tariff of ₹7/kWh



#### Unskilled workforce

Shortage of skilled professionals for OSW turbine installation, maintenance, operations, and site testing

Due to these challenges, offshore wind projects are unlikely to be commissioned in India before 2030

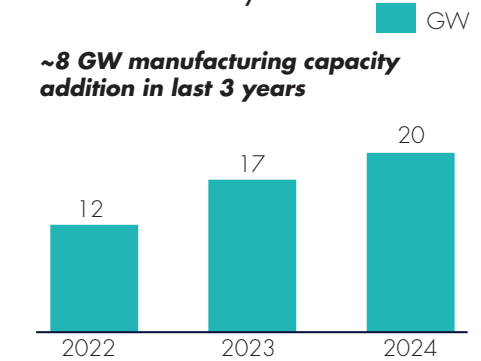
## Targeted government interventions have accelerated WTG component manufacturing, increasing production capacity from 12 GW in 2022 to 20 GW in 2024

Major central policy announcements in past years and their impact

	Oct 18...	Feb 23...	Oct 23...	Feb 24...	Apr 25...
Policy/ market mechanism	RLMM List	Excise Duty & CCDC	Other Financial Incentives	Mandatory localization (%)	Draft amendment to RLMM listing
Features of policies/ market mechanisms	<ul style="list-style-type: none"> <li>Mandated type certification and domestic assembly of nacelles</li> <li>Regulated &amp; ensured quality and standardization in wind turbines and components</li> </ul>	<ul style="list-style-type: none"> <li>100% exemption from excise duty on certain wind turbine components</li> <li>Financial incentive on import of sub-components by providing concessions on custom duty</li> </ul>	<ul style="list-style-type: none"> <li>Permitting FDI in the RE sector</li> <li>Special incentives for the promotion of WTG components' exports</li> <li>ISTS charges waiver</li> <li>Funding R&amp;D up to 100%</li> </ul>	<ul style="list-style-type: none"> <li>NITI Aayog has proposed to mandate a 60% cost percentage of locally manufactured components in WTGs</li> <li>Local content % to increase over time giving a boost</li> </ul>	<ul style="list-style-type: none"> <li>Mandated disclosure of key specs. and domestic vendors under revised RLMM clause</li> <li>Mandate to procure tower, blade, gearbox, generator locally, with limited import exemption</li> </ul>

■ Announced ■ Proposed

WTG Manufacturing capacity addition in last 3 years



Impact of policy/market mechanism on wind and hybrid installations

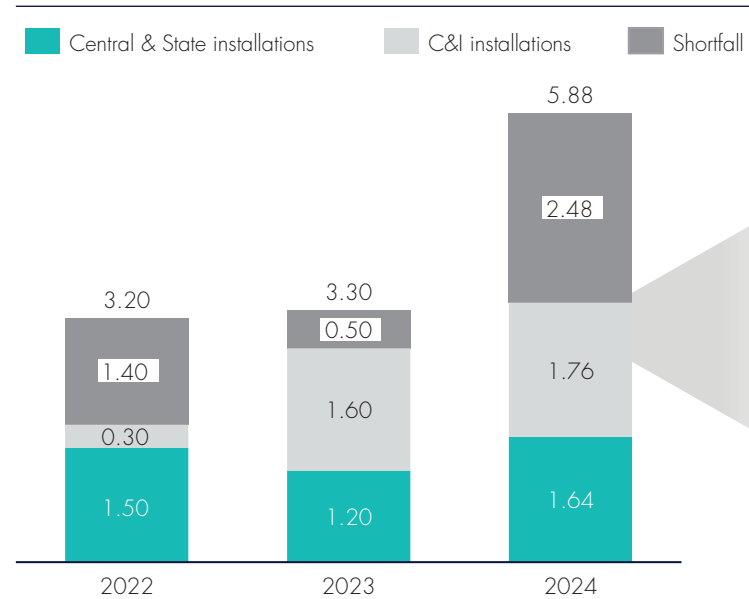


- Recent policies by government have propelled domestic manufacturing of WTG components (despite halt in manufacturing during COVID 19) as the production capacity grows by 74% from 2022 to 2024
- Government policies are aiming to reduce manufacturing costs, promote innovation, and enhance scalability in India's RE manufacturing sector

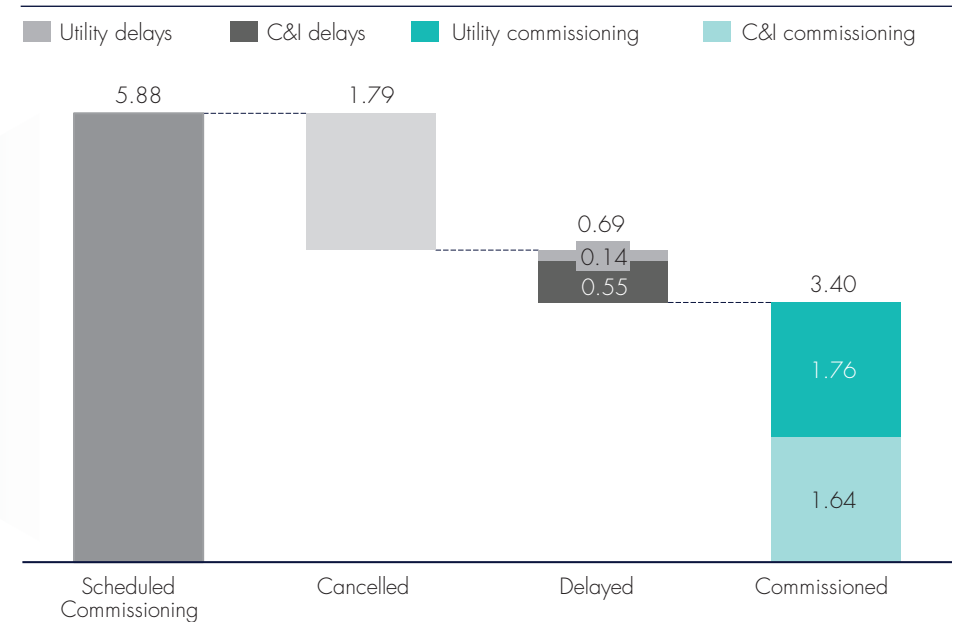
Note: RPO – Renewable Purchase Obligation; URET – Uniform Renewable Energy Tariff; GEOA – Green Energy Open Access; RE – Renewable Energy; PPA – Power Purchase Agreement; SCOD – Scheduled Commercial Operation Date  
 Source: ISTS waiver; Wind RPO; Tariff bidding update; 500 GW target by 2030; URET; CY – Calendar Year. MEC+ analysis

## Despite growth in 2024, wind energy's overall progress remains slow, significantly lagging anticipated commissioning timelines due to project delays and cancellations

Central & state utility and C&I wind installations over the years GW



Central & state utility and C&I wind projects commissioning status in 2024 GW



- While installations have increased over the years, they have consistently fallen short of the anticipated installations forecasted based on project commissioning timelines.
- The shortfall is mainly due to multiple project delays and cancellations

Note: Projects considered till Dec' 2024

Source: MNRE; SECI tender result announcement; MEC+ auction database; MEC+ Analysis

