FROM LOCAL WIND POWER TO GLOBAL EXPORT HUB

INDIA WIND ENERGY MARKET OUTLOOK 2023-2027

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About MEC+

MEC+, also known as MEC Intelligence, is a specialist consulting firm focused on the wind and renewables sector for the last 10 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.

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For further queries, please visit www.mecintelligence.com

About GWEC

The Global Wind Energy Council (GWEC) is the global trade association for the wind power 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.

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Abbreviations

AMPC	Advanced Manufacturing Production Credit
AD	Antidumping duty
ALMM	Approved List of Models and Manufacturers
BCD	Basic Custom Duty
CY	Calendar Year
CUF	Capacity Utilisation Factor
CAPEX	Capital Expenditure
CEA	Central Electricity Authority
CTUIL	Central Transmission Utility of India Limited
CMCT	City Maintenance & Construction Tax
C&I	Commercial & Industrial
CAGR	Compound Annual Growth Rate
CCDC	Concessional Custom Duty Exemption Certificate
COP	Conference of Parties
CIT	Corporate Income Tax
CVD	Countervailing Duty
CRMA	Critical Raw Materials Act
DISCOM	Distribution Company
EU	European Union
FY	Financial Year
GW	Gigawatt
GWEC	Global Wind Energy Council
GST	Goods and Services Tax
GUVNL	Gujarat Urja Vikas Nigam Limited
IPP	Independent Power Producer
INR	Indian Rupee
IRA	Inflation Reduction Act
IEA	International Energy Agency
IGST	Interstate Goods and Services Tax
ISTS	Inter-State Transmission System
kWh	Kilowatt-hour
LATAM	Latin America
LCOE	Levelised Cost of Energy
L1	Lowest price
MW	Megawatt
MEIS	Merchandise Exports from India Scheme
MNRE	Ministry of New & Renewable Energy
MOP	Ministry of Power
NIWE	National Institute of Wind Energy
NTPC	National Thermal Power Corporation
OW	Offshore Wind
OEM	Original Equipment Manufacturer
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PGCIL	Power Grid Corporation of India Limited
PLI	Production Linked Incentive
RoDTEP	Remission of Duties or Taxes on Export Products Scheme
RE	Renewable Energy
RPO	Renewable purchase Obligation
RfS	Request for Selection
RLMM	Revised List of Models & Manufacturers
RTC	Round-the-clock
SECI	Solar Energy Corporation of India Limited
UK	United Kingdom
USA	United States of America
UMCT	Urban Maintenance & Construction Tax
VAT	Value Added Tax
WTG	Wind Turbine Generator
YoY	Year on Year

Definitions

Decarbonisation	'Decarbonisation' tends to refer to the process of reducing 'carbon intensity', lowering the amount of greenhouse gas emissions produced by the burning of fossil fuels. Generally, this involves decreasing CO2 output per unit of electricity generated.
Hybrid Projects / tenders	Energy projects that use two or more energy sources for power generation. For example, SECI Hybrid Projects use solar and wind in combination
Net Zero	A target of completely negating the amount of greenhouse gases produced by human activity, to be achieved by reducing emissions.
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 a purchase certain percentage of electricity from Renewable Energy sources, as a percentage of the total consumption of electricity.
Distribution Licensee	A licensee authorised to operate and maintain a distribution system for supplying electricity to the consumers in his area of supply.
Supply Chain	A supply chain is a network of individuals and companies who are involved in creating a product and delivering it to the end user customers or other businesses.
Pipeline / pipelining	Pipelining is an ongoing, continuous process in which new instructions, or tasks, are added to the pipeline and completed tasks are removed at a specified time.
Calendar Year	The period of time beginning on January 1 and ending on December 31 of each year.
Financial Year	FY is a 12-month accounting period starting from April 1 and ending on March 31 of each year.
Base case scenario	The base case refers to a fundamental or standard scenario that is used as a starting point or reference for analysis, decision-making, or evaluation. It represents the most likely or realistic situation based on the available information and assumptions. The base case serves as a benchmark against which other scenarios or variations can be compared or assessed.
Ambitious case scenario	An ambitious case scenario refers to a situation or projection that assumes favourable or positive outcomes. It is a best-case or highly positive. It represents an idealistic view of the future with the belief that conditions will be highly favourable and result in the best possible outcomes.
Conservative case scenario	A conservative case scenario refers to a situation or projection that assumes unfavourable or negative outcomes. It represents a cautious or sceptical view of the future, with the belief that circumstances will be challenging and result in the least favourable outcomes.

Foreword

As temperatures reach record-highs around the world this year, there is gathering momentum among governments for the global energy transition. Global renewable energy capacity must triple by the end of the decade to at least 11 TW to keep a 1.5°C window alive. This calls for an unprecedented acceleration of large-scale wind and solar power to mitigate the most harmful effects of climate change. International leadership and cooperation will be critical to achieving this 2030 goal.

This year, India presides over the G20 grouping of the largest economies of the world representing 85% of global GDP and 80% of global carbon emissions. In this role, India can convene countries around the shared need to scale up wind energy, which is already transforming communities around the world with clean electricity, green jobs and an influx of public/private capital to propel economic growth. It must be clearly understood that renewables are not only the best solution we have to fight climate change, but also to drive sustainable development and industrial policy.

Global leadership in the energy transition must begin at home for India. Already the fourth-largest wind market in the world, India has tremendous potential to expand its domestic wind capacity. High-level targets have been set to reach 500 GW of renewable energy capacity by 2030, including 140 GW of wind energy. But recent annual growth has been dampened, averaging 1.74 GW over the last five years, due to bottlenecks around grid, downward price pressure and land availability.

As this report demonstrates, policy corrections could enable an ambitious scenario of more than 26 GW in wind installations over the next five years through 2027. Authorities are already taking promising steps to realise a faster pace of growth, such as revising the wind tender mechanism from a reverse-bidding model to a closed-envelope model earlier this year, and publishing a clear roadmap for annual auctions in 2024 split by agency and quarter.

The strength of India's domestic market will in turn determine whether the country emerges as a power player in the wind industry's global supply chain. Given the expansive growth for wind power ahead, GWEC foresees that global supply chain constraints will materialise from 2026 onward, due to a gap between the sector's production capacity and forecast deployment pipelines. India can play a critical role here to ramp up manufacturing and export of wind components to supply the industry in Asia and beyond.

Meanwhile, ongoing international dynamics – geopolitical tensions, an inflationary environment and

Ben Backwell

CEO, Global Wind Energy Council

the lessons learned from the price spikes and bottlenecks of the pandemic – have prompted countries to undertake a strategic shift to bolster local renewable energy supply chains. Industrial packages like the US Inflation Reduction Act and the EU Green Industrial Deal are designed to strengthen local supply chain investment and re-shore production activity. Against this backdrop of events, India has plenty of comparative advantages as a wind industry hub, such as an existing manufacturing base, favourable location for export and relatively attractive cost of labour.

But to capitalise on India's wind potential at home and its opportunities to become a global supply chain power, a few key actions will be needed:

1. **Enable the green open access market for the C&I segment**, to ensure economic routes for energy-intensive users to access green electricity.
2. **Prioritise the resolution of operational and grid-related challenges** with support for both ISTS and non-ISTS projects by state governments through a win-win partnership among key stakeholders.
3. **Ensure compliance of the wind RPO** to support the uptake of wind power, and aggregate trajectories set by states to overall targets of the country.
4. **Consider logistics corridors and indexation to ease supply chain challenges** in project implementation, and account for commodity price fluctuation to support the timely and cost-efficient commissioning of projects.
5. **Promote domestic innovation in wind manufacturing** through innovation and R&D grants. A targeted production linked incentive (PLI) scheme for the wind sector could also incentivise investment in components to increase the vertical integration of the domestic manufacturing industry and improve quality of locally supplied components.
6. **Lower import duties on raw material and work-in-progress goods** for the wind sector to create a more regionally and globally competitive cost of manufacturing for India in the wind industry. It would also help to ease documentation and approvals for the duty drawback scheme and leverage Free Trade Agreements (FTAs) to design and implement wind exports corridors for domestic manufacturers.
7. **Nurture an offshore wind ecosystem** in Gujarat and Tamil Nadu to set the foundation to achieve the Government of India's seabed lease tender trajectory of 37 GW in this decade.

This year's report theme – "From local wind power to global export hub" – conveys the strategic opportunities which India can seize if enhanced government ambition and a strong plan for implementation are in place. Scaling up the transition at home can then demonstrate the transformative social, environmental, industrial and economic benefits brought by wind and renewable energy to other G20 members and countries.

I heartily express congratulations to the GWEC and MEC+ teams for this timely and relevant report. Finally, I extend GWEC's support to the Government of India to host a successful G20 Leaders' Summit later this year, and realise its renewable energy ambitions in this decade.

Foreword

As the planet continues to warm and extreme weather conditions become more frequent, the need for radical collective actions to bend the emissions curve cannot be emphasized enough. In this spirit, the theme of India's G20 Presidency, ''Vasudhaiva Kutumbakam'' or ''One Earth· One Family · One Future'', is an implicit message to build greater global consensus for climate action, including climate change mitigation.

As per the IRENA Energy Transitions Outlook 2023, in the 1.5 degree scenario, global installed power generation capacity must have 77% and 94% of renewable energy in 2030 and 2050 respectively. The global deployment of renewable energy sources including wind energy must increase multi-fold. IRENA has projected 2040 GW of onshore wind and 500 GW of offshore wind deployment by the end of this decade. Earlier GWEC's Global Wind Report 2023, emphasized the historic milestone of 1 TW of global wind power deployment reached this year. Another TW is likely to be achieved within this decade. Translating these projections into reality implies proactive policymaking that will enable fast-paced tendering, commissioning of projects and a greater supply chain reliance.

Under the leadership of Hon'ble Prime Minister Narendra Modi Ji, India has undertaken decisive measures for enhancing the share of renewable energy in the generation mix, including wind energy which currently accounts for slightly more than 10% of the country's overall power generation capacity. In 2023, the central government notified a trajectory to auction 10 GW of annual wind capacity for the next few years this decade. The Ministry of Power notified ''Guidelines for Tariff Based Competitive Bidding Process for Procurement of Firm and Dispatchable Power from Grid Connected Renewable Energy Power Projects with Energy Storage Systems'' in June 2023. The centre also released a roadmap for strengthening the availability of the grid network for renewable energy capacity addition in this decade. It is worth commending how the Ministry of New and Renewable Energy (MNRE) has consistently been holding monthly meetings with central, state and industry stakeholders to address issues as well as to take feedback in order to accelerate deployment of wind energy projects.

This edition of the India Wind Energy Market Outlook 2023-2027 stresses the need for accelerated efforts by the industry and the government to achieve the 2030 target. As compared to the 140 GW target, several agencies have projected the likelihood of 100 GW of cumulative capacity due to various reasons that have been discussed in this edition. The Outlook also presses

Sumant Sinha

Chairperson GWEC India, and Founder, Chairman and CEO, ReNew

for a greater balance between manufacturing for domestic and export markets. There is a need for facilitating targeted incentives, for example to the castings segment, for quality upgradation as well as capacity enhancement. Global Wind Energy Council's Global Wind Report 2023 has already indicated likelihood of supply chain shortfalls in the US and Europe, and that the spare capacity in the industry being exhausted by 2026 if timely corrective measures are not undertaken through consensus-building.

A renewed policy environment, likelihood of diversification of wind actions across high-potential states and a thrust on decarbonization in the C&I segments are certainly reasons for renewed optimism. Together, wind energy capacity addition and scale-up of manufacturing capacities shall further drive job creation and investment opportunities in the country.

I congratulate the GWEC India and the MEC+ teams for yet another enriching and relevant edition of the Outlook which spells out priorities for the wind sector in India and presents a comprehensive picture of interventions that must be convened collaboratively to drive sub-national, national, regional and global clean energy transition priorities.

Foreword

Sidharth Jain

Founder and CEO, MEC+

India's wind power industry is poised to harness a number of opportunities. The prospects of growth in the domestic market and shift in the international supply chain requirements, provide an opportunity for Indian companies to increase their participation in the global supply chain.

Domestic volumes are on the up, and policy measures are in line with advocated changes

In 2022, the Indian market exhibited a robust expansion with the award of 4.7 GW tenders including standalone wind and wind-solar hybrid projects in state and central tenders. Between Jan to June 2023, nearly 3.5 GW tenders have been awarded and another 5 GW has been announced. The introduction of tenders by both central and state government agencies and the high engagement of C&I developers point towards promising growth. The government policy has emerged supportive of the requirements of developers. The central government has announced a Renewable Purchase Obligation (RPO) trajectory, a grid augmentation plan, and various measures to enhance pricing in wind tenders. This support has been complemented by the states' commitment to wind procurement – creating a transparent and sustainable pipeline.

New growth pillars towards 2030 are emerging, but short-term execution challenge forecasts

The development of the offshore wind market and the hydrogen ecosystem in India are emerging as key drivers for growth. Together, these advancements lay the foundation for a vibrant industry, setting the stage for a target of creating a 10 GW market for wind installations in India by 2030.

However, our analysis adopts a more conservative approach, as some of these policies are still under development, estimating the market to reach the 5 GW range due to potential challenges such as:

- Delays that happen in transmitting the central level policies to DISCOMs
- Local issues that significantly impact the cost of land, evacuation, and transportation of turbines along with high costs of equipment
- Issues regarding uniformity of open access rules

India is in a favorable position among global supply chain shifts

The global emphasis on climate change has increased the demand for RE projects. The lessons learned from the COVID-19 pandemic have underscored the need to diversify and expand the existing supply chain.

India, with its strategic geopolitical position and scale, has become a

prime destination for global players seeking to establish a manufacturing base. This trend is likely to strengthen as the enabling ecosystem develops in India.

Supply chain requires infrastructure and scale to emerge as one of the top 2-3 manufacturing locations globally

To fortify this opportunity, enhancing the supply chain's competitiveness is paramount. Over recent years, domestic volume constraints have compelled companies to pivot towards export of components. But as domestic volumes potentially triple from a three-year average of 1.5 GW to 4-5GW, and the demand for diversified wind component exports grows, the focus must shift towards reinforcing the supply chain.

In this edition of the report, we have delved into the various issues that are on the mind of supply chain companies considering exports and upgrade of capabilities. We present a comprehensive overview of the opportunities, the barriers to succeed, and why is now the time for the industry.

Our recommendations for the industry include:

- Ensuring that domestic market expands to encourage high volume and competitive production of tier-2 wind components and raw materials
- Creating Free Trade Agreements and refining tax and documentation procedures to get competitive access to raw materials and technologies
- Improving the ability to access to technology required to build next level models
- Reviewing and improving infrastructure to facilitate the transportation and storage of the large sized components

Through a combination of insightful analysis and industry feedback, this report aims to provide an understanding of the wind power trajectory in India and the avenues available for the industry. We hope as you delve into the report, you get equipped to navigate the realities.

Foreword

The pursuit of net-zero emissions and the drive for energy security are propelling the global revolution towards renewables. Leading this movement is India, the fourth-largest country in terms of renewable energy capacity. With 42% of its total energy capacity coming from non-fossil fuel sources, India has firmly established itself as a leader in advancing the transition to clean energy. This transformation is underpinned by a combination of progressive policy support, robust public-private partnerships, and the rapid growth of India's manufacturing capabilities.

The goal of achieving net-zero emissions by 2070 is reshaping India's energy landscape. Wind energy has emerged as a key catalyst for growth, contributing a substantial 43GW to the country's energy portfolio and registering a two-fold growth rate in the last decade. This success underscores India's increasing prowess in wind energy manufacturing. The government's recent policy aimed at adding 10GW of wind energy capacity annually until 2030 has further provided significant momentum to the industry. The shift from the reverse bidding mechanism is also expected to accelerate the pace of installations. Moreover, the integration of green hydrogen production with wind energy has opened new avenues for the sector's advancement. Building upon these positive developments, the wind industry is optimistic about its pivotal role in helping India achieve its climate objectives.

Looking to the future, new opportunities will accelerate the progress of the wind energy sector. India's extensive 7,600 km coastline presents an untapped opportunity for offshore wind energy. Further, policy initiatives aimed at establishing renewable energy parks can expedite the setup of necessary infrastructure. Additionally, advancements in large-scale battery storage research are crucial to address the intermittent nature of renewable energy sources.

I appreciate the efforts of GWEC for driving renewable energy advocacy globally and in India in particular. I congratulate GWEC and MEC+ in releasing ''India Wind Energy Market Outlook 2023-27,'' which provides a crucial overview and insights about wind energy in India.

By fostering strong collaboration between government, industries, and institutions, we can accelerate the widespread 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!