**Project delays and cancellations**

**Grid related delays**

- JSW 270 MW SECI IX
- Renew 400 MW RTC

**Developer related delays**

- NTPC 450 MW SECI Hybrid IV

**Land acquisition challenges**

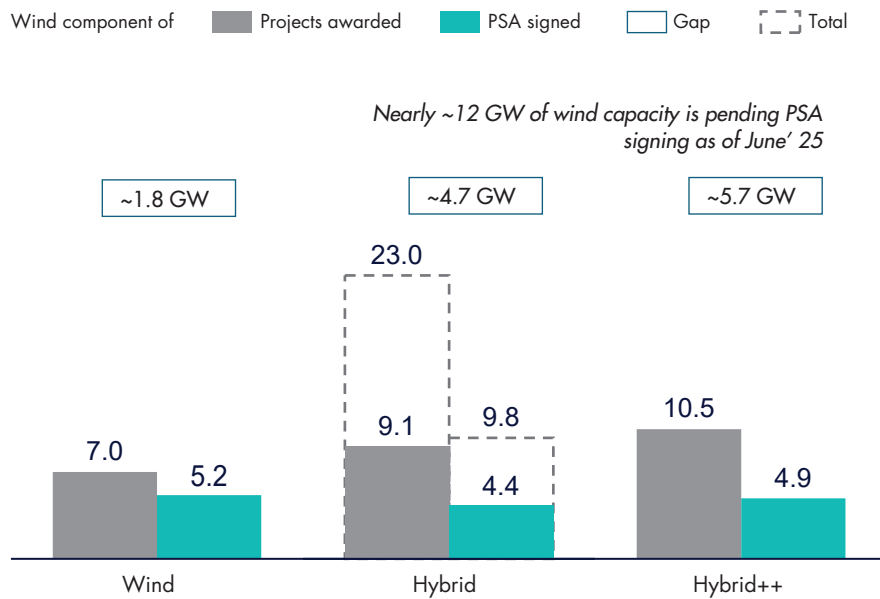
- Sembcorp's 180 MW SECI XI

**Project cancellations**

- Hindustan thermal RTC-II

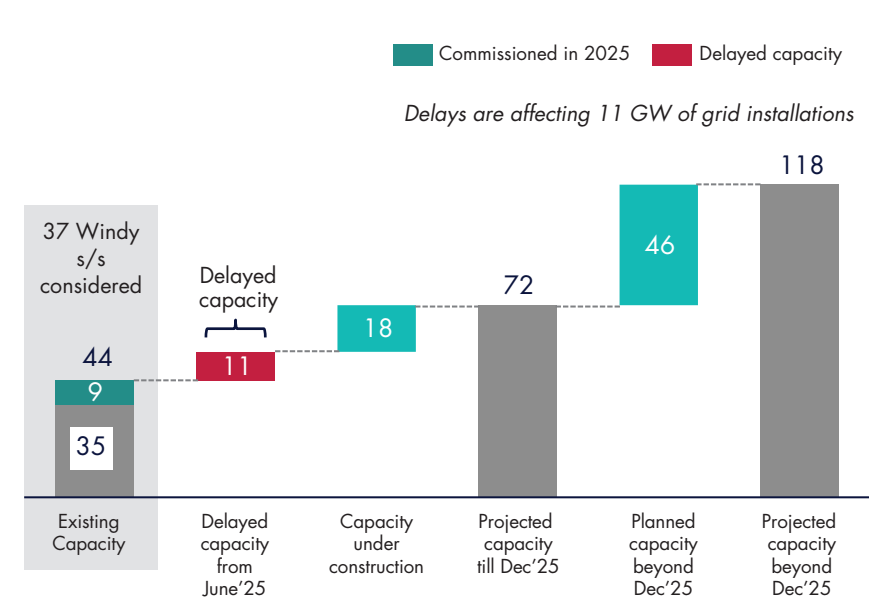
## PSA signing issues and grid commissioning delays continue to pose challenge for pipeline execution, potentially leading to lower installations

PSA signing status of wind/ hybrid pipeline by the end of 2024  
GW



- PSA signings remain low due to poor RPO compliance and the fragile financial condition of DISCOMs
- PSA signing delays hinder developers' ability to secure financing and proceed with construction
- The Govt. introduced the URET\* mechanism to address this, creating central pools for ISTS-connected RE sources; however, the same has been abandoned as on Aug'2025

RE grid pipeline construction outlook  
GW

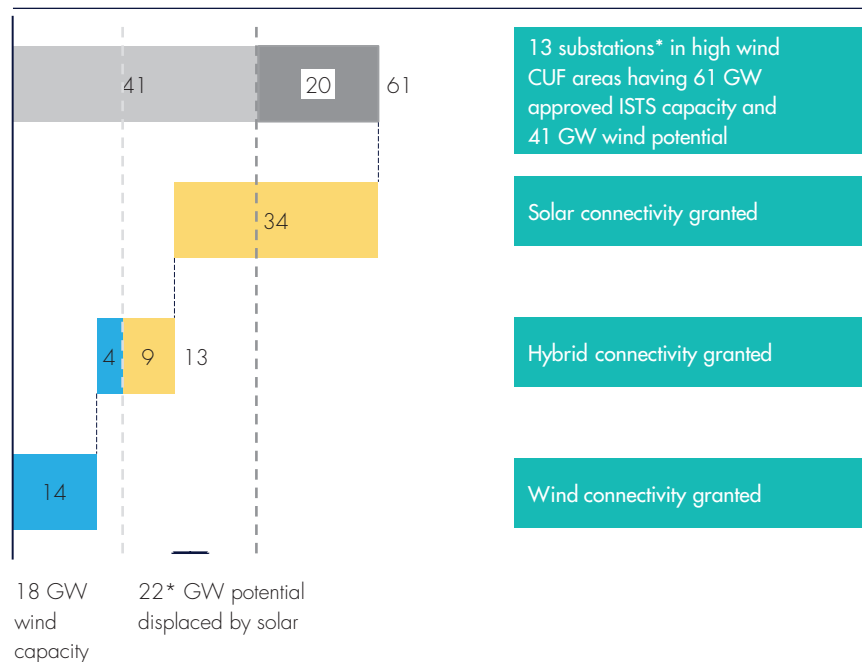


- Delays in five key ISTS RE substations lying in wind-rich zones, with a combined evacuation capacity of 11 GW are hindering grid infrastructure development
- These delays could impact the commissioning of approximately 5 GW of wind capacity of projects currently under various stages of development

Note: \*Uniform Renewable Energy Tariff  
Source: SECI tender result announcement; GWEC auction database; MEC+ auction database; CTU Status of Margin; CEA reports; MEC+ Analysis

## Wind's potential is further hindered by sub-optimal connectivity allocation, with solar competing for connectivity in wind zones and developers facing land/PPA risks, causing delays and cancellations

Sites with high wind resource are often allocated to PV developers  
GW



- Sub-optimal grid allocation limits wind generation and transmission capacity, with prime wind sites often allocated to PV developers, reducing wind potential
- Grid connectivity design should prioritize wind sites for optimal efficiency, as solar can be added to most wind locations, but not vice versa

Challenges faced by wind in land, project execution & PPA requirements

Parameter	Solar	Wind
Land Requirements	Not restricted to a specific location / site Ease of acquisition	Non-contiguous parcels increases ROW effort
Wind / Solar resource assessment	3 months	12-18 months
Project execution timelines	5-6 months	15-18 months
Risk if land acquired before connectivity	Less risky	Highly risky
Timing of securing grid connectivity	Can be done post securing PPA	Need upfront before PPA (due to 12-18-month project timelines)

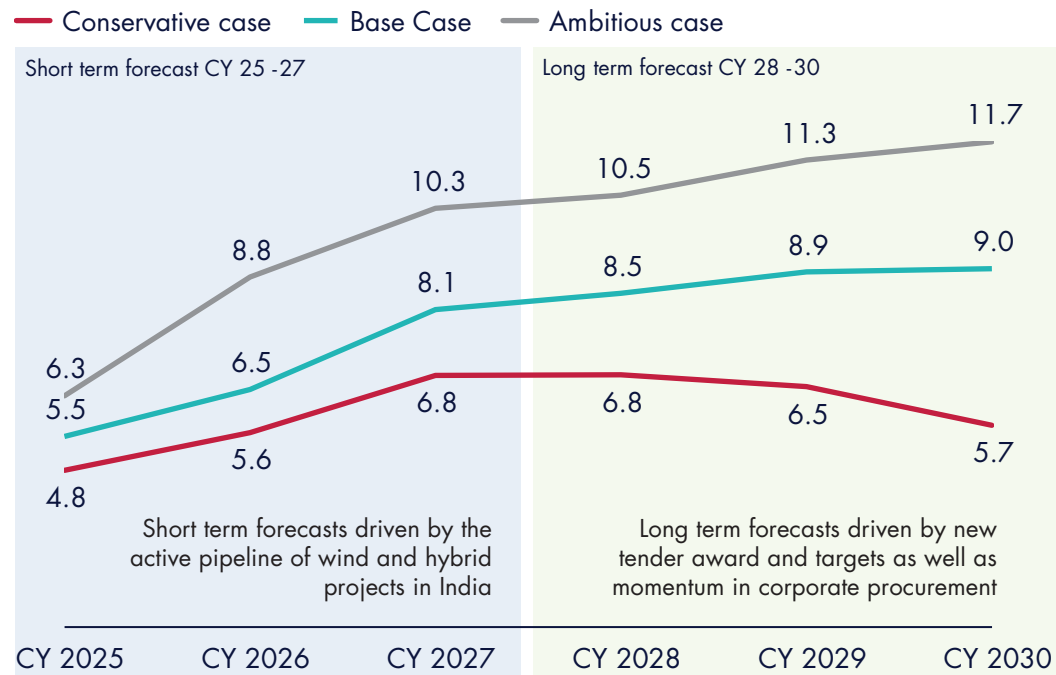
- Wind projects require specific, non-contiguous land parcels and longer completion times. Acquiring land before securing connectivity leads to significant execution challenges
- Developers are further facing issues in access and procurement of land through lease models

Note: \*Substations- Fatehgarh-III, Fatehgarh-IV, Barmer-I, Ramgarh-I, Jamkhambaliya-I, Lakhadiya, Lakhadiya -II, Radhanesda (Vav), Jamkhambaliya -II, Rajgarh, Pachora, Kallam, Solapur, Bellary

Source : CEA; MNRE; primary interviews; MEC+ analysis

## India can achieve the 100 GW wind target by 2030 if these challenges are addressed, unlocking faster progress and enabling alignment with the ambitious growth case

Forecasted Y-o-Y new onshore wind installations in India 2025-30  
GW



Installations 2025 -30	India at the end of 2030	Vs. CY 30 target
58.9 GW	107.0 GW	Achieved
46.5 GW	94.7 GW	-5.3 GW
36.1 GW	84.3 GW	-15.7 GW

*If current annual installation rates persist, cumulative capacity may fall to just 65-70 GW by 2030—well below the conservative case projection—calling for urgent action*

- Conservative case assumes delays in grids, land delays, and lag in RPO compliance in States leading to delays in Power Sale Agreement (PSA) and reaches 84.3 GW installed capacity
- Base case assumes that current grid plan gets executed but further enhancement is delayed, and PSA signing is delayed in some of the states while execution remains slow and reaches 94.7 GW installed capacity
- Ambitious case assumes accelerated grid development, compliance of all states to RPO, and C&I demand is able to find the grid 107 GW hence meeting targets

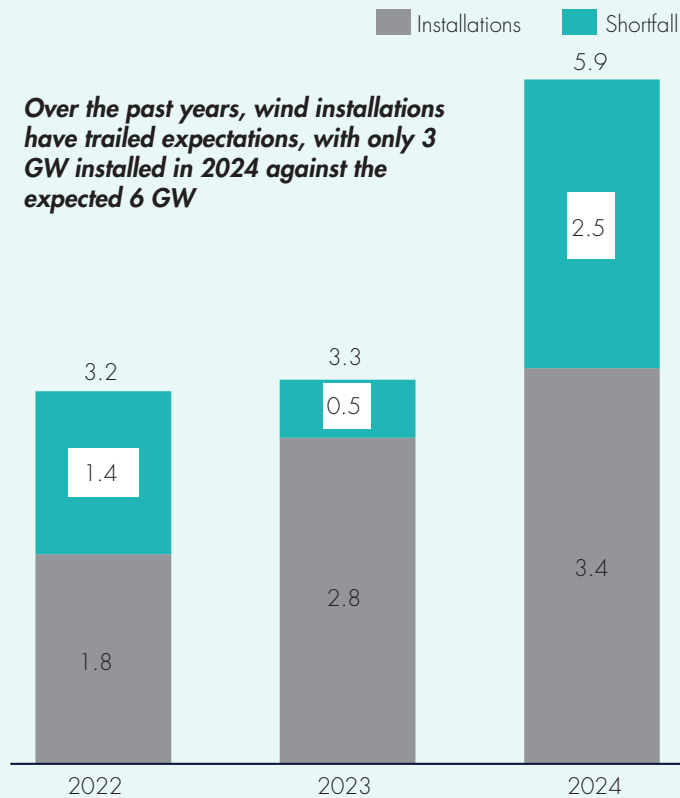
Note: As per calendar years; forecasts are inclusive of hybrid projects; \*Including 15 GW pipeline from tenders and 5 GW from corporate procurement

Source: RPO documents; Transmission system for integration of over 500 GW RE capacity by 2030; MEC+ Analysis

# Current slow progress, reflected in limited domestic scale, has affected not only jobs but also limited cost competitiveness and local content in turbines

## Current scale of wind installations GW

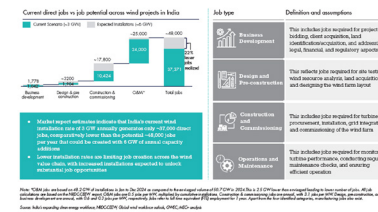
Over the past years, wind installations have trailed expectations, with only 3 GW installed in 2024 against the expected 6 GW



## Impact of Low Scale of Wind Installations

### 1. Jobs

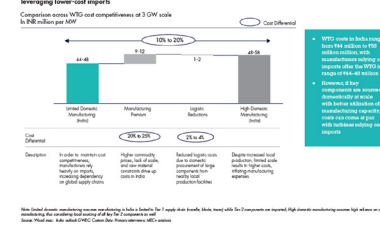
Due to low scale, 22% fewer direct jobs were realized across the value chain than possible with a 6 GW scale



Due to low scale, 22% fewer direct jobs were realized across the value chain than possible with a 6 GW scale

### 2. Cost Competitiveness

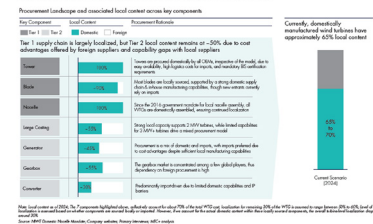
Due to low scale, Indian turbines that rely heavily on domestic manufacturing are 10-20% less cost-competitive than those leveraging lower-cost imports



Due to low scale, Indian turbines have yet to achieve cost competitiveness compared to China, where large-scale manufacturing has driven costs 10% to 20% lower

### 3. Local Content

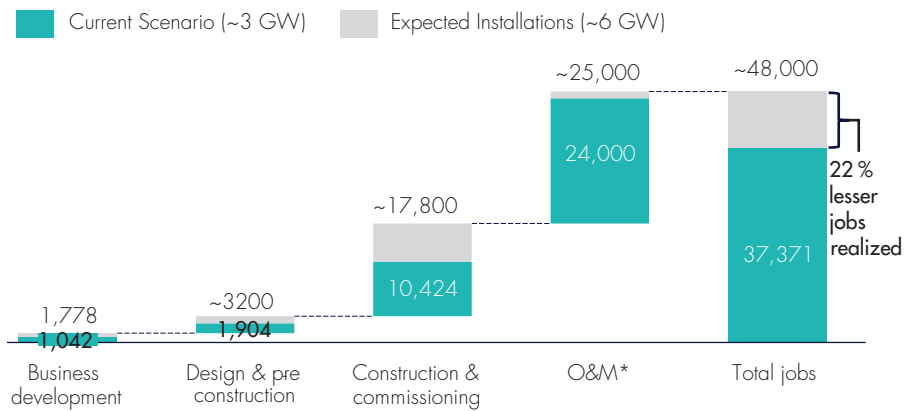
Due to low scale, turbines installed in India have achieved only about 65% local content



Due to low scale, turbines installed in India have achieved only about 65% local content

## Due to low scale, 22% fewer direct jobs were realized across the value chain than possible with a 6 GW scale

### Current direct jobs vs job potential across wind projects in India



- Market report estimates indicate that India's current wind installation rate of 3 GW annually generates only ~37,000 direct jobs, comparatively lower than the potential ~48,000 jobs per year that could be created with 6 GW of annual capacity additions
- Lower installation rates are limiting job creation across the wind value chain, with increased installations expected to unlock substantial job opportunities

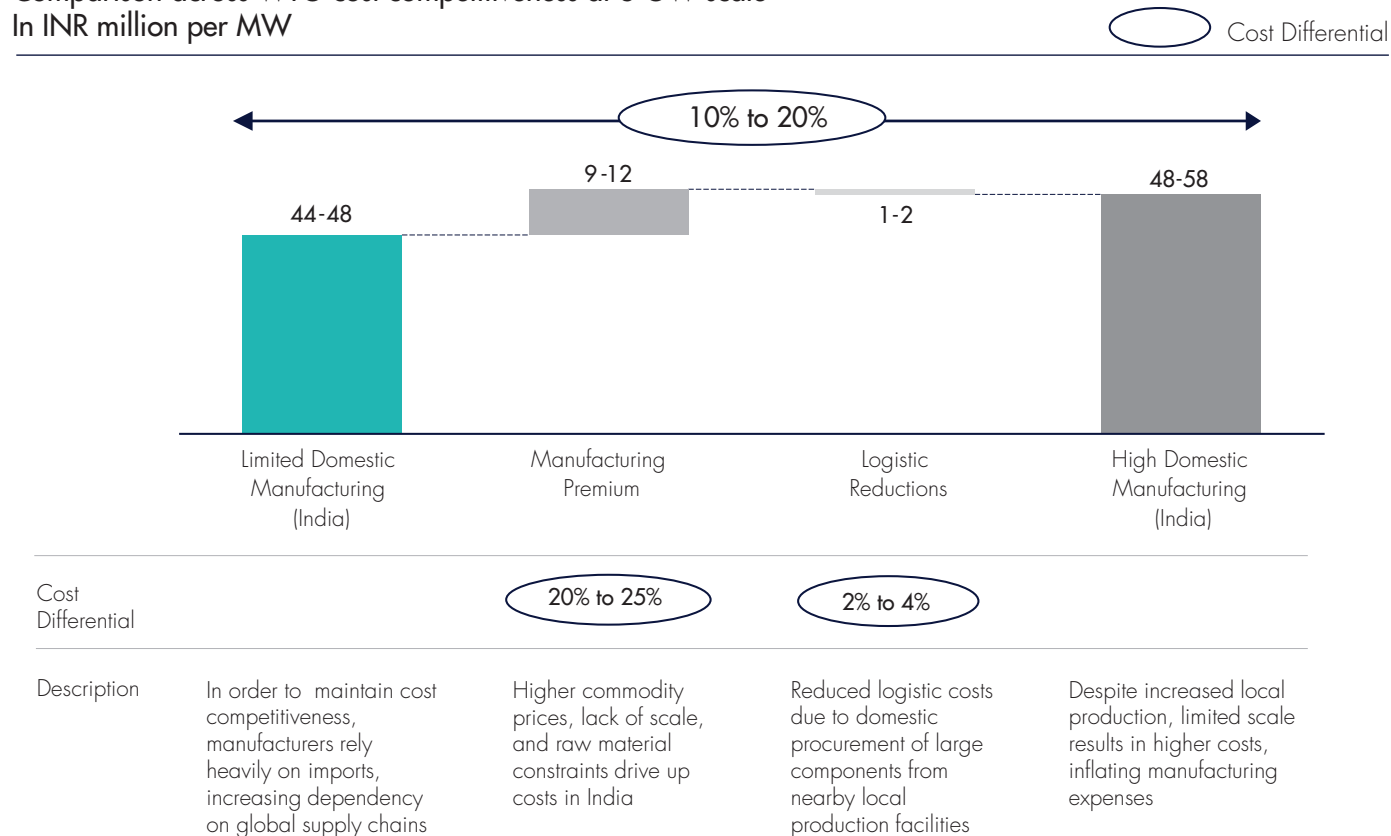
Job type	Definition and assumptions
<b>Business Development</b>	This includes jobs required for project bidding, client acquisition, land identification/acquisition, and addressing legal, financial, and regulatory aspects
<b>Design and Pre-construction</b>	This reflects jobs required for site testing, wind resource analysis, land acquisition, and designing the wind farm layout
<b>Construction and Commissioning</b>	This includes jobs required for turbine procurement, installation, grid integration, and commissioning of the wind farm
<b>Operations and Maintenance</b>	This includes jobs required for monitoring turbine performance, conducting regular maintenance checks, and ensuring efficient operation

Note: \*O&M jobs are based on 48.2 GW of installations in Jan to Dec 2024 as compared to the envisaged volume of 50.7 GW in 2024. This is 2.5 GW lower than envisaged leading to lower number of jobs. All job calculations are based on the NRDC-CEEW report. O&M jobs are 0.5 jobs per MW, multiplied by cumulative installations. Construction & commissioning jobs are annual, with 3.1 jobs per MW. Design, pre-construction, and business development are annual, with 0.6 and 0.3 jobs per MW, respectively. Jobs refer to full time equivalent (FTE) employment for 1 year. Apart from the four identified categories, manufacturing jobs also exist.