Kane Xu

Chairman, Envision Energy India

Executive Summary

The long-term growth and health of India's economy will depend on access to clean, reliable, and affordable power for all, as well as a strong manufacturing sector to support the renewable energy industry. This year's wind energy outlook outlines India's multiple domestic and international opportunities to capitalise on wind market growth and drive progress towards these goals.

India's wind market status and trends

In 2022, India installed 1.8 GW of onshore wind capacity – lower than the 2.2 GW in the conservative case of the previous edition of this outlook report. The shortfall was due to nearly 400 MW of project commissioning shifting from end of 2022 to March 2023, due to grid readiness and Right of Way issues. The capacity added during 2022 is an increase of 300 MW from 2021, and an increase of 500 MW from 2020. This brings cumulative installations of wind energy in India to 41.9 GW, as of December 2022.

India issued 10.4 GW of wind and standalone tenders in 2022, of which 4.7 GW was awarded, including 2.9 GW from central auctions and 1.8 GW from state auctions. The central pipeline for 2022 could have been higher if the L1+2% criteria was waived, as 700 MW of tenders could not be awarded due to price mismatch criteria. A welcome trend during 2022 was the inclusion of state tenders in the above pipeline after a long time – GUVNL and Kerala awarded standalone wind tenders[1] and hybrid tenders were announced by Madhya Pradesh, Maharashtra and Delhi.

The outlook to 2027

As outlined in Sections 4 and 5 on the market outlook for onshore and offshore wind, India's active wind pipeline at the end of June 2023 stood at 12.9 GW (including standalone wind and estimated wind component of hybrid tenders), with 10.7 GW from central tenders and 2.2 GW from state tenders.

Renewable Purchase Obligations (RPO) of Distribution Companies (DISCOMS) and the central government trajectory will drive the growth of wind installations. The Ministry of Power (MoP) has given an RPO target to DISCOMs of estimated 57.5 GW by 2027; 33.1 GW is already installed as of 2022, leading to a gap of 24.4 GW which needs to be fulfilled by 2027. State regulators have already set an RPO target of 19 GW, against which the state DISCOMS have committed to procure 17 GW from wind so far. These numbers will fuel future tenders and lead to further increase of the pipeline.

To give clarity on scale, during 2023 the Ministry of New and Renewable Energy (MNRE) announced a bidding trajectory of 50 GW renewable

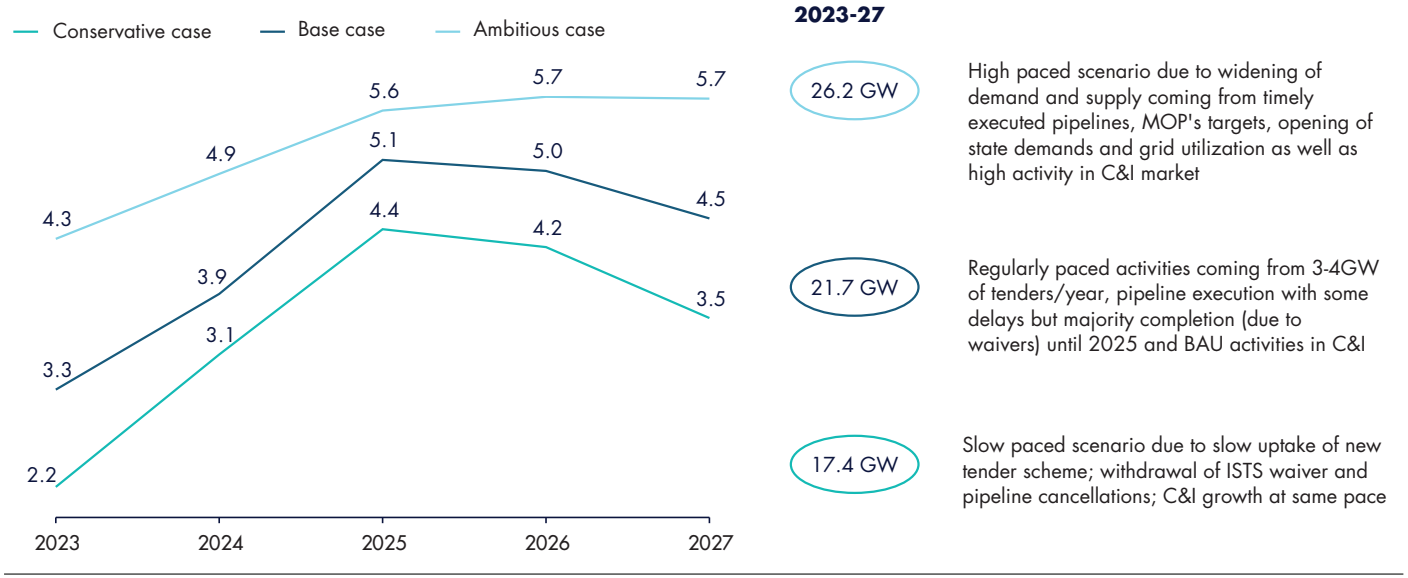
1 Kerala tender later cancelled – 60 MW wind project by KSEBL

auctions per year until FY 2028. Out of these auctions, 10 GW of exclusive tenders were carved out for wind and designated implementing agencies with a calendar of implementation.

Planning is underway for multi-fold GW upgrade of transmission infrastructure. The government plans to take up the grid infrastructure available to wind to 111 GW by 2030. Out of this, 94 GW is planned to be made available by 2027, 34 GW is already under construction and 6 GW is available.

Combining the existing pipeline of 12.9 GW, RPO obligations, bid trajectory announcements, and grid planning, India's wind market in likely to see an upswing in coming years. However, considering the past experience of time taken to align policy and budgets, project delays, issues in Right of Way, and tight financing requirements, delays or even cancellations cannot be entirely ruled out.

Figure I Onshore Wind Installation Forecast & Scenarios
GW



Note: As per calendar years; forecasts are inclusive of hybrid projects
Source: State Annual Revenue Requirement (ARR) under Tariff order published annually; RPO documents; Transmission system for integration of over 500 GW RE capacity by 2030; MEC+ Analysis

The total cumulative wind energy capacity in India by 2027 is expected to increase to ~63.6 GW and could range from 59.3-68.1 GW, depending on several factors and conditions across this report's conservative case, base case and ambitious case scenarios.

In terms of offshore wind, a strategy paper from MNRE in 2022 announced plans to award 37 GW in tenders towards 2030 in the states of Gujarat and Tamil Nadu. There are three models for offshore wind development that have been shared, which are explored in Section 4 of this report. Development of the offshore wind market and an emerging hydrogen ecosystem will complement growth of the wider wind industry, and propel wind into a more significant role in India's power mix after 2030.

Shaping India into a global export hub for wind power

Currently, India has an estimated 11 GW of annual nacelle capacity. With capacity additions of nearly 5-6 GW projected, the market will still have spare capacity, which can be targeted towards the regional and global wind

market. Annual global onshore wind installations are likely to increase from 69 GW in 2022 to 122 GW in 2027. The increase of 53 GW in nacelle assembly requirement can provide opportunities to build and export nacelles from India, particularly to serve the US market and new wind geographies in the Asia-Pacific, Africa and Middle East regions.

Beyond nacelles, there are attractive opportunities in components. Companies are heavily reliant on China for sourcing components: China accounts for 60%, 65% and 75% of global supply chain for blades, generator and gearbox manufacturing. India is in a favourable position to expand as it already has a manufacturing base which provides nearly 11%, 7% and 12% of the respective global manufacturing capacity for these components.

Given the lessons learned in supply chain security from recent events, including the COVID-19 pandemic, ongoing China-US trade tensions and geopolitical risks, India can serve to mitigate supply chain issues for global manufacturers as a location for friendly shoring. However, challenges must be overcome to seize these opportunities.

- First and foremost, India needs to create a strong and sustainable domestic market; interactions with industry stakeholders for this report reflect that it is difficult to invest in a geography solely for export, when that country lacks a robust domestic market.
- Second, India must align manufacturing capabilities to overlap with global product portfolios and roadmaps. While towers and blades demonstrate significant overlap with global sizes, nameplate capacity needs to ramp up to align with global platforms.
- Third, India needs to demonstrate cost leadership to develop as a global export hub. Indian turbines are 30-60% more expensive than their Chinese counterparts in the same product class. Indian turbines with majority imported components assembled in India are 30% more expensive than those manufactured in China, while locally manufactured WTGs come with a further 30% cost premium. Key here are differences in the cost of raw materials and access to components.
- Last, India needs to make its export incentives more accessible to boost export orientation. The current incentives for exports are difficult to access; the wind industry has highlighted a minimum 6-18-month cycle to secure the duty drawback on the paid duties for exported materials. The lengthy documentation process and multi-level clearance prolong the process and impact working capital.

These challenges can be mitigated as industrial scale increases and aligns to the regional and global demands for manufacturing. Section 8 of this report outlines several concrete recommendations for policymakers to reinvigorate the domestic wind industry and drive towards an ambitious case scenario for growth, as well as create the conditions for India to become a global export hub.

As India pushes towards its 2030 renewable energy goal and its long-term target of net zero by 2070, wind power is poised propel the country's economic growth and clean energy transition. This momentum can only be strengthened if the government of India undertakes a holistic strategy to shore up large-scale investment in the domestic market while accentuating its comparative advantages for the global export market.

1. India's wind energy sector: Background

India needs to meet its high-growth targets and climate goals

Access to clean, reliable, and affordable power for all, from households to industrial consumers, is important to advance economic growth. This makes the availability of adequate power infrastructure imperative for the long-term health of the Indian economy.

India's electricity demand is expected to grow at a CAGR of ~7% until 2032[2], driven by factors such as the push for 'Make in India', rapid urbanisation, and economic growth. The Government of India has also announced an ambitious set of goals for climate change mitigation and the clean energy transition during the COP26 summit held in November 2021 – ''Panchamrit'', which includes[3]:

- 500 GW of installed renewable energy by 2030, which includes 280 GW of solar power and 140 GW of wind power;
- 50% of energy requirements from renewable sources by 2030;
- The reduction in total projected carbon emissions by 1 billion tonnes between 2022 and 2030;
- The reduction of the carbon intensity of the economy by 45% by 2030; and
- Achieving the target of net zero by 2070.

More than one-third of India's electricity capacity comes from wind power

By the end of 2022 – with eight years to go to reach these targets – total installed power generation capacity[4] in India stood at 410 GW, out of which 121 GW was from renewable sources (excluding large hydro) amounting to ~30% of total installations. Out of the total renewable energy installed, wind contributes 35% (41.9 GW, including 9 GW from the C&I segment), second to solar[5]. This makes India the fourth-largest wind market in the world, in terms of cumulative installed capacity.

In 2022, the total wind installations added were 1.8 GW (see Figure 1). This contrasts with activity in the solar sector, which installed 12.9 GW in 2022 and saw rapid YoY growth primarily due to technological advancements leading to lower costs.

To revitalise the wind pipeline in India, the government has made a series of interventions in 2022 and early 2023. In July 2022, MNRE notified the MOP of the RPO trajectory until FY 2030, with a specific carve-out for wind RPOs increasing from 0.81%[6] in FY 2023 to 6.94 %in FY 2030. The move was designed to create a separate demand bucket for wind from other renewable energy sources. To support this schedule, the ministry further revamped the auction mechanism for wind. In January 2023, the government eliminated the reverse bidding mechanism[7] for

2 Report on 20th Electric Power Survey of India (EPS) – Volume I, published in November 2022

3 National Electricity Plan (NEP) – Volume I (Generation), published by CEA in March 2023

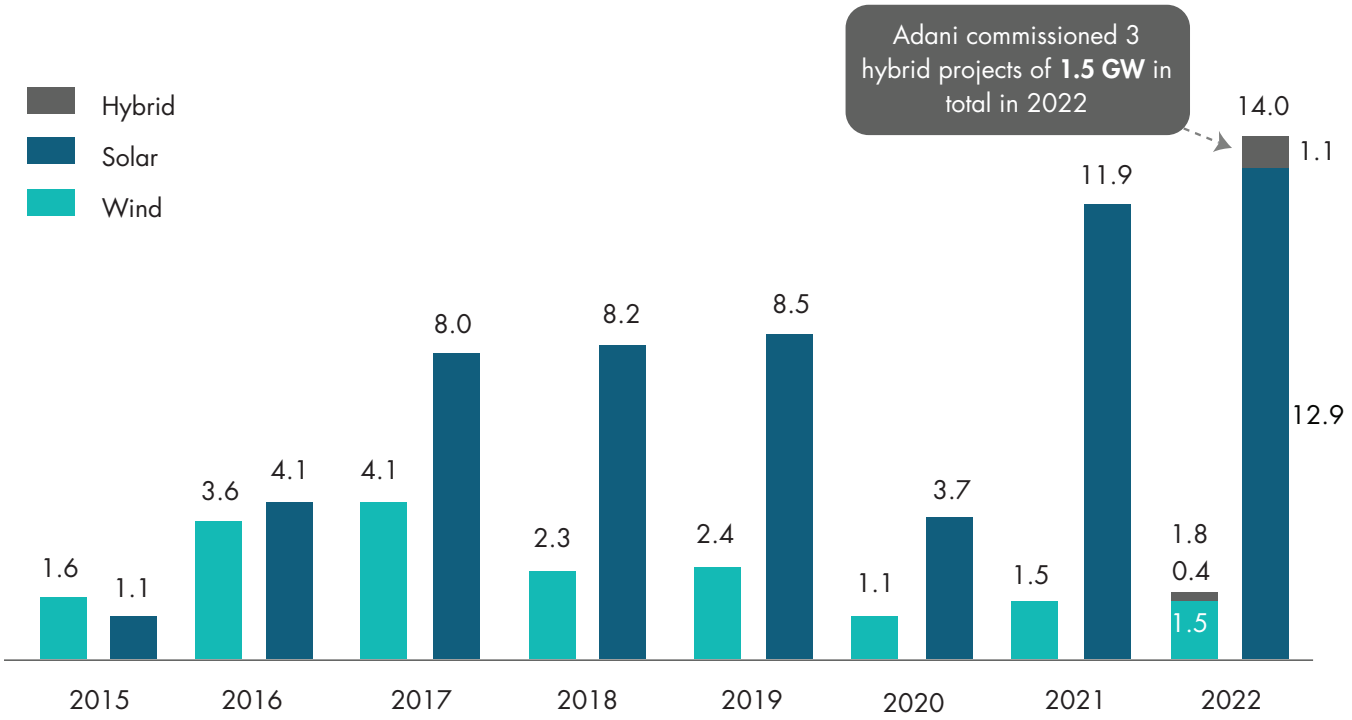
4 As on 31st Dec 2022, India installed capacity of power stations (Utilities) – Monthly report published by CEA

5 Solar contributes ~52% (63.30 GW) in total renewable energy installed (As on 31st Dec 2022 as per CEA monthly installed capacity report)

6 Only projects commissioned post March 2022 to be qualified for wind RPO

7 MNRE notification: https://mnre.gov.in/img/documents/uploads/file_f-16735154559O0.pdf

Figure 1: YoY onshore wind, solar and hybrid installations between CY 2015 to CY 2022
GW



Note: Only Utility scale hybrid projects are considered which includes Adani green energy 3 hybrid projects in FY2022 - Hybrid II in Rajasthan of 600MW (September); Tranche I in Rajasthan of 390 MW (May); Adani Renewable Energy Holding Nineteen Private Ltd. of 450 MW (December)
Source: CEA report – All India installed capacity of power stations (Utilities); Report on under construction Renewable energy projects by CEA; CTUIL report 2023; MEC+ analysis

onshore wind tenders and moved to a single-stage two-envelope bidding mechanism to avoid aggressive bidding creating extreme downward price pressure and utilise wind potential through state-specific auctions[8].

Consequently, at the end of March 2023, the government announced a bidding trajectory of 50 GW renewable auctions[9] per year until FY 2028 to achieve the 500 GW RE target for 2030. Of these, 10 GW of exclusive tenders were carved out for wind[10]. MNRE also designated[11] SECI, NTPC, NHPC and SJVN as Renewable Energy Implementing Agencies (REIAs)[12] for this bidding trajectory and outlined the calendar for auctions in FY 2024 by agency, quarter and technology. In Q1, 2.5 GW of wind tenders are to be issued by SECI[13], which has specified the Maximum Capacity to be awarded under the RfS in 5 states (TN, KA, TS, AP and MH).

Tapping into India's world-class wind potential

India has an estimated 214 GW onshore wind energy potential, with over 30% CUF which must be exploited to drive climate action, energy security, and clean energy ambitions. The revised tender regime gives a renewed thrust to the wind sector to tap into this resource and recover from the slowdown in installations experienced in recent years.

8 Guidelines for Tariff Based Competitive Bidding Process for Procurement Power from Grid Connected Wind Power Projects was notified on 26 July 2023.