Source: India's expanding clean energy workforce, NRDC-CEEW; Global wind workforce outlook, GWEC; MEC+ analysis

## Due to low scale, Indian turbines that rely heavily on domestic manufacturing are 10–20% less cost-competitive than those leveraging lower-cost imports

Comparison across WTG cost competitiveness at 3 GW scale  
In INR million per MW



- WTG costs in India range from ₹44 million to ₹58 million, with manufacturers relying on imports offer the WTG in range of ₹44–48 million
- However, if key components are sourced domestically at scale with better utilization of manufacturing capacity, costs can come at par with turbines relying on imports

Note: Limited domestic manufacturing assumes manufacturing in India is limited to Tier 1 supply chain (nacelle, blade, tower) while Tier 2 components are imported; High domestic manufacturing assumes high reliance on domestic manufacturing, thus considering local sourcing of all key Tier 2 components as well

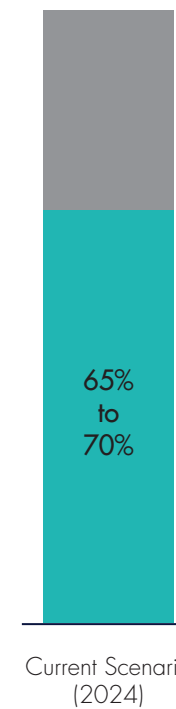
Source: Wood mac; India outlook GWEC; Custom Duty; Primary interviews; MEC+ analysis

## Due to low scale, turbines installed in India have achieved only about 65% local content

### Procurement Landscape and associated local content across key components

Key Component	Local Content	Procurement Rationale
	<div style="display: flex; justify-content: space-around;"> <span>■ Tier 1</span> <span>■ Tier 2</span> <span>■ Domestic</span> <span>□ Foreign</span> </div>	
<p>Tier 1 supply chain is largely localized, but Tier 2 local content remains at ~50% due to cost advantages offered by foreign suppliers and capability gaps with local suppliers</p>		
Tower	100%	Towers are procured domestically by all OEMs, irrespective of the model, due to easy availability, high logistics costs for imports, and mandatory BIS certification requirements
Blade	~90%	Most blades are locally sourced, supported by a strong domestic supply chain & in-house manufacturing capabilities, though new entrants currently rely on imports
Nacelle	100%	Since the 2016 government mandate for local nacelle assembly, all WTGs are domestically assembled, ensuring continued localization
Large Casting	~55%	Strong local capacity supports 2 MW turbines, while limited capabilities for 3 MW+ turbines drive a mixed procurement model
Generator	~45%	Procurement is a mix of domestic and imports, with imports preferred due to cost advantages despite sufficient local manufacturing capabilities
Gearbox	~55%	The gearbox market is concentrated among a few global players, thus dependency on foreign procurement is high
Converter	~30%	Predominantly import-driven due to limited domestic capabilities and IP barriers

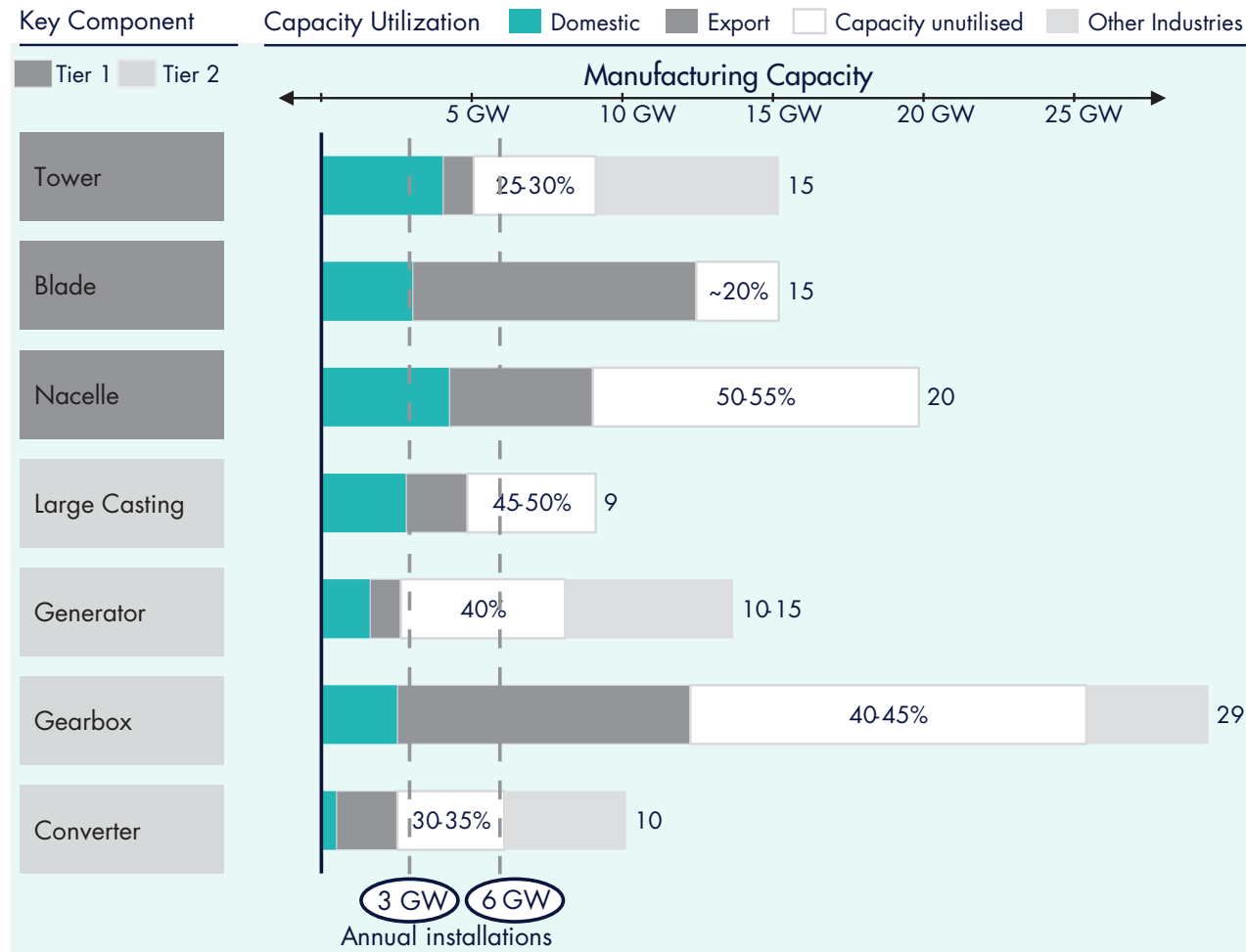
Currently, domestically manufactured wind turbines have approximately 65% local content



Note: Local content as of 2024; The 7 components highlighted above, collectively account for about 70% of the total WTG cost, localization for remaining 30% of the WTG is assumed to range between 50% to 60%; Level of localization is assessed based on whether components are sourced locally or imported. However, if we account for the actual domestic content within these locally sourced components, the overall turbine-level localization drops to around 30%

Source: NIWE Domestic Nacelle Mandate; Company websites; Primary Interviews; MEC+ analysis

## With existing capacity being underutilized, continued reliance on imports highlights the need to build scale and strike a balance between cost competitiveness and strengthening local manufacturing



- Existing manufacturing capacity can comfortably meet 3 GW of demand, with underutilization across components ranging from 20% to 55%
- Despite this, turbine OEMs continue to rely on imports due to cost advantages
- However, ongoing expansions in blades, gearboxes, and nacelles indicate supplier anticipation of rising demand
- To build scale and reduce import dependence, it is critical to strike a balance between cost competitiveness and the effective utilization of domestic capacity

Note: Capacity utilization based on visible demand across domestic component demand in 2024

Source: Company websites; Primary interviews; MEC+ analysis

## Government has renamed RLMM to ALMM (Wind) to bring it at par with ALMM (Solar) in a coordinated and open manner

Policy parity across ALMM policies (Solar vs Wind)