9 PIB notification: https://www.pib.gov.in/PressReleasePage.aspx?PRID=1913789

10 Not clearly stated if it includes onshore only or onshore + offshore wind.

11 Office memo: https://mnre.gov.in/img/documents/uploads/file_f-1682405289970.pdf

12 GWEC's publication "Accelerating Onshore Wind Capacity Addition in India to Achieve the 2030 Target", released in 2022, pressed for 8-10 GW of annual tender and designation of public sector entities, beyond SECI, for administering wind tenders. The publication discussed slowdown in wind capacity addition during the reverse auction regime.

13 Notice Inviting tender: https://www.seci.co.in/Upload/New/638209803994394872.pdf

2. India's wind pipeline

As of June 2023, India has a pipeline of 12.9 GW projects awarded as wind standalone or wind component of hybrid projects. Of this volume, 10.7 GW are from central tenders and 2.2 GW are from state tenders.

Renewed interest in recent tenders

In 2022, the total tenders issued for standalone wind & hybrid projects stood at 10.4 GW, higher than the 9.2 GW as of December 2021. Out of this volume, which included standalone wind and hybrid tenders, 4.7 GW tenders were awarded.

The central government auctioned 2.4 GW of tenders[14],[15] in 2022 for standalone installations, which were oversubscribed continuing the trend from 2021 (see Figure 2). Out of this, 1.7 GW was awarded. The gap between auctioned and awarded capacity is attributed to stringent criteria of L1+2%[16], where bids above the criteria were simply rejected. Easing this criteria would have led to an additional 0.7 GW in the pipeline.

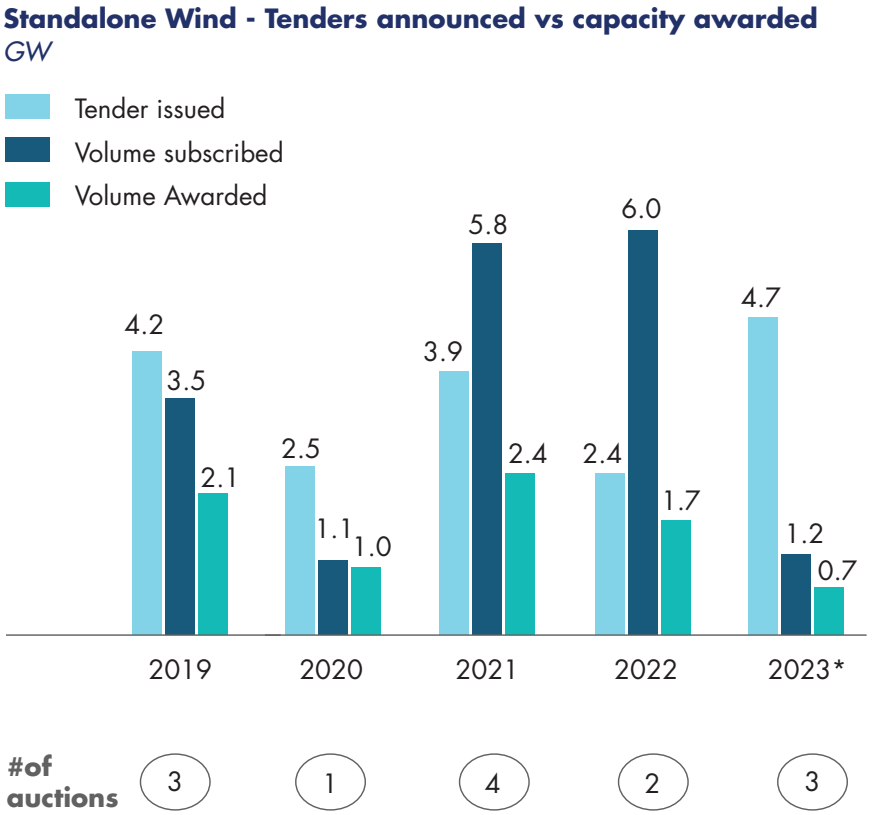
During 2022, central auctions for hybrid projects saw a surge of interest from developers. In the year, 5.7 GW of hybrid tenders were announced of which 1.2 GW was awarded. These were:

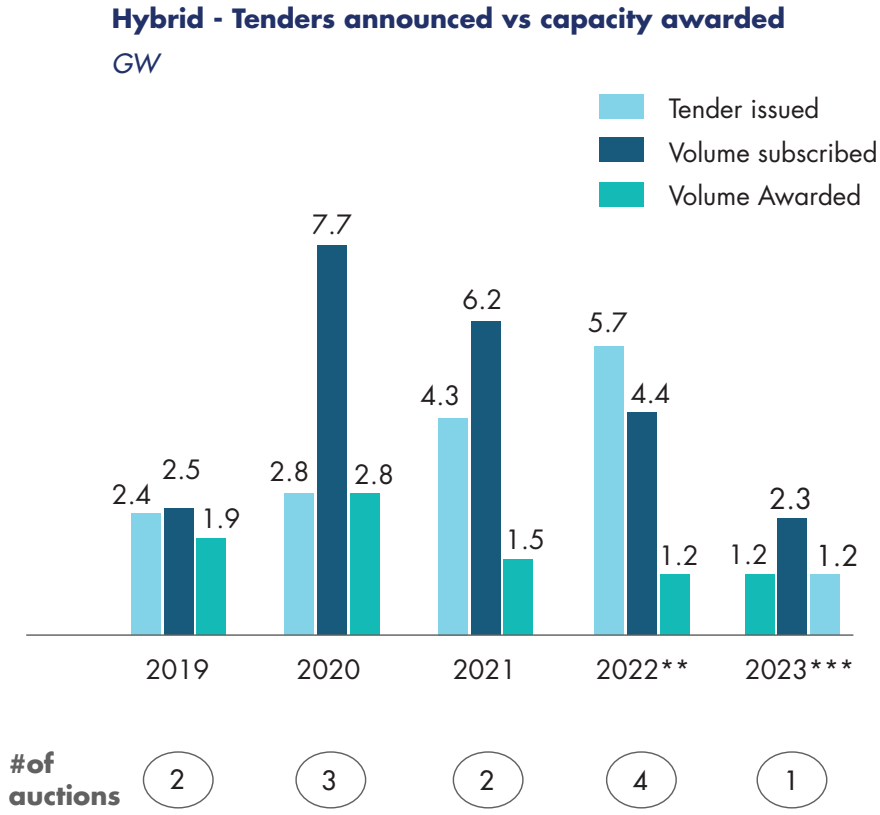
- SECI 1.2 GW ISTS connected wind-solar hybrid project - Tranche V[17] was announced and awarded.
- RTC III (2,250 MW), PTC pan India (1,000 MW) and SECI Tranche IV- Peak Power (1,200 MW) were issued in 2022 but not yet awarded.

SECI announced tranche XIV of wind of 1.2 GW in February 2023 and NTPC announced 1 GW wind project BoS tender in Gujarat in January 2023. Further, to achieve the target of 10 GW in wind tenders every year, the central government issued its first RfS in May 2023 for setting up 2.5 GW ISTS-connected wind power divided into five states: Tamil Nadu, Karnataka, Telangana, Andhra Pradesh, and Maharashtra.[18] Out of the 4.7 GW of announced standalone wind tenders in 2023, only SECI wind tranche XIV has been awarded for 0.7 GW as on June 2023. In addition to this, a hybrid tender- SECI hybrid tranche VI of 1.2 GW was awarded fully in April 2023.

14 SECI 1200 MW ISTS connected wind power project – Tranche XII
15 RfS for setting up of 1200 MW ISTS connected wind power project – Tranche XIII
16 Undersubscribed tender – SECI tranche XIII 1200 MW ISTS connected wind power project
17 SECI 1200 MW ISTS connected wind-solar hybrid project – Tranche V
18 RfS for selection of wind power developers for setting up 2500 MW ISTS connected wind power projects in India under Tariff based competitive bidding (Tranche XV)

Figure 2: Standalone onshore wind & hybrid projects - Central tenders from CY 2019 to CY 2023





Note: Total tender capacity for hybrid project has been considered, acual wind capacity for hybrid projects might different; Tenders issued till May 2023 are considered in CY 2023

*: For CY 2023 standalone wind tender includes 22500 MW ISTS connected wind tender and NTPC 1 GW wind tender for which RfS has been issued, SECI Tranche-XIV of 1200 MW was awarded

**: In case of hybrid tenders in 2022, 4 tenders including RTC III (2250 MW), PTC pan India (1000 MW), SECI Tranche IV (1200 MW), Hybrid Tranche V (1200) has been issued, but only Hybrid tranche V was awarded in 2022

***: In case of hybrid tender issued during CY 23, SECI hybrid tranche VI issued in April 2023 is considered

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

Expanding state tender activity for wind power

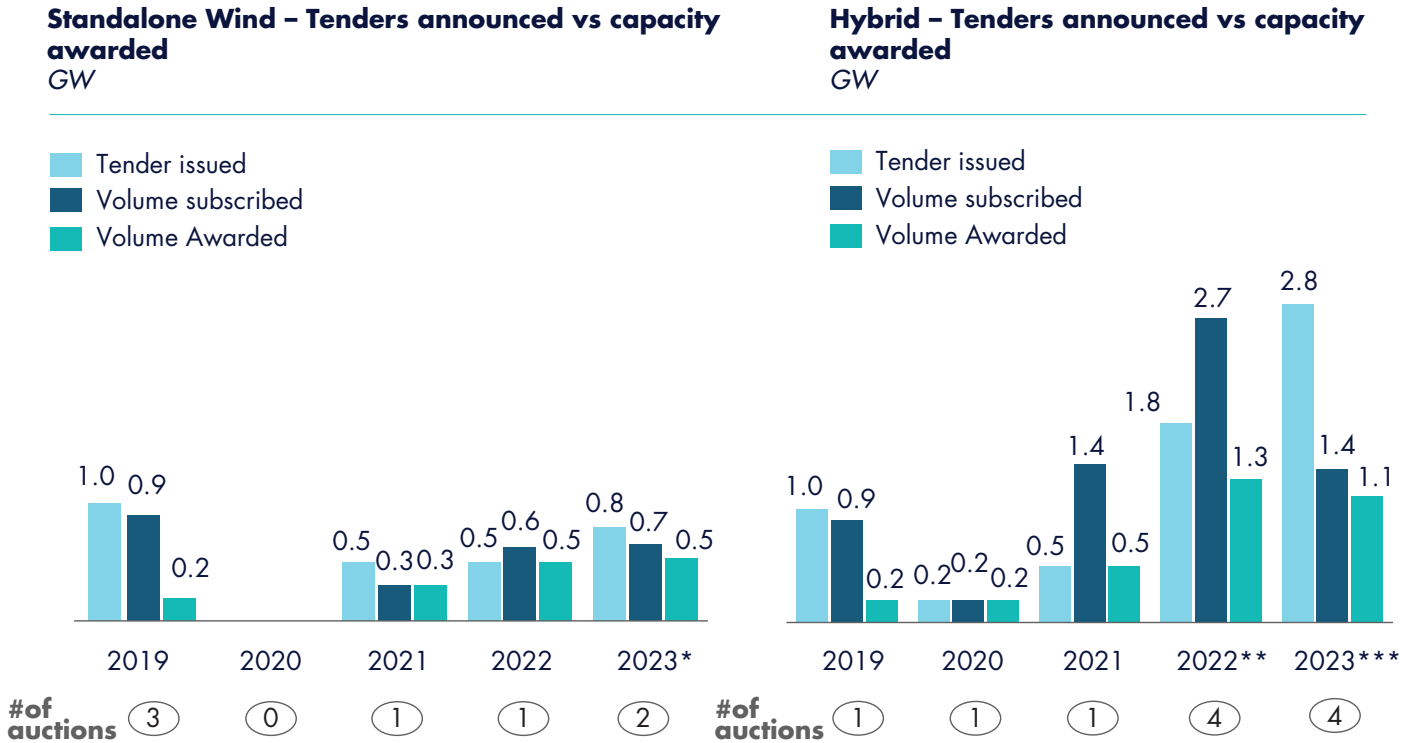
One of the key trends in 2022 was the re-opening of state volumes, largely muted since the start of central tenders. Altogether 0.5 GW of standalone wind and 1.25 GW of hybrid tenders were awarded (see Figure 3).

In 2022, one standalone wind tender, GUVNL- 500 MW, was issued and awarded. Kerala also issued a 60 MW tender, of which only 35 MW was awarded and later cancelled[19]. On the hybrid front, 3 states issued hybrid tenders which totalled to 1.25 GW in 2022, and all were fully subscribed: Madhya Pradesh 0.75 GW[20], Maharashtra 0.25 GW[21] and Delhi 0.25 GW[22].

In 2023, Gujarat continued the momentum by issuing two more standalone wind tenders: GUVNL Tranche IV and V of 300 MW and 500 MW in January and May 2023. Gujarat has been issuing wind tenders since 2017, while other states began to reconsider wind tenders in 2022 after

19 KSEBL – 60 MW wind project, Kerala
20 RUMSL – 750 MW wind-solar hybrid power projects
21 MSEDCL – 250 MW hybrid project
22 Tata Power Delhi Distributions (TPDDL) – 255 MW hybrid project

Figure 3: Standalone onshore wind & hybrid - Total state tenders announced vs capacity awarded



Note: Total tender capacity for hybrid project has been considered, actual wind capacity for hybrid projects might different; Tenders issued till May 23 are considered for CY 2023
*: Standalone wind tender issued in CY23 includes GUVNL Tranche IV and GUVNL Tranche V tender was issued and awarded, but volume of both the tenders got undersubscribed
**: Hybrid tender of CY22 also includes GUVNL Phase XV of 500 MW which was issued but not yet awarded
***: Under state hybrid project total 5 tenders are issued in CY23 including REMCL RTC Pan India 1000 MW, CESC Kolkata 150 MW, AEML 1500 MW, RUVNL 1500 MW (Cancelled) and West Bengal DISCOM 150 MW out of which only REMCL (950 MW) and CESC (150 MW) has been awarded by June 2023
Source: GUVNL; TANGEDCO; MSEDCL; RUMSL; TPDDL; REMCL; CESC; GWEC auction database; MEC+ auction database; MEC+ Analysis

the introduction of national wind RPO targets.

The focus of other states on hybrid tenders continued in 2023, wherein nearly 4.3 GW tenders were issued by various bodies: Railways (1 GW REMCL) and West Bengal (150 MW CESC), Mumbai (1.5 GW AEML) and Rajasthan (1.5 GW RUVNL) contributed to these tenders. Of this, 1.1 GW was awarded in REMCL and CESC West Bengal, while the 1.5 GW tender from RUVNL was cancelled. This shows that the evolution of tender conditions and government support for hybrid projects have led to increased state auction activity.

3. Wind's position in India's energy transition

India needs accelerated deployment and commissioning of wind power projects if it is expected to achieve 140 GW of wind capacity by 2030, and advance towards the long-term goal of net zero by 2070. The three major drivers of wind growth in India are:

- Cost competitiveness of wind in the overall mix;
- Dedicated grid infrastructure for integration;
- Compliance of wind RPO targets by states and other obligated entities; and
- Acceleration in C&I sector demand.

While these will push onshore wind capacity additions, beyond 2030 progress on offshore wind will further propel wind's position in the overall power mix.

With the increasing popularity of solar and wind hybrid projects in the C&I market[23], penetration of wind in the power mix is likely to increase. However, a recent report[24] from the Central Electricity Authority (CEA) indicates that a more cumulative installed capacity of 100 GW might only be achieved by 2030 as compared to the central government's target of adding a cumulative 140 GW installed wind energy capacity by 2030. In the meanwhile, the National Institute of Wind Energy (NIWE) has released "India's Wind Potential Atlas at 150 Above Ground Level" and has mapped a 1164 GW of technical wind power generation potential in pan India.

23 Jindal Steel and ReNew have joined hands to commission a 300 MW hybrid power plant; Amazon is setting up a cumulative 300 MW wind-solar hybrid project in Madhya Pradesh and Karnataka with Vibrant Energy. Tata Power Renewable Energy Limited (TPREL) and Tata Power Delhi Distribution Limited (Tata Power-DDL) have partnered to set up a hybrid project with an expected 340 MW wind capacity; Also, Amplus Solar and EverRenew have been reported to build a 200 MWp open-access wind-solar power plant in Tamil Nadu. Tata Power has reported that the Tata Power Renewable Energy subsidiary has received a Letter of Award to set up a 966 MW Round-the-clock (RTC) Hybrid Renewable Power Project for Tata Steel. Similarly, KPI Green has been reported to have received a letter-of-intent for executing a Wind-Solar Hybrid Power Project of 40 MW (with 21.50 MW wind power) capacity from Anupam Rasayan India, Gujarat. Amp Energy India is likely to set up a 150 MW hybrid power project for CESC Limited.

24 Report on Optimal Generation Mix 2030 Version 2.0 by CEA, published in April 2023

Cost competitiveness of wind energy in India

The average cost of conventional energy-based power is reportedly higher than the power tariff from wind, making wind power already competitive with traditional power sources[25].

However, wind generation costs in the country have recently increased. Bids for standalone wind in Tranche XIV in June 2023 were awarded in the range of INR 3.18-3.24 per kWh as compared to tenders awarded in 2020 which lies in the range of INR 2.99-3 per kWh. India saw a ~10-12% jump in generation costs[26] of wind projects between 2020 and 2022, causing the LCOE to increase from INR 2.8-3.3 per kWh in 2020 to INR 3.2-4.1 per kWh. This can be attributed to rising raw material costs in the supply chain, including steel (which comprises over 70% of raw material used for turbines)[27] and aluminium, logistic bottlenecks, an inflationary environment and fairly high taxes levied on wind turbines. Combining this cost increase with varying CUFs based on the location of projects produces a range of LCOE for wind power.

25 Accelerating Onshore Wind Capacity Additions in India to Achieve the 2030 Target, Global Wind Energy Council, 2022.

26 LCoE number is based on MEC+ analysis.

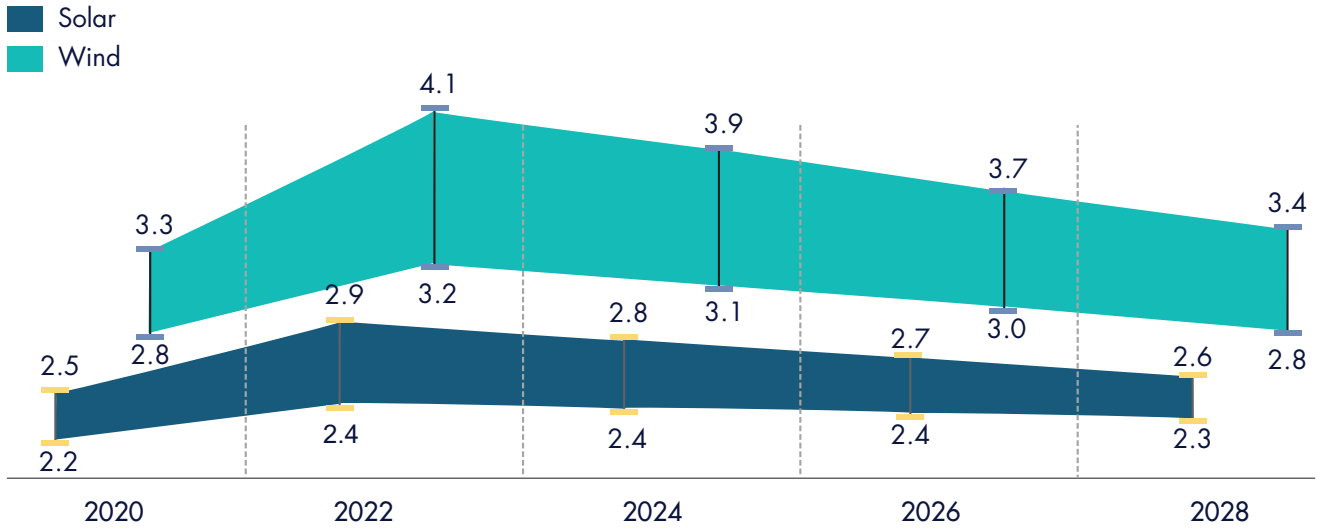
27 Cost of wind energy Review 2015, National Renewable Energy Laboratory (NREL)

For average sites located at Wind Zones II & III (WPD between 250 and 400 W/m^2)[28], an average CUF of ~31%[29] and 3.4 MW wind turbines generally carries an LCOE of INR 4.1/kWh. For the best sites located at Wind Zones IV (WPD above 400 W/m^2), a CUF of 37%[30] would generally carry an LCOE of INR 3.2/kWh in 2022.

The solar supply chain faced similar pressures in 2022, primarily due to a hike in polysilicon prices post-2020 owing to manufacturing bottlenecks in China. Certain policy interventions in India[31] and high demand for solar panels kept prices high until Q1 2023. As polysilicon manufacturing has returned to normal levels, the price of solar cells and modules is expected to decline.

The drop in the cost of wind power is likely to be less than that of solar towards 2028, as an exponential decrease in the cost of steel and aluminium is not foreseen in the near future. It is projected that wind power costs will remain around INR ~3.4/kWh by 2028 (see Figure 4).

Figure 4: LCoE for standalone onshore wind and solar projects in India between 2020 to 2028
INR/kWh



Source: Case study on C&I wind solar hybrid plant by JMK research; A 100% renewable power system across India by 2050 study by Wartsila and LUT University; Multiplying the Transition: Market-based solutions for catalyzing clean energy investment in emerging economies published by BNEF; MEC+ LCoE Model; MEC+ Analysis

Nevertheless, wind remains well positioned against conventional power, as coal plants' LCoE in 2022 reportedly ranged from INR 5.2-6.2/kWh and expected to remain in the range of INR 4.8-6.0 per kWh towards 2028, due to soaring coal prices. This reflects a promising outlook for wind power projects in India.

Gearing up grid infrastructure for wind power

The total grid available to wind power projects in India comprises (a) grid capacity that is underutilized because of termination/non-execution of tendered renewable projects; (b) grid capacity that is under construction; and (c) grid capacity additions that have been planned for augmentation.

To support the wind pipeline, robust grid infrastructure is required to ensure that clean power can be efficiently transmitted to where it is needed. The central government has undertaken significant planning around grid needs.

28 WPD: Wind Power Density, Petition for seeking revision in wind zone by MEDA with respect to wind power projects
29 Lazard's Levelised Cost of Energy analysis – Version 15.0 (Page 10)
30 Wind repowering in India: Potential, Opportunities and Challenges by USAID
31 MNRE order for ALMM of Solar Photovoltaic modules

As of April 2023, there are 6.4 GW[32] of margins available in ISTS substation for new grid connection, where wind resource is above 6m/s at 150m hub height. In addition to this existing capacity, government has planned new capacity augmentation for wind power projects. This plan can be segmented in three parts:

1. The 66.5 GW RE capacity integration[33] plan for ISTS grid infrastructure, planned by MNRE in 2018. As on December 2022, 58 GW of planned grid capacity is under various stages of construction and is yet to be augmented. Of which, 34 GW is relevant for wind projects given the wind resource. The 34 GW capacity under-construction comprise 14 substations in the states of Karnataka, Gujarat, Andhra Pradesh, Maharashtra, and Tamil Nadu.
2. The second part of grid planning is related to renewable energy parks and zone allocation, wherein 55 GW of capacity is planned for augmentation. Within this plan, 12.6 GW capacity from Gujarat (Khavda Zone) and Leh RE parks are relevant for wind
3. Lastly, the latest plan from the the CEA's ''Transmission System for over 500 GW RE capacity by 2030'' report[34], 58 GW of grid is planned for wind evacuation towards 2030, divided in 24 GW by 2025, 17 GW by 2027 and 17 GW by 2030; distributed across 6 states of Rajasthan, Andhra Pradesh, Karnataka, Telangana, Madhya Pradesh & Maharashtra for onshore wind and Gujarat and Tamil Nadu for offshore wind.

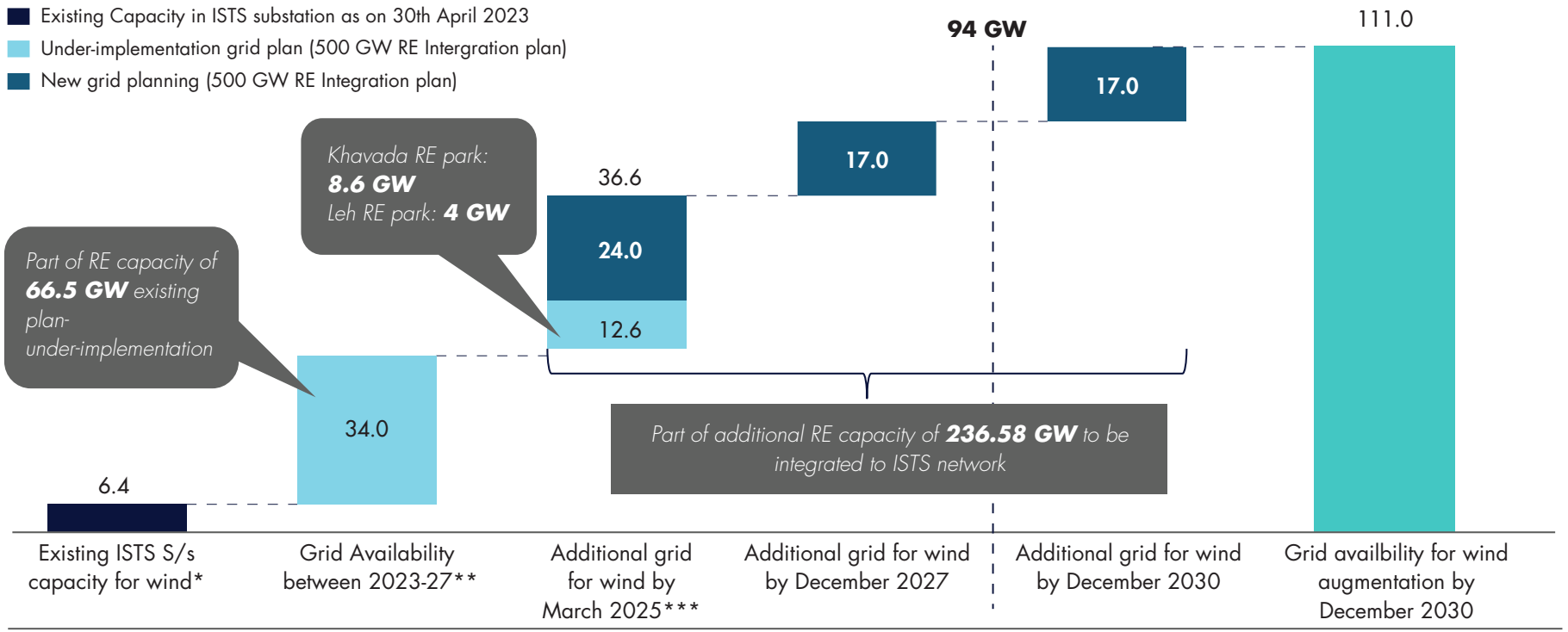
32 Based on a substation for resource above 6m/s at 150m hub height from the margins available at the existing ISTS substation; see status of margins available at existing ISTS substation for proposed RE integration as on 30th April 2023 by PGCIL

33 https://cea.nic.in/wp-content/uploads/2020/03/1st_trans-1.pdf

34 Transmission System for over 500 GW RE capacity by 2030. Published by CEA, Ministry of Power, Government of India.

Figure 5 below illustrates the break-down grid availability by time period for wind power augmentation. It may be interpreted that an ISTS grid capacity of 94 GW may be available by 2027 and a total of 111 GW of ISTS grid capacity may be available by 2030, reflecting the overall step-up in alignment between an expanded wind pipeline and grid infrastructure plans of the central government.

Figure 5: Status of grid availability for onshore wind by CY 2027 and CY 2030



Note: Substation above 6ms/s resource at 150m hub height has been considered under existing pipeline

*: Existing capacity of 6.4 GW coming from PGCIL S/s available margins database shows, 5.4 GW of readily available pipeline and addition of 1GW with ICT augmentation on Kurnool

**: Under the category of RE capacity of 66.5 GW to be integrated to ISTS network and mapping the resources available; Total 14 S/s falls into the category and the augmentation grant accounts to 34 GW

***: Accounts for additional 13 GW coming from Khavada RE park: 17.2 GW (assuming 50% wind component 8.6 GW) and Leh RE park: 4 GW wind (from 55 GW augmentation plan and 24 GW planned until March 2025 from 181 GW augmentation plan)

Source: Transmission system for Integration of over 500 GW RE capacity by 2030 report by Ministry of Power; Report on optimal generation Mix 2030 version 2.0 by CEA; Status on margins available at existing ISTS substations for proposed RE integration as on 30th April 2023 published by CTUIL; MEC+ Analysis

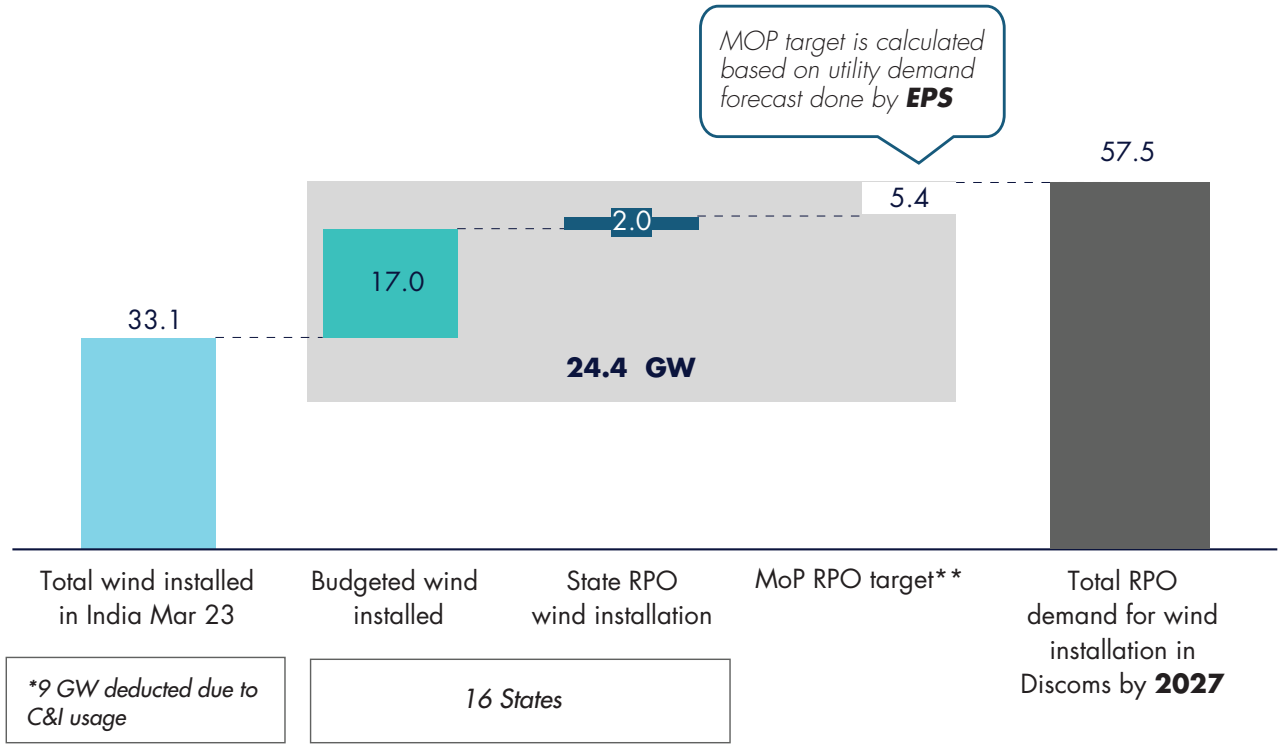
The wind RPO as a demand driver in the utility sector

Growing grid infrastructure will support the increased demand coming from the RPO mechanism under central and state governments. In July 2022, the MoP[35] announced a new trajectory to 2030 with separate wind RPOs – a welcome move to reignite wind power procurement in India.

Total wind installations in India stand at 41.9 GW[36] which includes ~9 GW of C&I installations. Annual growth in the last few years has been relatively slow, averaging 1.74 GW from 2018 to 2022. According to state RPO targets, a capacity of 17 GW in the next four years is likely to be added (see Figure 6), which more than doubles the annual installation rate to 4.25 GW.

In the conservative scenario, if states execute on their committed renewable purchase capacity from annual plans, 17.4 GW of wind will be installed by 2027. Additionally, if states were to align to the MoP trajectory, new wind installations can

Figure 6: Total RPO demand between FY 2023 to FY 2027



Note: Study for 16 states including 28 discoms who have procured wind energy from SECI and state based tenders since 2018

*: 9 GW installed wind by C&I excluded from total wind installations till Dec 2022

**: Calculated based on total demand forecasted in 20th Electric Power Survey (EPS) report and wind installation of 4.29% (MOP target)

Source: SECI; GUVNL; MSEDCL; TANGEDCO; NTPC; MNRE; Renewable Purchase Obligation (RPO) and energy storage obligation trajectory till 2029-30; Report on 20th Electric Power Survey (EPS) in India (Volume – I); MEC+ analysis

35 Renewable Purchase obligation (RPO) and energy storage obligation trajectory until 2029-30 by Ministry of Power (MoP) published on 22nd July 2022

36 India installed capacity of power stations by CEA as on 31st December 2022

go up to 24.4 GW between 2023-2027[37]. This would mean an average annual installation of around 6.1 GW for the next 4 years, which is the most ambitious case, and this could lead to a total of 57.5 GW wind installed capacity at the end of 2027.