Impact on domestic manufacturing ■ High ■ Medium ■ Low

	ALMM (Solar)	ALMM (Wind)
Policy Objectives and Goals	<ul style="list-style-type: none"> <li>Focuses on building a competitive domestic solar manufacturing ecosystem by mandating quality assurance and domestic content deceleration, reducing import dependency</li> </ul>	<ul style="list-style-type: none"> <li>Aims to ensure turbine quality and grid stability with introducing mandatory use of major wind components from ALMM (Wind Turbine Components) list thus providing a boost to local wind manufacturing ecosystem</li> </ul>
Eligibility Criteria for Manufacturers	<ul style="list-style-type: none"> <li>Enforces strict eligibility by mandating domestic manufacturing validation and adherence to BIS/IEC standards, ensuring high-quality Indian-made products</li> </ul>	<ul style="list-style-type: none"> <li>No stringent domestic content requirements, but has mandated the use of major components from ALMM (Wind Turbine Components) and locating wind turbine R&amp;D center and or servers to strengthen wind energy ecosystem</li> </ul>
Compliance and Certification Processes	<ul style="list-style-type: none"> <li>Enforces strict compliance with BIS/IEC standards, including mandatory audits and BIS certification to ensure high-quality, reliable domestic products</li> </ul>	<ul style="list-style-type: none"> <li>Has fewer compliance checks and no prototype testing mandates for locally manufactured components, raising reliability concerns and encouraging the import of well-tested components</li> </ul>
Financial Incentives and Support Mechanisms	<ul style="list-style-type: none"> <li>Provides government-supported incentives like Production Linked Incentives (PLI), which directly encourage local manufacturing by offering financial support, boosting competitiveness in the global market</li> </ul>	<ul style="list-style-type: none"> <li>Lacks equivalent financial support mechanisms, such as PLI, which could directly impact the growth of indigenous manufacturing in the wind energy sector</li> </ul>
	<p><b>ALMM (Solar)</b> effectively drives local manufacturing and technology improvements by offering structured incentives and enforcing stringent standards, leading to increased domestic production and adoption of advanced technologies</p>	<p><b>ALMM (Wind)</b> has limited focus on localization and technological progress, but with minimal financial support and no mandatory local testing, constraining the growth of a fully localized manufacturing ecosystem</p>

Source: ALMM; RLMM; Domestic solar cell mandate; MEC+ Analysis

## And to provide direct support to R&D for wind turbine technology development within India

### Global R&D Landscape

		Turbine design origin			
		Chinese	European	Indian	Others*
WTG OEMs					
TURBINE RATING	2 MW	✓	✓	✓	✓
	3 MW	✓	✓	✓	✓
	4 MW	✓	✓	Limited	✓
	5 MW	✓	✓	Limited	✓
	Globally, turbine design is led by Chinese and European OEMs, while Indian R&D remains limited to a few players				

Note: \*Others include WTG turbine from Americas and MEA;

Source: NITI Aayog Cyber security, Wood Mac, Company websites, MEC+ analysis

### Potential risks of limited Indian R&D

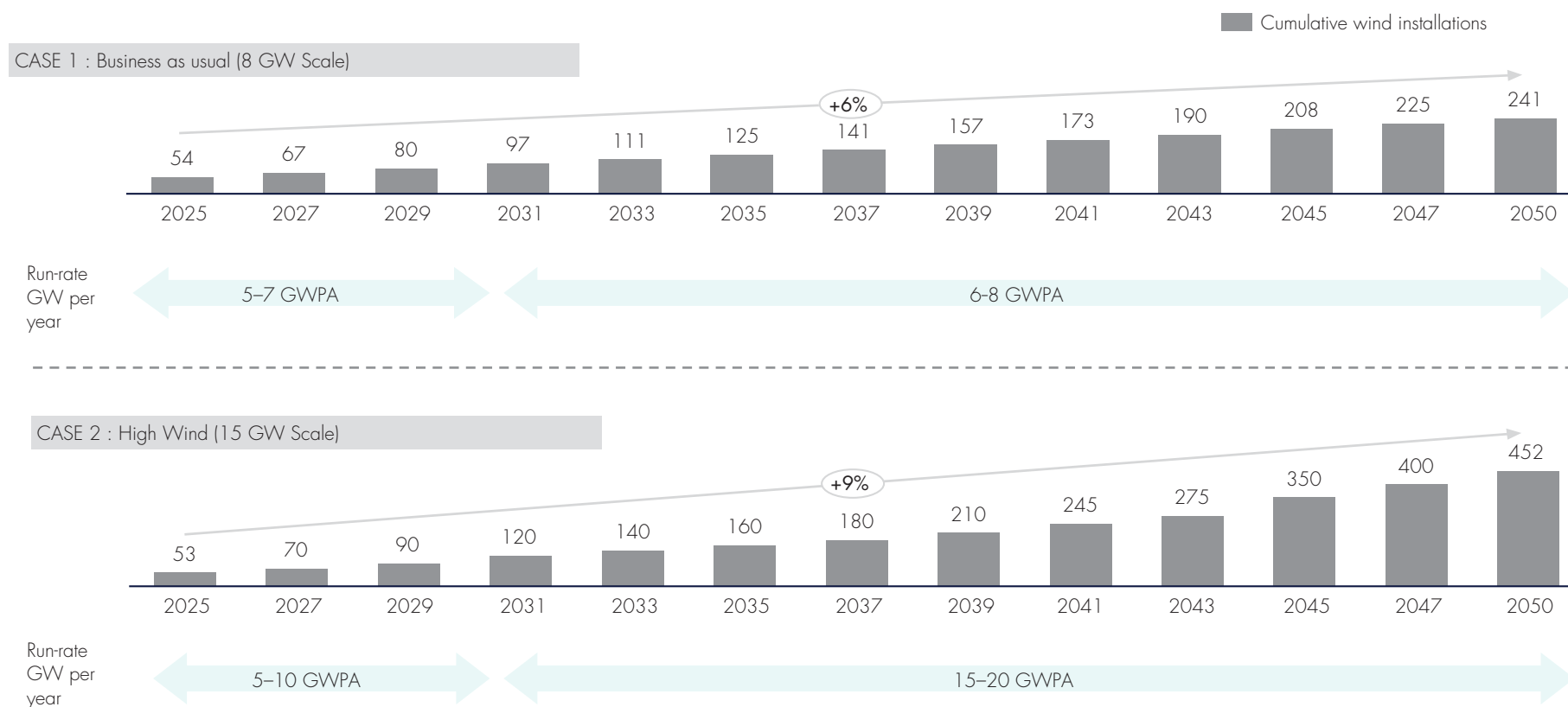
- 1 **Cybersecurity vulnerabilities**
  - Foreign control of critical systems
  - Lack of indigenous security protocols
- 2 **Supply chain limitations**
  - Import dependency of critical components
  - Cost escalation due to global supply chain disruptions
- 3 **Technological stagnation**
  - Outdated turbine designs
  - Inability to customize
- 4 **Grid stability risks**
  - Incompatible systems
  - Delayed response to cyberattacks
- 5 **Policy and regulatory gaps**
  - Certification delays
  - Skill deficit

A photograph of a multi-lane highway curving through a green landscape. In the background, several large wind turbines are visible against a golden, hazy sky. A dark green horizontal band is overlaid across the middle of the image, containing the text "Scaling Wind and its Benefit" in white. The overall scene is bathed in the warm light of a sunrise or sunset.

# Scaling Wind and its Benefit

## Addressing current challenges could scale annual wind capacity additions to 8 GW. But achieving the GOI's 2047 target will require further acceleration to at least 15 GW per year

Wind installation forecast till 2050  
GW

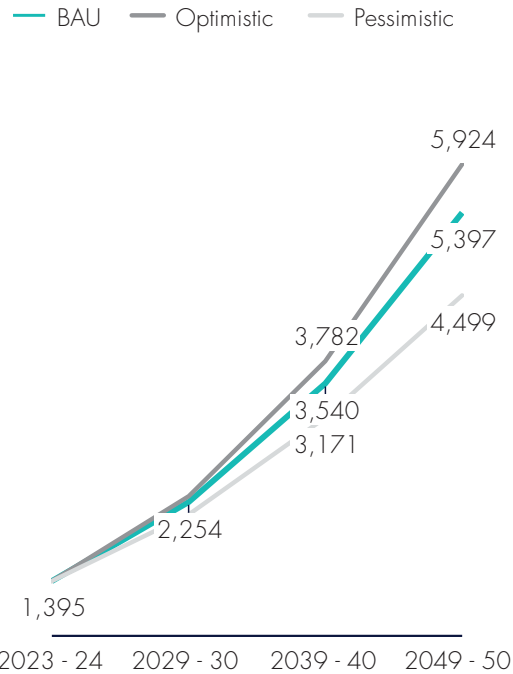


If current challenges are addressed, wind capacity could reach 241 GW by 2050, averaging around 8 GW annually. However, these projections fall short of the government's 2047 target of 400 GW, which necessitates annual installations of roughly 15-20 GW

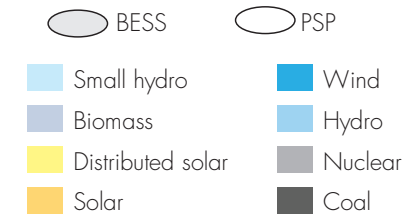
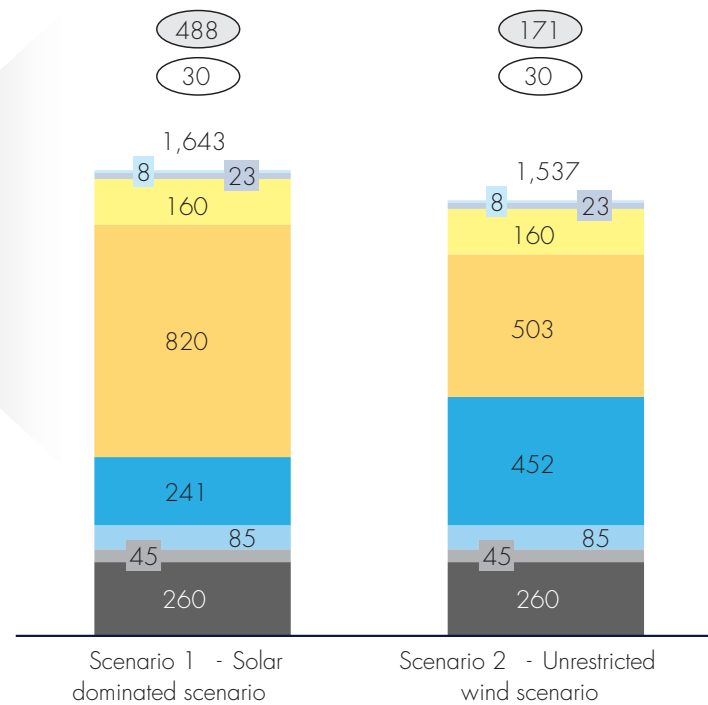
Source: Energy transition for Viksit Bharat 2047; MNRE; SECI tender result announcement; MEC+ auction database; MEC+ Analysis