Among the 28 states and 8 UT, 4 states[38] have adopted the RPO of MoP. The progress of these will determine whether the installed capacity will be higher or not. Delhi was the first to issue an RPO trajectory until 2026[39]. Apart from Delhi, in the states of Rajasthan[40] and Haryana, the respective Regulatory Commissions have notified wind RPOs. The state of Bihar as well has made progress on this front[41]. Hence, both wind power generating and non-wind power generating states have made progress on the wind RPO.

Demand from the C&I market for wind

Wind installations in India started on back of corporate procurement mechanism back in 90s. However, given the lower per unit economics of solar as compared to onshore wind, solar has now become the first choice of C&I procurers to lower their electricity overheads and offset carbon emissions through least cost pathway. In 2022, ~300 MW of wind was installed in the C&I sector, significantly higher than ~100 MW in 2021, however, in the same period, 3.4 GW of solar was installed in 2022 and ~700 MW in 2021[42]. The numbers indicate the preference of C&I consumers towards solar installations.

Positive undercurrents are visible in the market, indicating the re-emergence of wind as the part of portfolio of corporate power procurement. In 2022, multiple corporates indicated the need of round-the-clock power, including a 1 GW tender from Indian railways for supply of round-the-clock RE power with combination of wind, solar and energy storage. Additionally, nearly 2.3 GW of pipeline for hybrid projects in visible in the market currently, which can be calculated to be 700 MW to 1 GW of wind project pipeline for the sector.

Multiple drivers are visible for uptake of wind in the C&I sector including:

- Saturation of C&I consumers with 20-30% power consumption coming from solar, expansion beyond which is difficult without storage or supportive banking regulations;
- Central government's efforts to align the regulations and charges across states through Green Energy Open Access regulations;
- India's focus on green hydrogen and other green derivatives, which will open up demand for round-the-clock power, with a major role for wind; and
- Opening of multiple revenue streams for developers in open access market, including exchange-based products, as well as tertiary[43] and secondary reserve ancillary markets[44].

But sensitivity to state level charges, regulations, and continuous withdrawal of waivers, banking provision, especially for vanilla wind projects will keep the C&I outlook lumpy. Despite a huge potential, the market can swing between 200 MW to 700 MW in the coming 5 years, unless C&I consumers' needs become more specific to wind generation needs.

37 Calculated based on demand projected in the 20th EPS report (Volume – I) by CEA and multiplied by wind RPO trajectory set by MoP in document RPO and energy storage obligation trajectory until 2029-30

38 States and UTs whose Regulatory Commissions have notified wind RPOs are Delhi, Rajasthan, Haryana and Bihar.

39 https://www.derc.gov.in/sites/default/files/DERC%20DRAFT%20RPO%20%26%20REC%20Regulation%2C%202023_First%20Amendment.pdf

40 Rajasthan Electricity Regulatory Commission (Renewable Purchase Obligation) Regulations, 2023. Accessed online from https://rerc.rajasthan.gov.in/rerc-user-files/regulations on 31 July 2023 and Haryana Electricity Regulatory Commission (Terms and Conditions for determination of Tariff from Renewable Energy Sources, Renewable Purchase Obligation and Renewable Energy Certificate) Regulations, 2021, (2nd Amendment) 2022. Accessed online from https://herc.gov.in/WriteReadData/Pdf/R20230103.pdf on 31 July 2023.

41 "Bihar Electricity Regulatory Commission (Renewable Purchase Obligation, its compliance and REC Framework Implementation) (4th Amendment) Regulation 2022. Accessed online from https://berc.co.in/orders/other-orders/2670-suo-motu-proceeding-for-4th-amendment-of-berc-renewable-purchase-organisation-its-compliance-and-rec-framework-implementation-regulations-2010-regulations-2010-4 on 31 July 2023.

42 Mec+ C&I project tracker

43 Detailed Procedure for Tertiary Reserve Ancillary Service (TRAS) https://testancillary.grid-india.in/assets/files/TRAS%20Detailed%20Procedure%20April_2023_Final_Website.pdf

44 Central Electricity Regulatory Commission (Ancillary Services) Regulations, 2022 https://cercind.gov.in/Regulations/Ancillary-Service-Regulations-2022.pdf

4. Looking ahead to offshore wind development

Globally, India ranks fourth in installed onshore wind energy capacity[45]. While onshore wind power has been a backbone of the country's RE journey, there is now growing domestic and international appetite to tap into India's significant offshore wind resource. Harnessing the full potential of offshore wind energy will be needed to lever the country towards its net zero target by 2070.

A strategy paper released by the MNRE in July 2022 announced the trajectory to award 37 GW of offshore wind tenders towards 2030[46] in the states of Gujarat and Tamil Nadu. The strategy includes:[47]

Three models of offshore wind development in India

- Model 1 (1 GW): PPA award along with exclusive lease award based on quoted tariff / VGF requirement bid for Gujarat Zone B3.
- Model 2 (divided into models 2A and 2B): Model 2A (24 GW) is for non-exclusive lease award on a 'first-come-first-served' basis, for consequent procurement by the government through PPAs. Model 2 (no stated volume) is for non-exclusive lease award rights on a 'first-come-first-served' basis, for captive/ open-access sales.
- Model 3 (12 GW): Exclusive lease award based on the lease fee bid for captive/open access sales (no government-backed PPA) for Tamil Nadu.

As shown in Figure 7, 1 GW, 24 GW, and 12 GW capacities are planned to be auctioned under models 1, 2A, and 3, respectively. However, looking at the recent developments in the offshore wind areas in India, none of the capacities will come online in this report's forecast period of 2023 to 2027.

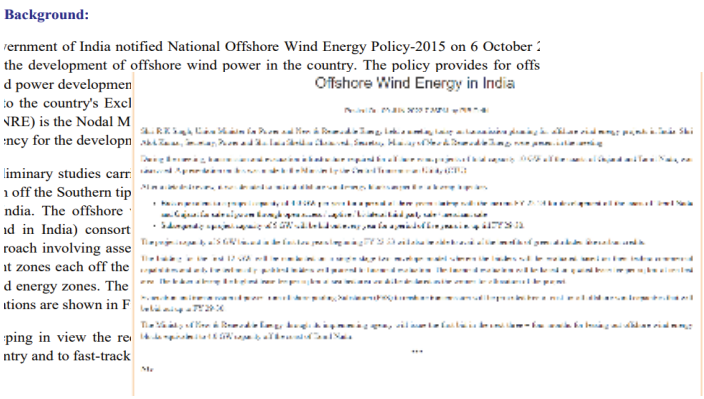
45 Global Wind Energy Council: GWEC database
46 Strategy paper for establishment of offshore wind energy projects in India published by MNRE in 2022
47 The authors note that a Revised Offshore Wind Strategy paper was released on 17 August 2023; the analysis in this section is based on the previous version of the strategy paper, and not the revised version.

Figure 7: India Offshore wind - different models and planned trajectory

India OW Strategy paper

MNRE notified a trajectory for bidding out Offshore wind energy blocks from FY 23 to FY 30, cumulating to 37 GW in June

3 models of OW development are suggested in the strategy paper



Strategy Paper for

Establishment of Offshore Wind Energy Projects

Background:

ernment of India notified National Offshore Wind Energy Policy-2015 on 6 October 2
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Offshore Wind Energy in India

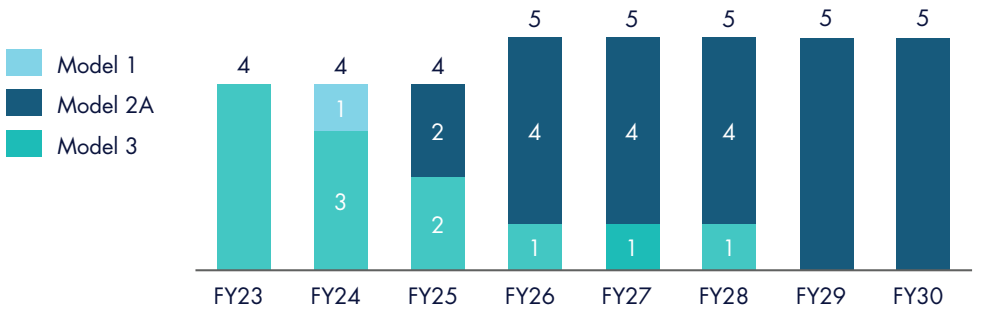
India OW bidding models

Model 1 — 1 GW — PPA award along with exclusive lease award based on quoted tariff / VGF requirement bid

Model 2

- **2A** — 24 GW — Non-exclusive lease award on 'first-come-first-serve' basis, for consequent procurement under model 1
- **2B** — Non-exclusive lease award rights on 'first-come-first-serve' basis, for captive/ open-access sales

Model 3 — 12 GW — Exclusive lease award based on lease fee bid for captive/ open access sales



Note: VGF – Viability Gap Funding
Source: Strategy Paper for establishment of offshore wind energy projects; MEC+ analysis

5. The onshore wind outlook in India: 2023-2027

Wind installations in India between 2023 to 2027 are forecast in three different scenarios:

- **Ambitious case**: High-paced scenario with total 26.2 GW installations. Acceleration driven by alignment of state RPOs to MOP's RPO targets, opening wider demand for wind, as well as acceleration in C&I related wind installations with corporates looking to expand beyond pure solar and more load following generation.
- **Base case**: Normal-paced scenario with 21.7 GW of installations driven by existing pipeline and continued current pace of tender award at 3-4 GW of new capacity award annually. The scenario expects a peak in the installations in the year 2025, due to tapering off of the ISTS charge waiver starting in June 2025. In the scenario, C&I installations related to wind also scale up from current levels, although slower than ambitious scenario.
- **Conservative case**: Slow-paced scenario estimating 17.4 GW installations, wherein the market takes some time to adjust to the new mechanism for bidding and demand for wind suffers a setback due to increased price of wind discovered in tenders. As for C&I related wind installations, a higher price of wind than solar continues to deter scale-up and the market remains at current pace.

In the base case, India is expected to install 21.7 GW by 2027. This installation rate could go up to 26.2 GW in the ambitious case and down to 17.4 GW in the conservative case (see Figure 8).

Ambitious case analysis

In the ambitious scenario, India installs 26.2 GW of onshore wind between 2023 and 2027, reaching 68.1 GW onshore wind capacity by 2027. The 26.2 GW can be segmented into 23.4 GW coming from central and state tenders and 2.8 GW from the C&I sector wind installations. Of the volume coming from central and state tenders, 12.5 GW is from existing pipeline (including 400 MW cancellations) and 10.9 GW from new tender awards.

The scenario anticipates acceleration in the tender activity on back of the

10 GW[48] trajectory announced by the central government, leading to higher and faster new pipeline creation. Although the scenario, does not anticipated successful 10+ GW award annually, it does assume an acceleration in tender activity to award 10.9 GW in 2023 and 2024, all of which comes online by 2027.

In order to achieve the scenario, it is critical for state RPO trajectories to align with the central MOP RPO trajectory, taking the demand to 24.4 GW for wind procurement until December 2027.

Out of 26.2 GW additions in the scenario, C&I is expected to contribute 2.8 GW of installations, increasing from 300 MW in 2023 to 700 MW per year in 2027. The opening of voluntary offtakers for green power needs and global renewable energy commitments remains crucial for achievement of this scale of activity.

Base case analysis

In the base case, India is expected to install nearly 21.7 GW of wind capacity between 2023 and 2027, reaching cumulative installation of 63.6 GW at the end of December 2027. Of the new installations, 19.4 GW is expected to be contributed by central and state tenders while nearly 2.3 GW is from C&I-related wind installations.

Out of the 19.4 GW capacity from central and state tenders, the scenario assumes successful execution of the 12.5 GW existing wind pipeline in India including few cancellations, estimated to be in range of 400 MW. The existing pipeline is supported by 3 GW of new capacity awarded in 2023, which comes online in 2026, and ~3.9 GW of new capacity award in 2024, coming online in 2027. The scenario does not account for the impact of the 10 GW tender trajectory in the forecast period, as it is too early to anticipate the impact.

A factor which inhibits overall ramp-up is delay in the adoption of MOP RPO trajectory within states. The current RPO trajectories and targets of 16 states that are active buyers in wind auctions, aggregates to 19 GW, capping the demand from wind auctions in the market. Even if the central government were to auction 10 GW annual wind capacities, procurement beyond 19 GW would be a challenge.

Secondly, but more pertinently, the tapering of ISTS charge waivers from June 2025[49] will impact the economics of the new wind tender capacities in the latter half of 2023 and 2024, since the capacities would be coming online after June 2025. Hence, the subscription of tenders and offtaker interest would be impacted, leading to installations peaking in this year, as the pipeline rushes to commission before the deadline.

On the other hand, nearly 2.3 GW of capacity within 21.7 GW forecast in next five years, is expected to come from the C&I market. The interest in procurement of hybrid capacities has been gaining traction in the C&I market as they move beyond meeting initial demand from solar. The base case assumes annual installations ramping from 300 MW per year in 2023 to 600 MW per year in 2027.

To meet the upcoming demand, the central government has also planned ISTS grid infrastructure with an addition of 40.4 GW, assuming 6.4

48 Accelerating Onshore Wind Capacity Additions in India to Achieve the 2030 Target, Global Wind Energy Council, 2022.

49 Waiver of Interstate transmission charges on the transmission of electricity generated from solar and wind sources of energy under Para 6.4 (6) of the tariff policy, 2016

GW is currently in the pipeline, and 34 GW as part of 66.5 GW will be augmented by 2027.

Conservative case analysis

In the conservative case scenario, onshore installations in the next 5 years reach 17.4 GW, and cumulative installations total 59.3 GW at the end of 2027. The 17.4 GW of installations are segmented into 16.4 GW of installations via central and state tenders and 1 GW in the C&I sector.

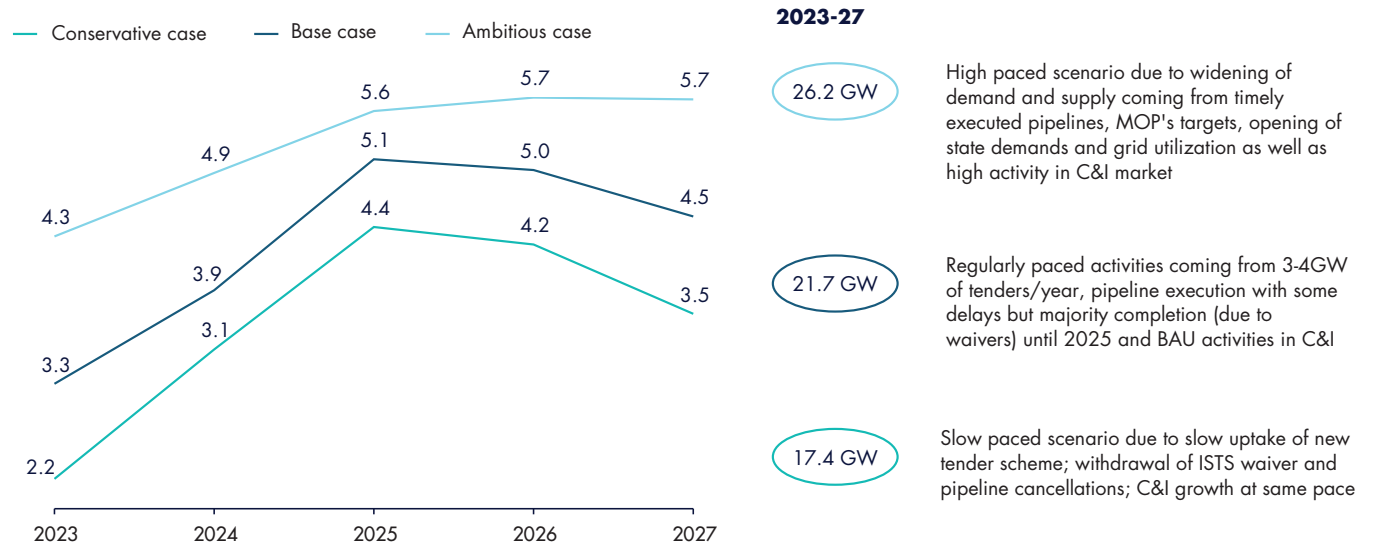
The 16.4 GW of installations within central and state tenders are driven by the delivery of 12.2 GW from the existing pipeline and 4.2 GW from new tender award. This scenario assumes a higher cancellation of projects in the existing pipeline by as much as 700 MW, leading to delivery of 12.2 GW from the existing pipeline of 12.9 GW. The cancellations arise from challenges in timely availability of land for projects and Right of Way issues, which increases the time for delivery to 36-42 months. In addition, the scenario assumes 4.2 GW of new tender capacity to be commissioned by 2027, lower than the base case, due to a change in tender rules and the time required for market to adjust.

The conservative case assumes that the state will stick to its committed wind procurement volume of 17.4 GW as per respective RPO budgeting, capping the overall volumes from offtaker side.

In addition to 16.4 GW, 1 GW is anticipated from the C&I market. The scenario assumes a continued current pace of 200 MW installations per annum in the mechanism until 2027. This is driven by the focus of C&I offtaker to secure the lowest cost in renewables contracts and finding least cost of carbon abatement, as well as limitation of offtakers to those mandated by targets and not voluntary uptake.

Given current market drivers, GWEC with MEC+ believe that the base case forecast of 3.3 GW in 2023, 3.9 GW in 2024, 5.1 GW in 2025, 5 GW in 2026 and 4.5 GW in 2027 seems most likely, leading to the cumulative installation of 21.7 GW in the forecast period. Additionally, this will lead to a total cumulative installed capacity of 63.6 GW in India by 2027. If India continues installations with the same average rate of 4.5 GW p.a. installations, then India could reach ~77.1 GW of onshore wind by 2030.

Figure 8: Forecast YoY new onshore wind installations in India between 2023 to 2027
GW



Note: As per calendar years; forecasts are inclusive of hybrid projects
Source: State Annual Revenue Requirement (ARR) under Tariff order published annually; RPO documents; Transmission system for integration of over 500 GW RE capacity by 2030; MEC+ Analysis

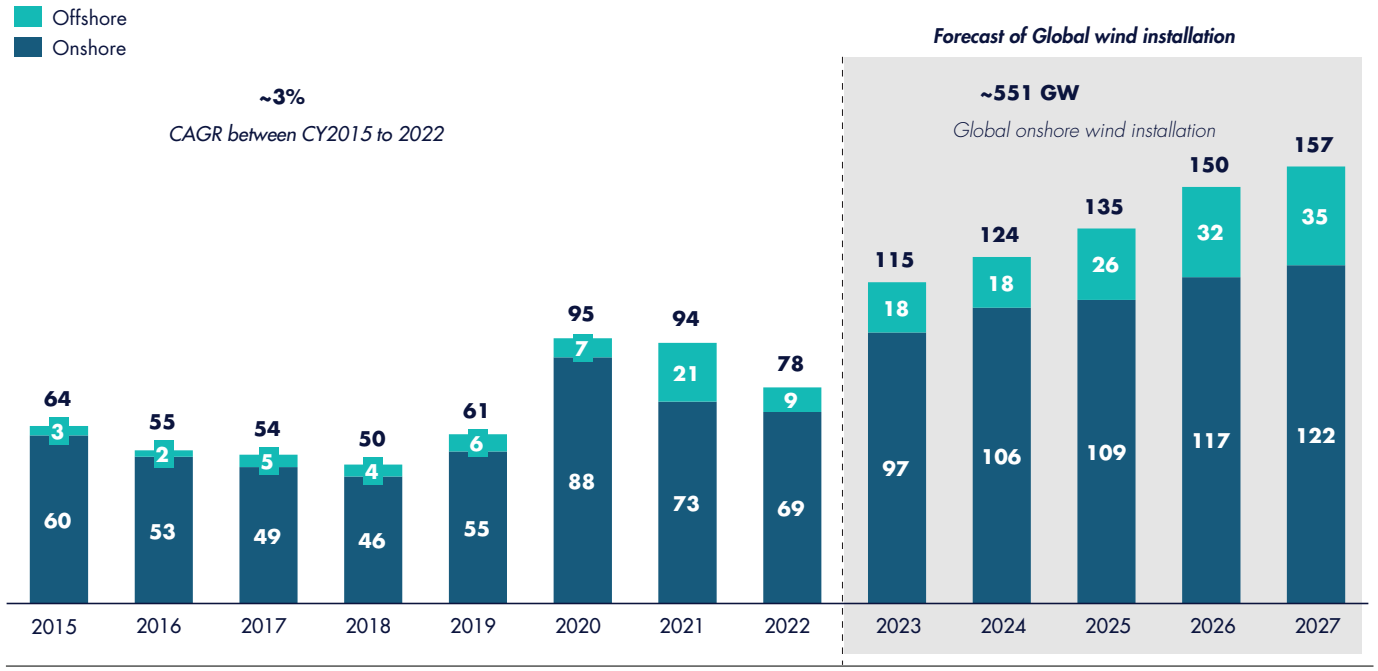
6. Expanding the Indian supply chain for the export market

The big picture: The global wind supply chain

The global power sector is witnessing a momentous transformation as the world moves towards a decarbonised future. Global RE installations have increased at a rapid pace. According to GWEC's Global Wind Report 2023, wind installations have grown by a CAGR of ~3% over the last eight years (see Figure 9).

The pace of growth is set to accelerate, spurred by net zero targets and an expanding coalition of countries committing to renewable energy. Several countries have raised their national targets for wind power, as a means to increase energy security and combat climate change. GWEC forecasts that global wind installations could increase by 551 GW in the next five years.

Figure 9: YoY global wind installation between CY 2015 to 2022 and forecast between CY 2023 to 2027



Source: GWEC Global Wind Report 2023

The key drivers for this are[50]:

- An anticipated 10-year installation uplift in the US, driven by the passage of the IRA (Inflation Reduction Act) and the national goal to achieve a carbon-free power sector by 2035 and net zero greenhouse gas emissions by 2050[51] (see Appendix).
- The EU has also set ambitious targets for renewable energy deployment as part of its efforts to reduce greenhouse gas emissions under the REPower EU program, including up to 480 GW of installed wind capacity by 2030. It aims to enhance energy security by achieving a share of 45% of renewable energy in the total energy consumed by 2030[52].
- Additionally, the EU Renewables Directive seeks to simplify and fast-track permitting procedures for climate-neutral industrial infrastructure, mandating a two-year limit for new projects to attain administrative, grid connection and Environmental Impact Assessment permits. Efforts are also being made to reduce dependence on non-EU sources of raw materials and rare earth elements (REEs) under the Green Deal Industrial Plan (see Appendix).
- Many geographies like Vietnam, South Africa, China and Colombia are setting aggressive new targets for wind power. Additionally, some markets, including Turkey, UK and Sweden, are accelerating wind installations.

When comparing existing production capacities with expected onshore wind installations, GWEC concludes that the supply chain in China, India, and Latin America will have enough nacelle production capacity to meet demand through 2030 (see Table 1). On the other hand, if countries such as US and Europe prioritise domestic manufacturing industries via "Made in the USA" or "Made in Europe" initiatives, these markets may face chronic production shortages as soon as 2026.

Table 1: Onshore wind demand and nacelle supply benchmark between CY 2023 to CY 2030

Sufficient | Potential bottleneck

	Demand vs Supply analysis between CY 2023-2030 (in MW)								
	Annual nacelle capacity	2023	2024	2025	2026	2027	2028	2029	2030
Europe	21,600	14,500	17,750	18,920	20,950	23,290	23,500	24,000	25,000
USA	13,600	8,000	9,000	10,000	13,000	15,000	17,000	18,000	20,000
LATAM	6,150	5,860	5,362	5,200	5,050	5,030	5,000	5,000	5,000
China	82,000	60,000	60,000	60,000	60,000	60,000	65,000	65,000	65,000
India	11,500	3,400	4,200	4,500	4,700	4,500	4,500	5,000	5,000
Rest of World	350	5,619	9,955	10,424	13,560	13,705	14,000	14,300	15,000

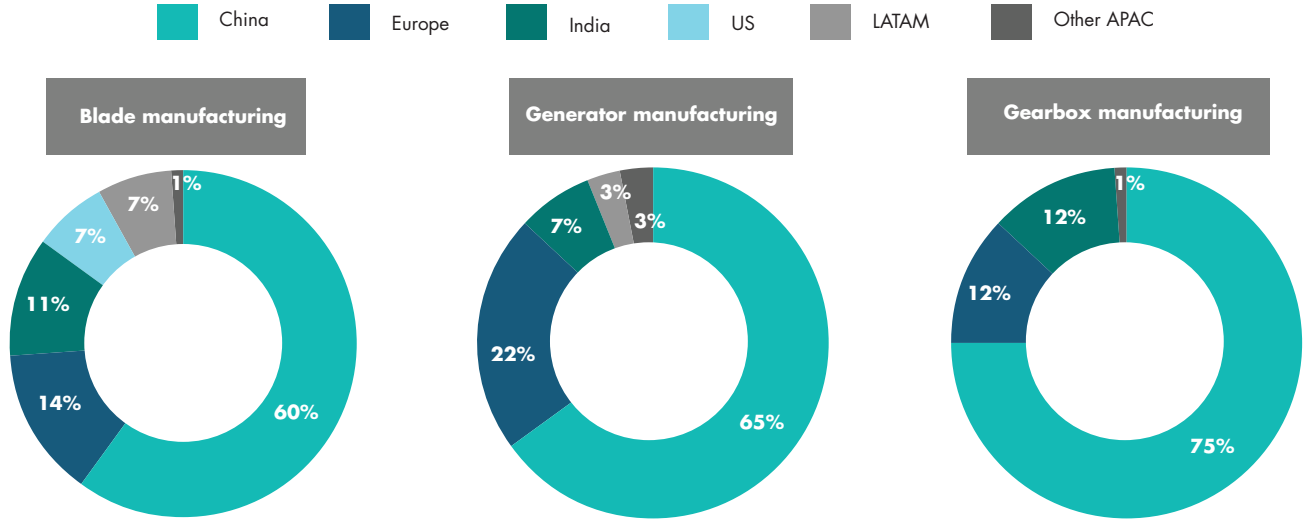
Source: GWEC Global Wind Report 2023

50 GWEC Global Wind Report 2023
51 US net zero target by 2050
52 European Commission: Targets for renewables

Additionally, if we look beyond nacelle demand versus supply analysis, the problem is likely to be exaggerated due to a much higher dependence on imports at the sub-component level. Majorly subcomponents such as towers, gearboxes, generators, etc., are imported (see Figure 10), highlighting the high degree of concentration of the global wind supply chain in a few geographies, with 70-80% of these components coming from China, India, Latin America and the rest of the world.

A concentrated supply chain combined with domestic sourcing strategies are certain to generate bottlenecks. As shown in Figure 10, manufacturing of 60% of blades, 65% of generators and 75% of gearboxes produced for the global wind power industry currently takes place in China. In addition to these components, China controls the global supply chain for castings, forgings, slewing bearings, towers and flanges, with more than 70% global market share. A shift to ''de-couple'' or ''de-risk'' supply chain dependencies from China will take considerable time, learning and cost reduction curves, which could slow down the deployment of wind energy in the meantime, or erode its cost-competitiveness versus conventional fuel sources. Although, the shift has already started to emerge, as per data published by US department of energy and Berkeley Lab analysis. In 2020[53], China contributed 13% in US imports whereas India contributed 19%. Furthermore, in 2022, India drastically increased its share to 24% whereas imports from China reduced to 4%. The shift indicates a changing trend in global trade dynamics and highlights India's growing importance as an export hub.

Figure 10: Global wind key component supply chain overview in 2022



Source: GWEC Global Wind Report 2023

53 Land based wind market report: 2021 Edition by US Department of Energy, Office of Energy Efficiency & Renewable Energy

Worldwide manufacturers are exploring opportunities to diversify the location of their manufacturing units with an aim to cut future supply chain risks due to geopolitical concerns, situations like COVID-19, and to capitalise on attractive incentives available in markets outside China.

Status of the Indian wind supply chain

India is witnessing a revolution in its domestic manufacturing capabilities due to various initiatives such as ''Make in India'' as well as ''Atmanirbhar Bharat.''

Currently, India has 11.5 GW of nacelle manufacturing capacity located in the states of Karnataka, Maharashtra, Gujarat, and Tamil Nadu (see Figure 11). In 2016, the Government of India set a target of installing 175 GW of renewable energy capacity by 2022, including 60 GW of wind power[54] which

54 In 2016, Government of India plans to produce 175 GW of renewable energy by 2022

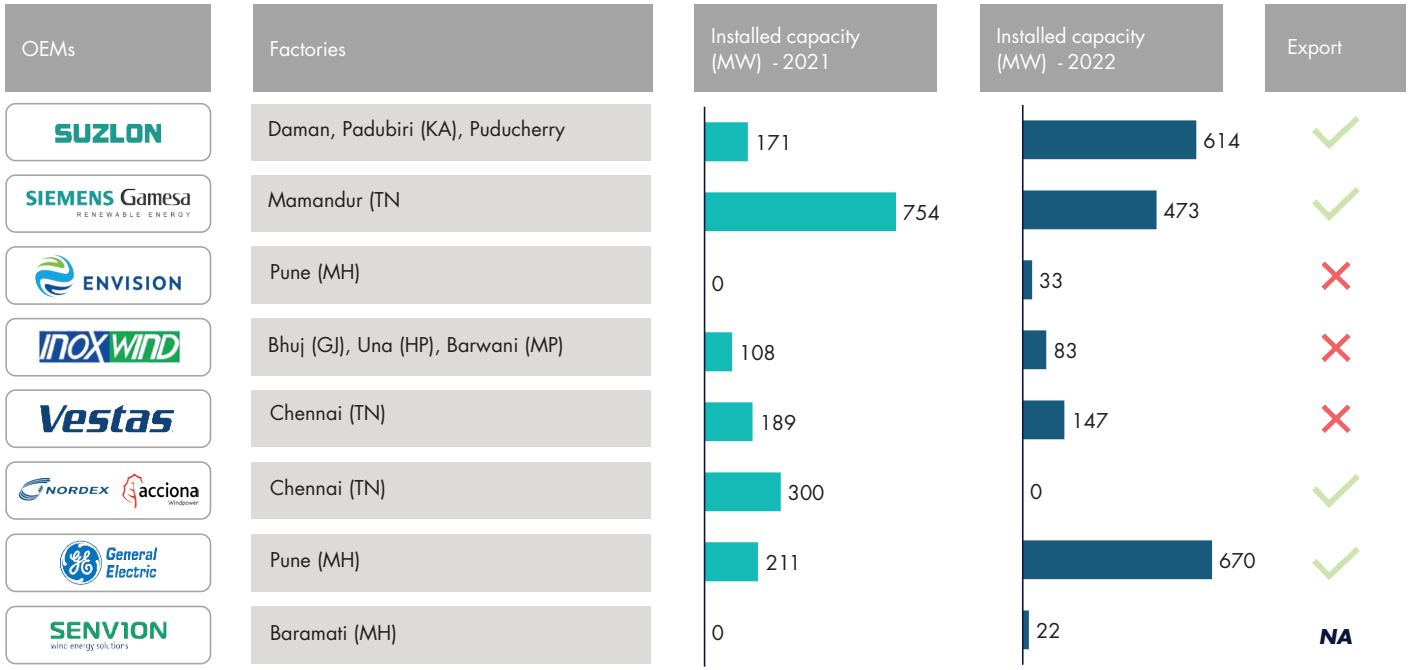
meant additions of 5 GW per year. This would have led to domestic manufacturing investments by OEMs[55]. However, the market has been muted since 2017 with the end of the FiT regime, and India only recorded an average commissioning volume of 1.74 GW from 2018-2022.

As Figure 11 shows, out of the total 11.5 GW, only ~2 GW was utilised and installed in 2022. Most of the manufacturing capacity was underutilised due to lower volume in the domestic market and relatively low exports of nacelles from India. Suzlon and GE have significantly increased installations in 2022 as compared to 2021, which increased the utilisation of their manufacturing capacities in India. SGRE has been a leading supplier and manufacturer in India and continues to show consistent results in terms of installations. Other OEMs including Envision, Inox Wind, Vestas and Senvion saw installations of 758 MW in 2022.

Although wind manufacturing facilities are underutilised compared to current and forecast demand, a significant upside can be obtained in the domestic wind market. Maximum wind power installations per year under the base, conservative, and ambitious scenarios stand at 5.1 GW, 4.4 GW, and 5.7 GW, respectively, which may still lead to underutilised manufacturing capacity in India.

Therefore, this creates an avenue of export potential for manufacturers to enhance their position within the global wind supply chain.