## A higher amount of wind is expected to ease the pressure on the storage requirements for the system which will be required with solar to manage the transition

Electricity demand scenario of India TWh



Supply scenarios to meet BAU demand of 2050 GW



- Demand scenarios considering the Make in India plan (32 industrial corridors), GSDP growth, and maximum electricity efficiency

- An incremental increase in wind capacity leads to a reduction in battery storage requirements
- Which is further reduced in case wind and solar are co-located

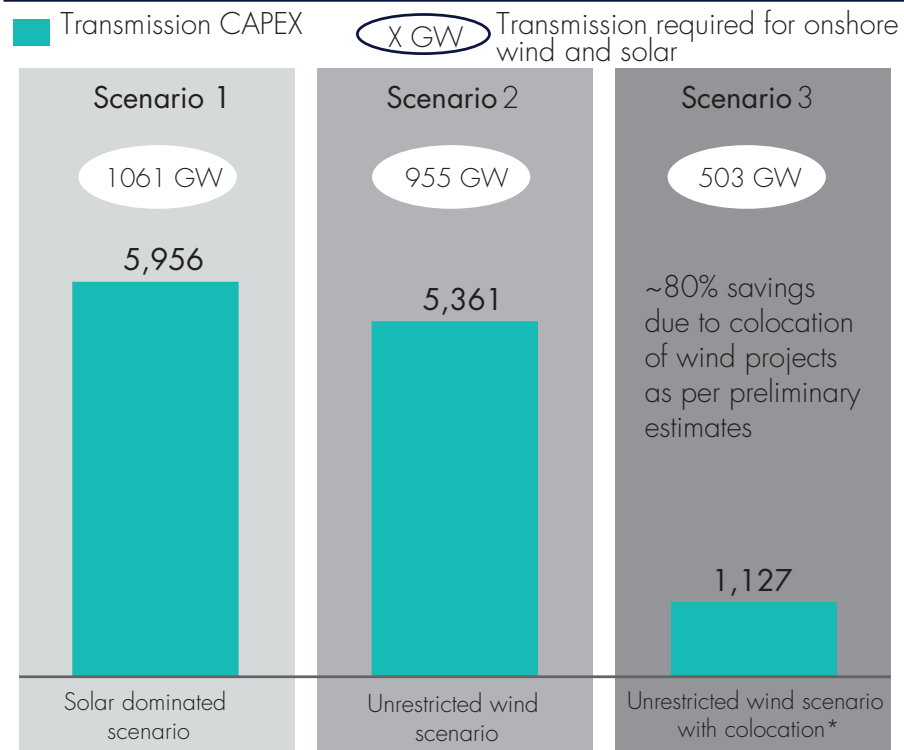
- Preliminary assessments indicate unrestricted wind scenario results in better utilization of the system resources
- Further, analysis is needed to assess the amount of wind that can be integrated into the system especially as other energy options emerge

Note: Assumption: Total generation assumed to be 5397 TWh as per base case estimates of demand. Supply scenario is considering BAU scenario with capacity additions in line with India's historical trajectory. Coal continue to serve as the base-load supply in India in same proportion. Gas additions are replaced with solar and wind; Scenario 3, considering 201 GW of collocated hybrid, requires a total capacity of 452 GW wind and 201 GW solar for its computation;

Source: NREL Least Cost Pathways report; Energy transition for Viksit Bharat 2047; PIB, CEA, MEC+ analysis

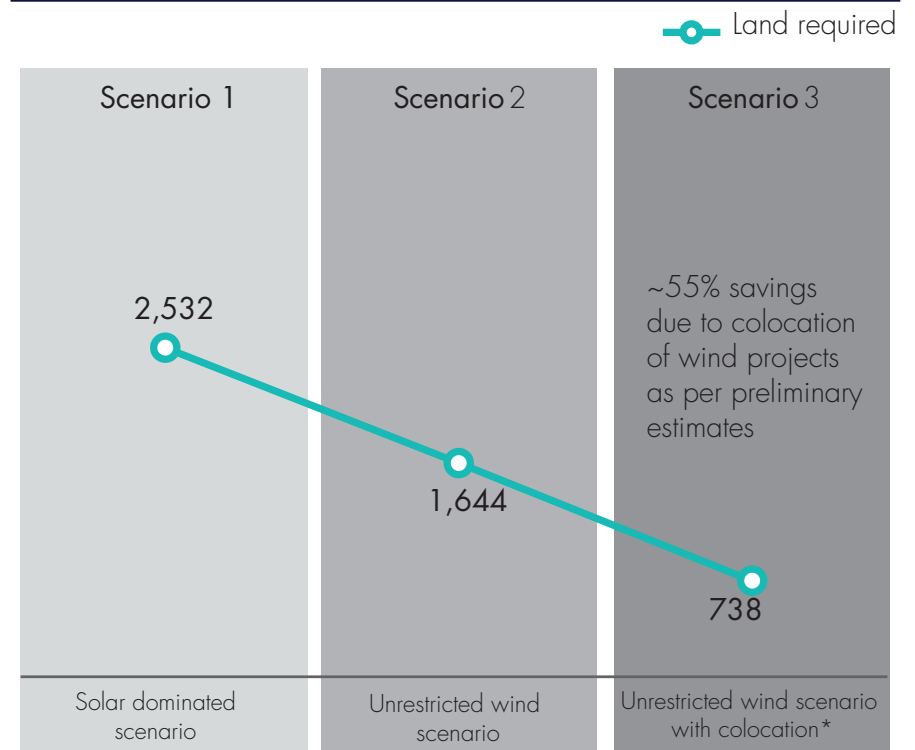
## Which if set up in a co-located RTC system is expected to lower costs by optimizing transmission and land use, yielding greater savings at scale

Transmission infrastructure requirements across different 2050 scenarios  
INR billion



- Co-located hybrid projects efficiently utilize grid infrastructure by leveraging the complementary nature of wind and solar, allowing for the transmission of the same electricity with reduced transmission capacity

Land requirements across different 2050 scenarios  
Th. acres

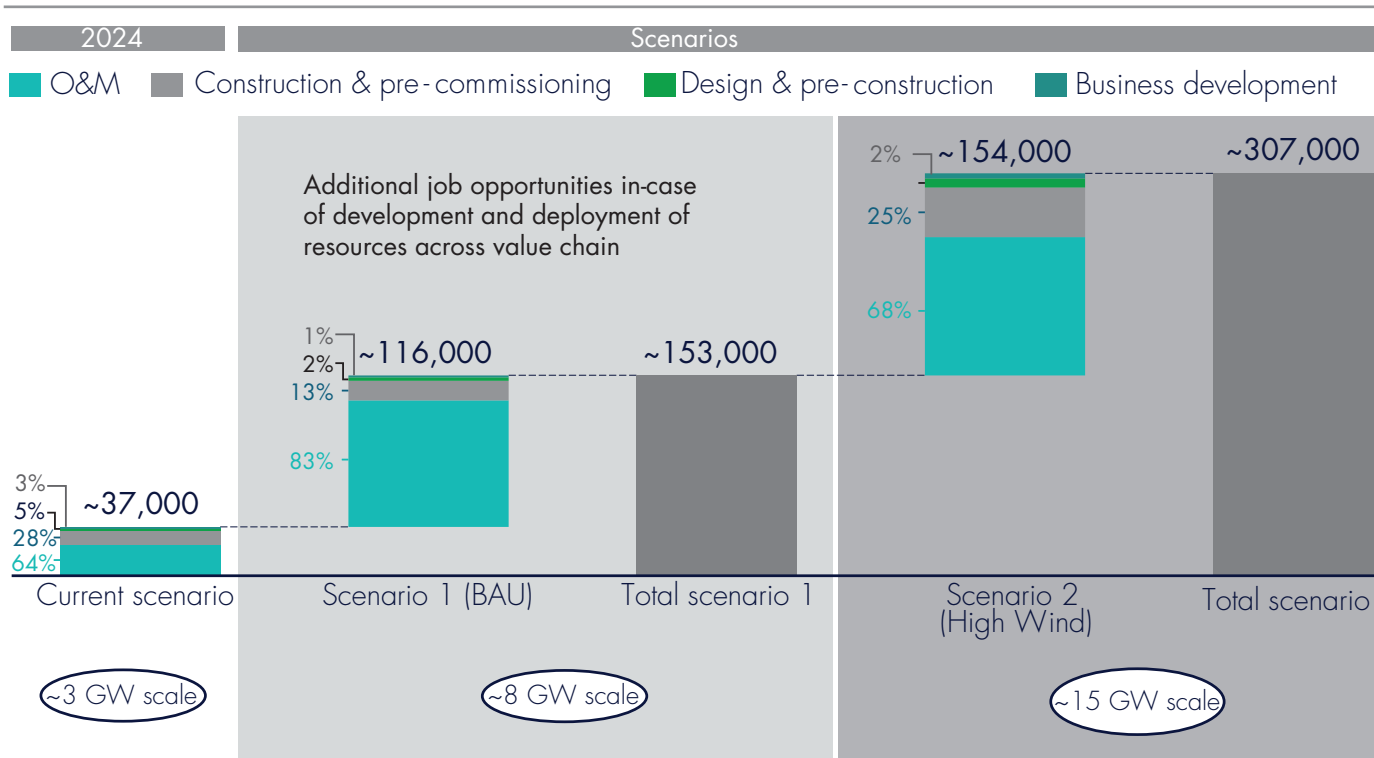


- Solar projects require more land per MW than wind projects. Co-locating both resources reduces overall land use by combining them in the same area