Figure 11: OEM wise onshore wind installation done in CY 2021 and CY 2022 in India



Note: KA- Karnataka; TN- Tamil Nadu; MH- Maharastra; MP- Madhya Pradesh; GJ- Gujarat; HP- Himachal Pradesh

*: Installed capacity in year 2021 and 2022 is as per Calender Year (CY)

Source: Company websites; Directory India wind power 2022 by Consolidated Energy Consultants Ltd (CECL); MEC+ analysis

55 Accelerating Onshore wind capacity addition in India to achieve the 2030 target by GWEC

Indian opportunities in the global supply chain

Driven by pressures to reduce wind power LCOE, the global wind supply chain has been heavily reliant on low-cost and high-scale manufacturing in China and Eastern Europe. However, due to concentration risk in the supply chain, countries and regions are now emphasising the importance of self-reliance. Several factors have contributed to this shift, including the impact of COVID-19 pandemic, geopolitical tensions such as the China-US trade disputes and Russia's invasion of Ukraine.

Consequently, numerous countries are actively engaged in reshoring or "de-risking" initiatives, aiming to diversify their supply chains away from China and reduce vulnerabilities. This strategic shift is expected to have substantial implications for the global supply chain dynamics and the relationships between suppliers and buyers.

- **COVID-19 supply chain disruptions**

  Like many other sectors, the COVID-19 pandemic disrupted and imposed a drag upon the global wind supply chain. This prompted the shift of manufacturing and export activity from China to India. India was recognised by leading turbine OEMs like Vestas as a stopgap solution after turbine manufacturing and component production facilities in China were locked down due to the pandemic. To support their new supply chain strategies, sub-suppliers cooperating with major Western turbine OEMs such as Baetter, LJM, and Flender have either invested in new production facilities or expanded existing facilities in India.

- **US-China trade disputes:**

  The onset of the China-US trade disputes in 2018 triggered a notable transition in the global wind gearbox supply chain, redirecting it from China to India. The world's three major wind gearbox manufacturers, ZF, Winergy, and NGC, are the primary suppliers to the US and have facilities in India. To supply competitively to the US, however, all of them utilised their manufacturing base in China to meet demand. This supply chain model worked well until 2018, when the US imposed a 25% tariff on US$50 billion of Chinese exports including wind gearboxes. The two European suppliers ZF and Winergy were able to utilise their global footprints to shift to production facilities in both Europe and India. Since NGC was producing exclusively in China at that time, the Chinese gearbox producer experienced more pressure than its European counterparts. NGC started building a gearbox assembly factory near Chennai in 2019, with an annual production capacity up to 2,000 units. At the same time, ZF and Winergy also expanded production facilities in India. Following the new investment in the past four years, India has now replaced Europe as the world's second-largest wind gearbox production hub.

- **Geopolitical concern and building supply chain security**

  Russia's invasion of Ukraine has amplified the critical need to reinforce security of supply and reduce dependency on single geographies for materials and components critical for energy systems. To mitigate insecurity in the energy supply chain, countries are now initiating policies aimed at reshoring manufacturing away from China. While this carries the risk of increasing the overall costs of renewable energy and creating new logistics bottlenecks that could slow down deployment, some countries are willing to pay for the redundancy in order to shore up supply chain resilience. Policies such as 'reshoring', 'de-risking' and 'China plus One' enhanced manufacturing and export opportunities for countries with relatively low production and labour costs, and established infrastructure and seaways.

Against this backdrop of events and geopolitical shifts, India is well positioned to take advantage of opportunities in the global wind supply chain – but it will need to resolve a few critical challenges to do so.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5707469
OVER SIZE LOAD
TURNS
TURNS
NORTH
35

7. Rising up to global supply chain opportunities

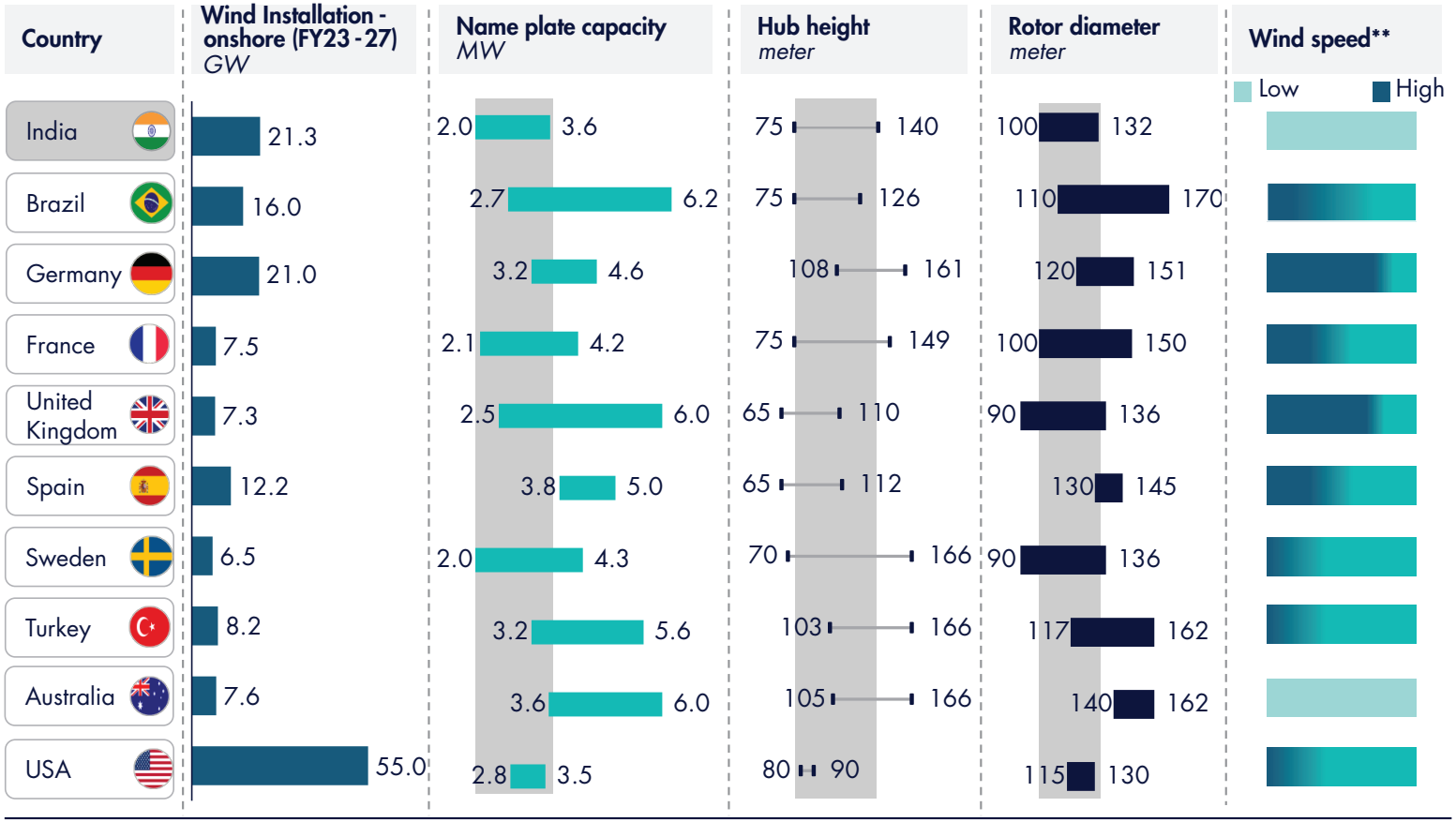
Attracting investments for the scale-up of manufacturing will have massive socio-economic benefits. Wind companies that may be exploring investment decisions in India will make rational business decisions based on multiple factors, including cost-competitiveness, infrastructure highways, ease of doing business and other factors. These decisions are highly likely to be also influenced by comparative advantages with other countries seeking supply chain investments. To enhance its competitiveness in a supply chain moving towards fragmentation, India must address key priorities like technology alignment, convergence in costs and a supportive tax and incentive regime.

Technology alignment of Indian turbines with other countries

Globally, wind turbine technology choice depends on available sites and resource in the region. Currently, India produces 2-3.6 MW wind turbines, as a reflection of its current domestic deployment needs[56]. Figure 12 reviews this relationship between localised manufacturing and deployment needs in detail:

56 Wind turbine models included in RLMM after the declaration of the new procedure (i.e. 1st November 2018) by MNRE. Adani New Industries Ltd. turbine of 5.2MW which is expected to be launched in the Indian market in 2023.

Figure 12: Global product technology roadmap for onshore wind turbines by top 10 countries as per forecast installations



Note: Top countries are being selected based on forecasted installation between FY 2023 to 27 to map potential global market for Indian supply chain; China is excluded from the list due to its self-sufficiency in wind turbine and component manufacturing

*: 2021-22 wind data is used for all countries; Spain and Sweden data obtained from different OEMs through news article and may not include all installations in 2021-22

**: Wind speed is categorized using weighted average of top turbines data

Source: German Wind Energy Association; France Wind Observatory; UK onshore wind farms; Sweden OEM; Turkey Wind Energy Statistics; US wind market; India wind power market directory by CECL; ABEEólica (Primary); MEC+ analysis

The primary challenge is technological advancements of wind turbines, which can be mapped on three major parameters: nameplate capacity, hub height and rotor diameter. Upon analysing the top 10 countries for wind installations until 2027, it can be inferred that India lags behind in terms of nameplate capacity, lags to a lesser degree on rotor diameter and fares well on hub height.

In the case of **nameplate capacity**, limited overlap is seen between the technologies of different countries. Three out of 10 countries, including the US, France, and Sweden, use almost the same size turbines which can be targeted by Indian manufacturers. This opens an immediate market for India at the sub-component level, including generator and gearbox, which accounts for ~65 GW until 2027. If India wishes to supply turbines to Brazil, the UK, and Australia, a significant upscaling will be required to open an opportunity of ~31 GW market by 2027.

In terms of **rotor diameter**, India holds a good position. Additionally, the US, France, the UK, and Sweden can become major hubs to expand India's wind supply chain. Moreover, India can become an export hub for blades as the technological requirements for rotor diameter by other countries are in line with India's manufactured turbines.

India is at a sweet spot in terms of **hub height** which is in the range of 75-140 meters. While looking at recent technological installations, countries have installed turbines in the same category, which would support the export of towers from India. Among the top countries in terms of forecast wind installations, the US, Brazil, and France can be directly targeted, accounting for ~78 GW of the installations between 2023 and 2027, providing a vast opportunity for the Indian wind supply chain to become a part of the global wind market.

Box 1: US Calls for Countervailing Duty on Indian Wind Energy OEMs

In September 2020, the US Department of Commerce received Countervailing Duties (CVD) petitions concerning imports of utility-scale wind towers from India and Malaysia, filed on behalf of the Wind Tower Trade Coalition, whose members are Arcosa Wind Towers and Broad Wind Towers.

The petitions were accompanied by anti-dumping duty petitions concerning imports of wind towers from India, Malaysia, and Spain. The alleged dumping margins as per the petition filed under the International Trade Administration (ITA) are as follows: 54.1% for India; 93.8% for Malaysia; and 73% for Spain.

The coalition alleged that India and Malaysia provide countervailable subsidies to producers of wind towers and argued that the imports of the towers are materially injuring, or threatening material injury to, the domestic industry producing wind towers in the United States.

For India, the Department of Commerce initiated an investigation on 69 subsidy programmes, including the provision of goods for and services for Less than adequate remuneration (LTAR), direct/indirect tax programmes, export subsidies, energy and resource subsidies, loans, and grant programmes.

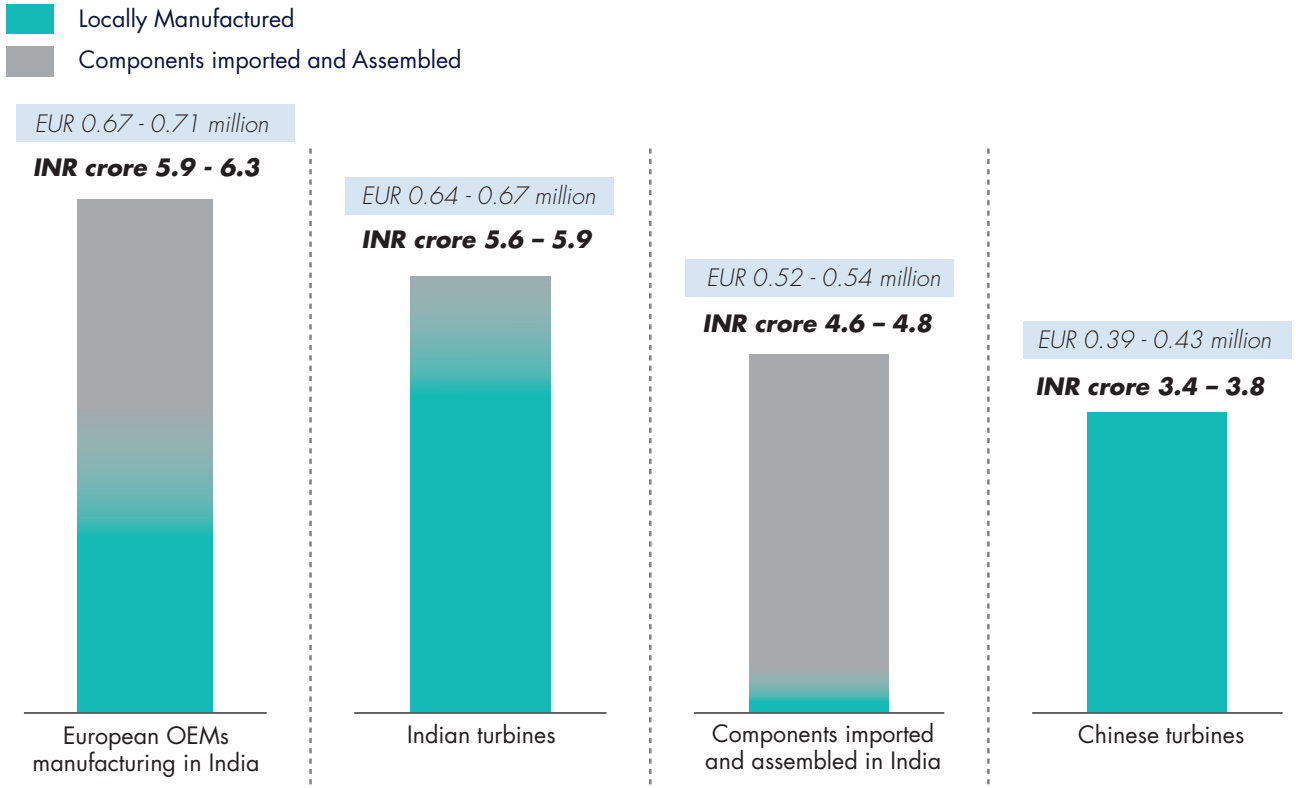
In October 2021, the Department of Commerce announced its affirmative final determinations in the antidumping duty investigations and CVD investigation of utility-scale wind towers from India. The final rates imposed were streamlined across all OEMs at 51.9%.

Cost competitiveness and convergence

While India has competitive advantage in relatively low labour costs, it still lags behind other countries in terms of manufacturing efficiency and cost-competitiveness. The major challenge is the significant difference in the manufacturing cost of turbines in India versus China.

MEC+ has drawn a comparative analysis between WTG OEMs: manufacturing in India, importing components and assembling in India, and Chinese local manufacturers. Chinese-made turbines are considered to be the most cost-effective in the global market. The Chinese wind industry has invested heavily in manufacturing technology, and raw materials are available domestically at a cheaper rate than the other regions. Consequently, China has achieved economies of scale that enables it to produce turbines in the range of INR 3.4-3.8 crore per MW (EUR 0.39 to 0.43 million), which is almost 30% lower than the cost of locally assembled Indian turbines that lie in the range of INR 4.6-4.8 crore per MW (EUR 0.52 to 0.54 million). However, turbines mostly manufactured in India are the most costly, and lie in the range of INR 5.6-6.3 crore per MW (EUR 0.64 to 0.71 million) (see Figure 13).

Figure 13: Cost range of Chinese vs Indian onshore wind turbines
INR Crore per MW



Source: Companies Annual report; Investors Presentation; MEC+ Analysis

The difference of ~30% in the cost of turbines is mainly due to:

- **Costs of raw materials:** With up to 50-60%[57] of a wind turbine's mass made of iron and steel, there will be heightened demand for these materials as the global wind fleet expands. India faces constraints like low supply

57 Study by IEA on the impact of increasing commodity and energy prices on solar PV, wind and biofuels; SGRE capital market day 2022 presentation (Page no. 7)

and high cost of raw materials including the steel, copper, and rare earth elements (REEs) required in the wind turbines. In 2022, the difference between the cost of steel in India[58] and China[59] was INR ~16,000 per tonne (EUR 181), which increased for specific grade steels that were required for wind turbines up to INR 16,400-20,500 per tonne (EUR 186-233). This makes a ~9-12% cost difference.