Note: \*Further analysis is needed; Assumption: Wind is considered to have 0.3 acres requirement per MW while solar requires 3 acres per MW; CAPEX required to add 1 MW of transmission infrastructure is taken as 5.6 million  
Source: CEA, MEC+ analysis

## Scaling wind installations will drive direct job creation, generating 1.1 lakh jobs at 8 GW and further doubling at 15 GW scale

Expected direct job creation  
Jobs by activity



- Annual direct wind sector jobs are expected to multiply ~8 fold to become 307,000, driven by increased demand scale
- Currently, 3 GW of annual wind installations generate ~37,000 jobs, but scaling up to 8 GW translate to ~153,000 jobs while 15 GW annually could create ~307,000 jobs per year
- Majority of the jobs are expected to come from O&M and construction & pre-commissioning areas

Note: \*O&M jobs are based on 48.2 GW of installations in Jan to Dec 2024 as compared to the envisaged volume of 50.7 GW in 2024. This is 2.5 GW lower than envisaged leading to lower number of jobs. All job calculations are based on the NRDC-CEEW report. O&M jobs are 0.5 jobs per MW, multiplied by cumulative installations. Construction & commissioning jobs are annual, with 3.1 jobs per MW. Design, pre-construction, and business development are annual, with 0.6 and 0.3 jobs per MW, respectively. Jobs refer to full time equivalent (FTE) employment for 1 year. Apart from the four identified categories, manufacturing jobs also exist.

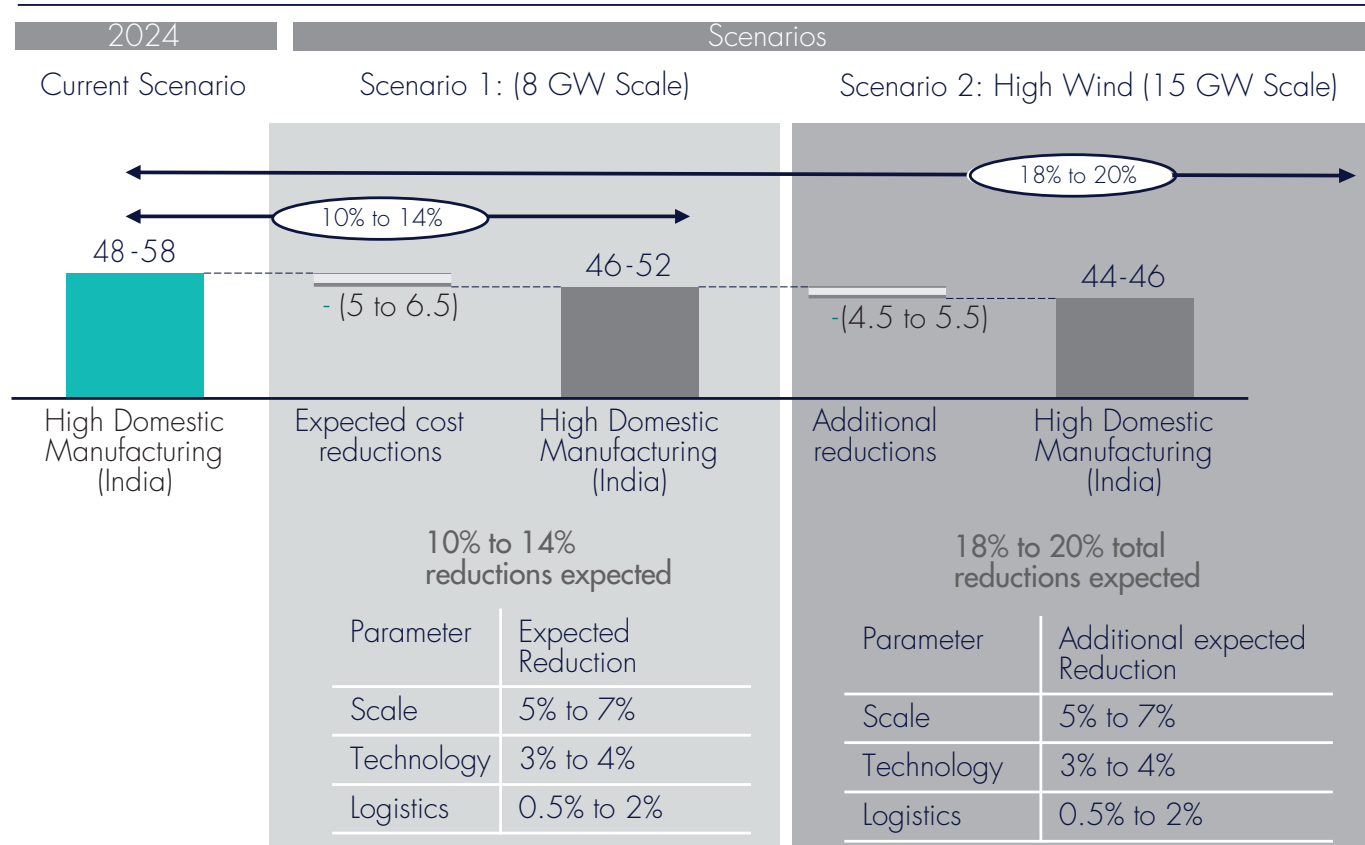
Source: India's expanding clean energy workforce, NRDC-CEEW; Global wind workforce outlook, GWEC; MEC+ analysis

## Scaling wind installations will enhance cost competitiveness, improving by ~10% at 8 GW and reaching up to 20% at 15 GW annual scale

Expected cost competitiveness  
 INR million per MW

Reductions due to  Scale  Technology advancement  Logistic optimization

○ Cost Differential



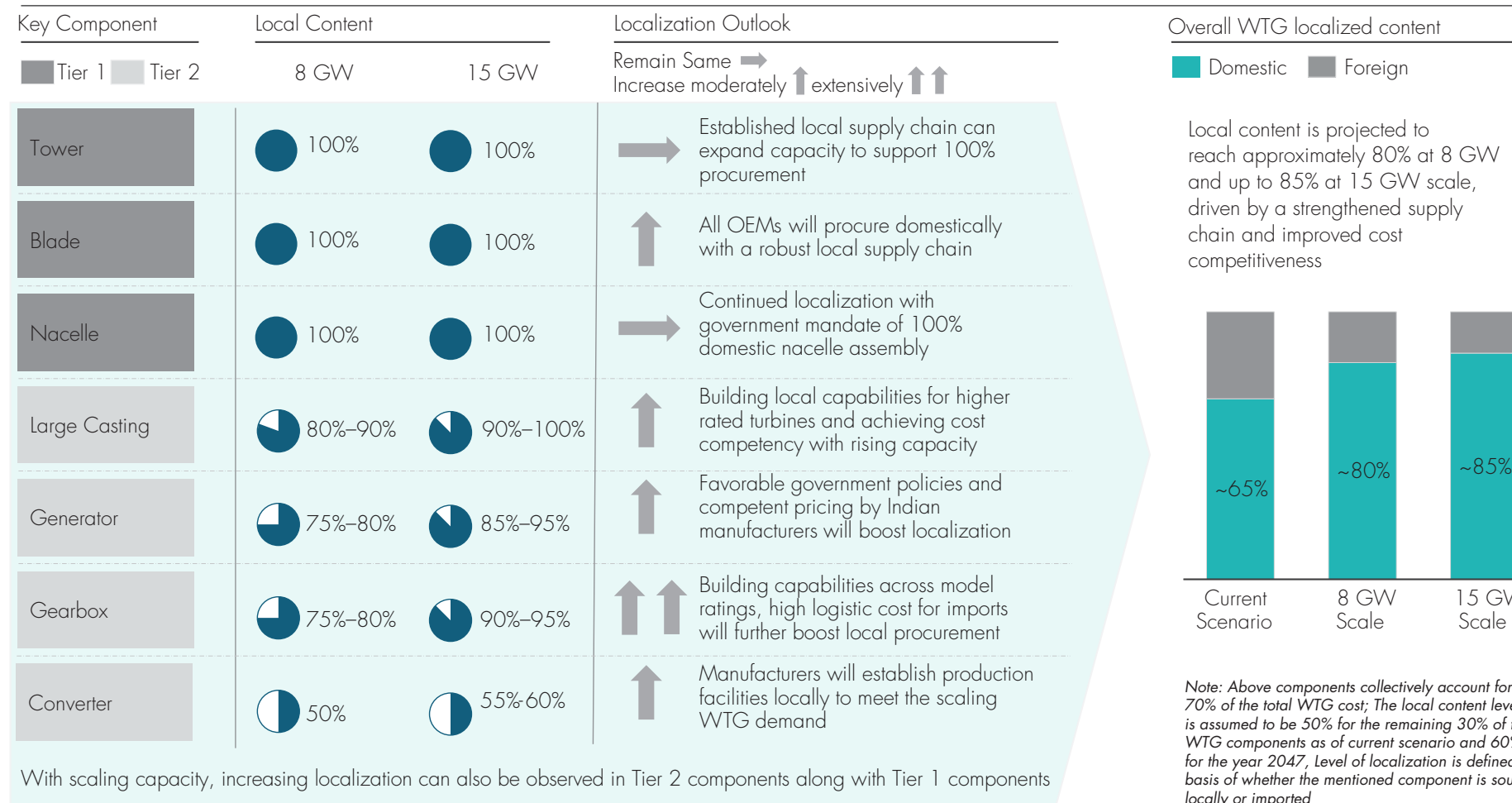
- Wind turbines manufactured in India can achieve greater cost competitiveness, with costs reducing by 10% at an 8 GW scale and up to 20% at a 15 GW scale
- These reductions will be driven by economies of scale, technological advancements (transition from 3 MW to 5 MW+ turbines), government support, and logistics optimization

Note: Assumptions for computing future cost competitiveness: 1) Overall turbine cost, that contribute to 55% of CAPEX costs will collectively reduce as forecasted by Berkeley Lab (~20% by 2050) driven by scale, technology advancement and optimized transportation 2) WTG manufacturing costs in sync with LCoE will reduce at a rate slightly less than global average of 7% (as India is a low-cost country) 3) Cost reductions due to technology know-how will be in sync with past cost reductions 4) Logistic cost reductions will be in lines to LCoE reductions, i.e. around 7% of logistic costs

Source: Learning rate (IRENA); IRENA study for 2025; 2050 scenario by Berkeley Lab; NREL: Wind Energy Cost; MEC+ analysis

## Scaling wind installations will boost local content by driving domestic manufacturing scale, raising it to 80-85%

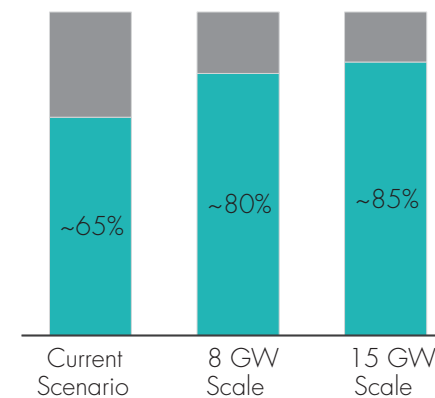
### Expected Local content across WTG components



### Overall WTG localized content

Domestic Foreign

Local content is projected to reach approximately 80% at 8 GW and up to 85% at 15 GW scale, driven by a strengthened supply chain and improved cost competitiveness



Note: Above components collectively account for 70% of the total WTG cost; The local content level is assumed to be 50% for the remaining 30% of the WTG components as of current scenario and 60% for the year 2047, Level of localization is defined on basis of whether the mentioned component is sourced locally or imported

Source: NIWE Domestic Nacelle Mandate; Company websites; Primary Interviews; MEC+ analysis



# Abbreviations

<b>ALMM</b>	Approved List of Models and Manufacturers	<b>FY</b>	Financial Year	<b>NITI</b>	National Institution of Transforming India	<b>SECI</b>	Solar Energy Corporation of India
<b>BAU</b>	Business as Usual	<b>GEOA</b>	Green Energy Open Access	<b>NIWE</b>	National Institute of wind energy	<b>SCOD</b>	Scheduled Commercial Operation Date
<b>BU</b>	Billion Unit	<b>GW</b>	Gigawatt	<b>NREL</b>	National renewable energy laboratory	<b>SJVN</b>	Satluj Jal Vidyut Nigam Limited
<b>BESS</b>	Battery Energy Storage System	<b>GWEC</b>	Global Wind Energy Council	<b>NTPC</b>	National Thermal Power Corporation	<b>TERI</b>	The Energy and Resources Institute
<b>C&amp;I</b>	Commercial & Industrial	<b>IEA</b>	International Energy Agency	<b>OW or OSW</b>	Offshore wind	<b>TW</b>	Terawatt
<b>CAGR</b>	Compound Annual Growth Rate	<b>IEX</b>	Indian Energy Exchange	<b>O&amp;M</b>	Operations and Maintenance	<b>TWh</b>	Terawatt Hour
<b>CAPEX</b>	Capital Expenditure	<b>IRA</b>	Inflation Reduction Act	<b>PPA</b>	Power Purchase Agreement	<b>UNGA</b>	United Nations General Assembly
<b>CCDC</b>	Concessional custom duty certificate	<b>ISTS</b>	Inter State Transmission System	<b>PSA</b>	Power Sale Agreement	<b>URES</b>	Unrestricted Renewable Energy Scenario
<b>CEA</b>	Central Electricity Authority	<b>INR</b>	Indian Rupee	<b>PHS or PSP</b>	Pumped Hydro	<b>URET</b>	Uniform Renewable energy tariff
<b>CERC</b>	Central Electricity Regulatory Commission	<b>JEDI</b>	Jobs and Economic Development Impact	<b>PV</b>	Photovoltaic	<b>WTG</b>	Wind turbine Generator
<b>CFE</b>	Carbon Free Energy	<b>KW</b>	Kilowatt	<b>RE</b>	Renewable Energy	<b>VGF</b>	Viability Gap Funding
<b>CRES</b>	Constrained Renewable energy Scenario	<b>LBNL</b>	Lawrence Berkeley National Laboratory	<b>REIA</b>	Renewable Energy Implementing Agency		
<b>CTU</b>	Central Transmission Utility	<b>LCoE</b>	Levelized Cost of Energy	<b>RES</b>	Renewable Energy System		
<b>CUF</b>	Capacity Utilization Factor	<b>MCP</b>	Market Clearing Price	<b>R&amp;D</b>	Research and Development		
<b>CY</b>	Calendar Year	<b>MMS</b>	Module Mounting System	<b>RPO</b>	Renewable Purchase Obligation		
<b>DFIG</b>	Doubly Fed Induction Generator	<b>MNRE</b>	Ministry of Renewable Energy				
<b>DISCOM</b>	Distribution Company	<b>MU</b>	Million Unit	<b>RLMM</b>	Revised List of Models and Manufacturers		
<b>FDRE</b>	Firm and Dispatchable Renewable Energy	<b>MW</b>	Megawatt	<b>RTC</b>	Round the Clock		
<b>FDI</b>	Foreign Direct Investment	<b>NEP</b>	National Electricity Plan				
		<b>NFS</b>	No Fossil Scenario				

# Definitions

- **Carbon Free Energy:** It refers to the electricity that doesn't directly emit carbon dioxide and comes from sources like solar, wind, geothermal, hydropower, nuclear, and biomass
- **CUF (Capacity Utilization Factor):** Ratio of the actual output from a power plant over the year (kWh) to the maximum possible output from it for a year (kWh) under ideal conditions
- **Decarbonization:** 'Decarbonization' refers to reducing 'carbon intensity', lowering the amount of greenhouse gas emissions produced by burning fossil fuels. Generally, this involves decreasing CO<sub>2</sub> output per unit of electricity generated
- **Evening Peak:** It refers to a period during the late afternoon or early evening hours when electricity usage is significantly higher than other times of the day
- **Hybrid++:** It refers to tenders that have requirements beyond the combination of wind and solar but require a certain profile output such as peak power requirement, round-the-clock profile, or load-following requirements, i.e., block-wise CUF requirements.
- **Hybrid projects/tenders:** It is energy projects that use two or more energy sources for power generation. For example, SECI hybrid projects use solar and wind in combination
- **LCoE:** The levelized cost of electricity (LCoE), is the net present value of the unit-cost of electricity over the lifetime of a generating asset
- **MCP:** Market Clearing Price, which is based on the cost of producing one MWh of electricity. This varies daily based on the energy mix, demand, and supply within each ISO
- **MMS:** It refers to the physical frame or fixture used to securely hold solar panels in place, whether on a rooftop, the ground, or a pole, ensuring they are positioned optimally to capture sunlight and providing structural stability to the solar system
- **Morning Peak:** It refers to a period during the early morning hours where electricity usage significantly spikes, typically occurring when most people wake up and begin their daily activities like turning on lights, making coffee, and using appliances, placing a high demand on the power grid at that time
- **Net-zero:** A target of completely negating the amount of greenhouse gases produced by human activity, to be achieved by reducing emissions
- **Pumped Storage Projects:** It is a form of clean energy storage(hydro) that is ideal for electricity grid reliability and stability.
- **Renewable purchase obligation (RPO):** Under Section 86(1) (e) of the Electricity Act 2003 and the National Tariff Policy 2006, renewable purchase obligation (RPO) is a mechanism by which the obligated entities are obliged to purchase a certain percentage of electricity generated from renewable energy sources as a percentage of the total consumption of electricity
- **URET:** It is the tariff computed by the implementing agency separately every month for each category of the central pool under URET, at which the intermediary procurer will sell power from renewable energy from that central pool to all the end procurers
- **Utility:** Electric lines or electrical plant, and includes all lands, buildings, works and materials attached thereto belonging to any person acting as a generating company or licensee under the provisions of this Act
- **VGF:** Viability Gap Funding (VGF) is a financial support scheme that helps make infrastructure projects commercially viable. It's used when a project is economically desirable but doesn't have enough financial backing.

# Legal Disclaimer

In rendering our advisory service MEC Intelligence and its subsidiaries have solely relied on information given to us orally and written.

The work was done over a period spread through February 2025 to March 2025. We have taken into consideration the knowledge made available to us and the knowledge available to us previously to evaluate the businesses.

This report is supplied on the understanding that it is solely for the use of Client, subject to the terms of the Agreement as per the Letter of Proposal (LOP)

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