- **Unavailability of components:** The challenge of unavailability of components, including large castings, generators, and other critical components, can pose significant challenges for the wind supply chain in India, which in turn leads to a significant cost difference in the turbine components, including blades, towers, and gearboxes, as compared to China. These components contribute ~55% of the total cost of turbines, and a significant cost difference of almost INR 0.9 - 1 crore per MW (EUR 0.10 to 0.11 million) between Indian and Chinese wind turbines.

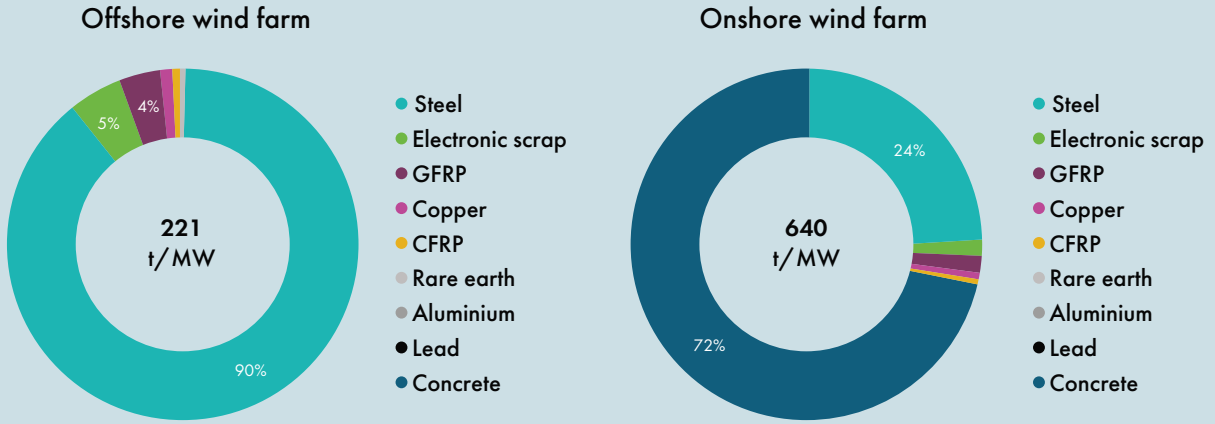
58 Cost of steel in India – MEPS International Ltd.
59 Steel Home China Steel Price Index - SHCPI

Box 2: Capital expenditures on materials for onshore and offshore wind

The sudden recovery of industrial production following the pandemic shock of 2020 led to fierce competition among different industries for raw materials and bottlenecks in manufacturing capacity and transport logistics such as shipping. This had a significant impact on the wind industry as procurement and freight for raw materials and commodities of wind turbines, including steel, concrete, copper, nickel and a small but high-value volume of REEs, and their subsequent manufacturing into wind turbine components make up the lion's share of wind project CAPEX.

For onshore wind, turbine capital costs are estimated to contribute 70% of total CAPEX; viewed as measure of LCOE across a 25-year project lifetime, nearly 50% of onshore wind project LCOE is made up of turbine costs, according to NREL. For offshore wind, turbine capital costs are estimated to contribute 34% of total CAPEX; viewed as a measure of LCOE across a 25-year project lifetime, 23% of offshore wind project LCOE is made up of turbine costs.

These substantial capital expenditures on turbine procurement of raw materials and commodities make the wind supply chain highly sensitive to upstream cost inflation and trade protection measures. Price spikes for raw materials, as well as price fluctuations for the electricity to power heavy manufacturing operations, affect cost recovery and timely delivery for suppliers fulfilling contracts for wind turbine components. Changes in electricity and fuel prices, commodities and raw materials, freight and logistics can in turn significantly impact the economic feasibility and commissioning timelines of projects.



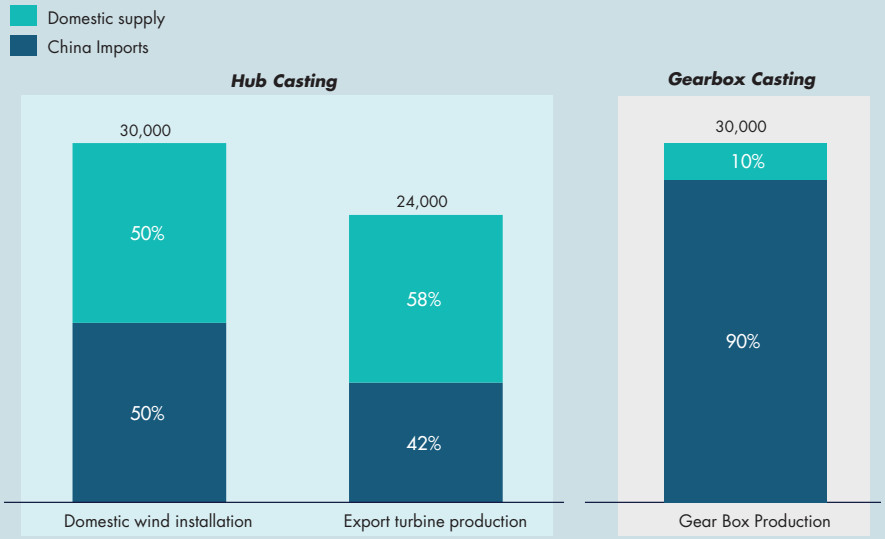
Source: BloombergNEF. Note: GFRP = Glass fibre reinforced plastic. CFRP – Carbon fibre reinforced plastic

Box 3: Cost differentiation between Indian and Chinese casting manufacturing*

Large size castings are among the most critical components for the wind turbine industry, with hub casting holding all three blades and mainframe casting accommodating all the nacelle parts. Currently, India is the second-largest manufacturer of castings after China, producing 11.5 million MT per year. However, despite this position, India holds only 10% of the global business share due to uncertain domestic wind demand and tough competition from China.

While India is the second-largest manufacturer for casting, ~42% of total casting required for turbine export production and 50% of total casting required for domestic wind installations come from China. Furthermore, almost 90% of the total castings required for gearbox manufacturing domestically come from China, as shown below.

Wind casting demand and supply source
MT



Source: Synergy Green Industries Limited

India should create specific policies to expand its share of inputs for castings into the domestic and export markets. The Government of India has taken steps in this direction, such as imposing anti-dumping duties on Chinese imports during the 2017-22 period. However, China's foundries are still ahead due to factors such as:

- Significant local WTG demand leading to economies of scale and viability of investments in machining and logistics costs.
- Lower commodity and input prices, drastically bringing down the price of finished products.
- Export incentives.

These factors combined create a cost differential of around **25%**, in favour of China, which **narrows down to 10%** after accounting for logistics and custom duties. However, export of Indian turbines to meet global demand will create a much higher cost differential in China's favour, as the duties on castings imported by OEMs from China will be waived against the export obligation – this will further challenge domestic casting manufacturers. To eliminate the price gap, further investments are needed to increase production volumes and upgrade technology to produce higher MW turbine castings, as well as increase access to renewable power to optimise power cost.

Indian foundries are poised to be competitive and self-sufficient in meeting domestic demand, cand an even become net exporters to other countries. The following policies could be considered:

- Nominal duty, for instance 15%, on Chinese imports for wind & gearbox castings consumed for domestic demand and exports.
- Incentives for infrastructure investments.
- Accessibility of low-cost funding for investments.

With the above-mentioned policies and government support, India would have the potential to emerge as a global leader in wind turbine casting manufacturing, boost domestic employment and increase export revenues.

* A case study by Synergy Green Industries Ltd. which is one of the India's leading manufacturers of large size castings to wind turbine industry established in 2011. SGIL is a state-of-the-art foundry installed with India's largest semi-automated fast loop moulding line for large castings in the weight range of 3 MT to 30 MT with an annual capacity of 30,000 MT

Supportive tax regime and other incentives

Another key challenge that India faces is the lack of a supportive tax regime and incentives. India and China are two of the largest and fastest-growing economies in the world, with vast domestic markets and highly skilled workforces. While both countries have made significant progress in recent years, there are still differences between their respective tax regimes and incentives for import and export. Key differences seen between tax systems between India and China include which may impact India's positioning in the global wind supply chain include:

- Inconsistency in the Indian tax system and policies leading to increasing difficulty in compliance for both domestic and foreign investors;
- India has a relatively higher number and higher rates of taxes as compared to China, as shown in Table 2, which ultimately increases the cost of goods;
- China has a 'refund upon levy' policy applicable on their standard VAT where a refund of 50%[60] is applicable on the payable amount (i.e., the excess of output VAT over the input VAT), leading to low cost of goods as compared to India; and
- China receives an Export Tax Rebate in the range of 9-13% along with a corporate income tax rate of 15%, which is favourable compared to India's 33.8%.[61]

These taxation distinctions contribute to a higher final cost of goods manufactured in India, encouraging foreign investment in China to produce goods for export. The Indian government should consider implementing robust policies that will reduce taxes and encourage manufacturers to enter the Indian market.

60 Standard Chinese taxes

61 It should be noted that most Chinese incentives and taxes differ from province to province and are awarded on a case-to-case basis

Table 2: Standard taxes for wind turbine manufacturing - India vs China

	India		China	
Category	**Tax**	**Value**	**Tax**	**Value**
CIT	CIT	33.8%	CIT (standard) CIT Qualifying Wind Power Enterprises Operating in the Western Region	25.0% 15%
General Tax	Composite Supply GST IGST	13.8% 12.0% 18.0%	VAT	13.0%
Electricity	Electricity Duty	5 - 15%	Supply of Electricity	13.0%
Land and Assests Tax	Land Tax Property Tax	Rs 5 to Rs 44 sq mtr	Land Use Tax Property Tax Resource Tax	CNY 1.2 to 30 per sq mtr/yr 2-3% CNY 0.3 to 1500 per tonne
Surcharges/Cess			Local Surcharges Local Eductaion Surcharge	7/5/1% 2%
Environmnetal Tax	Environmnetal Taxes	Rs 400 per tonne of waste	Environmnetal Protection Tax	1.2 yuan per pollutant equivalent.
Legal Tax	Stamp Duty	5-7%	Stamp Duty	0.01-0.05%
Other Tax/Social/ Municipal Tax	Employment Taxes Professional Body Tax Central Sales Tax Municipal Corporation Tax	16.75% max of Rs2500 2.0% 1%	CMCT/UMCT	7.0%

Source box: Article on GST on Renewable energy sector by InCorp Advisory; A new golden age for renewable energy report by KPMG published in March 2023; Worldwide tax summaries report by PWC; Article by China Briefing on Selected tax incentives in China's renewable energy sector; MEC+ Analysis

Interviews conducted by GWEC and MEC+ with industry stakeholders further reveal the major challenges faced by OEMs in India, such as:

- Duty on raw materials remains higher than on semi-finished or finished components. For example, the duty on steel is 18% and the duty on steel plates is 12%, driving up costs for domestic sourcing and discouraging manufacturers from producing components from raw materials.
- For exports, the manufacturer of the wind turbine can claim an IGST refund for materials (convertor, generator etc.), but this is not applicable for capital goods, including machinery and land, which increases CAPEX and adds to costs.

India has tried to address these disparities in incentives to boost the domestic wind manufacturing sector, and combat the rise in costs due to taxes and duties. The main incentives deployed by the government are:

- Extension of the Concessional Custom Duty Exemption Certificate (CCDC)[62] policy up until 31 March 2025, from 31 March 2023.
  - The government provides a financial incentive in the form of Concessional Custom Duty Exemption on some of the critical components required to be imported for manufacturing of WTGs (effectively reducing basic customs duty to 5% for imports).
- Remission of Duties or Taxes on Export Products Scheme (RoDTEP) scheme replacing the Merchandise Exports from India Scheme (MEIS) scheme, allowing a 0.8% credit rebate[63] on all wind turbine parts exported out of India.
  - The RoDTEP Scheme allows exporters to receive refunds on taxes and duties that are not exempted or refunded under any other scheme. The scheme will ensure that the exporters receive refunds on the embedded taxes and duties which were previously non-recoverable.

Overall, by providing additional advantages to Indian manufacturers, and drawing parallels to other funding schemes such as the solar PLI in India and IRA in the US, the government of India can deepen investment in the country's wind supply chain and position the country as a key global export hub for a fast-growing renewable energy industry.

62 CCDC Policy extension announced in 2023

63 RoDTEP scheme replacing the MEIS scheme was announced in 2021 January, and the credit rebate reduced from 2% to 0.8% for wind turbine components

8. Conclusion and recommendations for policymakers

Overall, India's growing wind industry holds multiple domestic and international opportunities. The recent acceleration of domestic growth, combined with a forecast demand-supply gap in the global supply chain, creates favourable dynamics for the country. However, India must implement concrete policy actions to seize these opportunities.

Reinvigorating the domestic wind industry

Across the interactions conducted by GWEC and MEC+ with industry stakeholders, the common ask was for expansion of domestic market volumes. Investors perceive India's domestic market with huge potential but low actualisation. The market is expected to accelerate towards 2027 with annual installations increasing from 1.8 GW in 2022 to 2.8 in 2023, 3.7 GW in 2024, and peaking at 5 GW in 2025 in the base case. Overall, India's wind market offers an opportunity for 21.7 GW of installations from 2023-2027. The drivers for wind installations will strengthen towards 2030 as India approaches its target of reaching 500 GW renewable energy capacity and 50% of energy requirements from renewable energy.

In 2022 and early 2023, authorities have been actively working on reigniting volumes in the domestic market. Interventions include revamping the wind tender mechanism from reverse bidding to closed envelope, introducing state-specific auctions, and publishing a clear roadmap for annual auctions in FY2024 split by agency and quarter. Industry actors are hopeful that the interventions cover supply-side dynamics; however, they are sceptical of off-taker participation in the newly discovered prices, which are likely to be higher than the previous rounds.

If the new auction mechanism does take off, India may move from the base case scenario to the ambitious scenario post-2025 (when these tendered projects are installed), installing annually ~5 GW of volume. This increase in the annual market will positively impact India's domestic investment environment, and further serve to inject a new wave of capital into manufacturing capacity. A major lesson to be learnt from China, which has consistently installed 10+ GW of wind power annually since 2010, is that large domestic volumes can support supply chain expansion, new investment in R&D and cost-competitiveness.

Most manufacturing capacity in India is centred on 2 MW class turbines, which are increasingly obsolete. While the new capacity for nacelle assembly, towers, and to some extent blades, is focused on 3-5 MW class turbines, the majority of the tier 2 supply chain, including gearboxes, castings, main shafts and other heavy equipment, is restricted to 2 MW or sub-2 MW class.

A lack of local manufacturing capacity combined with low import duties leads to continued dependence on Chinese imports in India, especially for components like generators, castings and power

electronics, and within the majority of tier 3 supply chain, like fabricated equipment, epoxy resins, glass, fibre, etc. Targeted incentives are needed to support India's strive for self-sufficiency and its shift from domestic assembly shop to global manufacturing hub.

Setting the conditions for an export hub

India's existing wind manufacturing capacities are primarily inclined to meet the needs of the domestic market. For the Indian wind manufacturing industry, wind exports often facilitate the balancing of CapEx and margins when volumes available in the domestic market are very skewed. However, given emerging global supply chain opportunities, the industry as well as the governments must work together to strike a balance so that domestic needs are met while the country's share in global supply also continues to strengthen.

Globally, about 551 GW[64] of wind is expected to be installed between 2023 and 2027, with onshore wind contributing 422 GW, an increase of 100 GW over the previous five years (2018-2022). There is a need to ramp up the worldwide supply chain to match greater volumes of annual installation. According to GWEC's Global Wind Report, supply constraints are projected to occur in the US, EU, and rest of the world from 2026 onward due to a mismatch between production capacity and deployment pipeline.

As OEMs focus on diversifying suppliers and shoring up supply chains, the ongoing dynamics present an opportunity for India to play a critical role in supplying the global wind industry.

First and foremost, India needs to create a strong and sustainable domestic market. Interactions with industry stakeholders reflect that it is difficult to invest in a new geography solely for export, when that country lacks a robust domestic market.

Second, India must align manufacturing capabilities to overlap with global product portfolios and roadmaps. While towers and blades demonstrate significant overlap with global sizes, nameplate capacity needs to ramp up to align with global platforms.

Third, India needs to demonstrate cost leadership to develop as a global export hub. Indian turbines are 30-60% more expensive than their Chinese counterparts in the same product class. Indian turbines with majority imported components assembled in India are 30% more expensive than those manufactured in China, while locally manufactured WTGs come with a further 30% cost premium. Key here are differences in the cost of raw materials and access to components.

Last, India needs to make its export incentives more accessible to boost export orientation. The current incentives for exports are difficult to access; the wind industry has highlighted a minimum 6-18-month cycle to secure the duty drawback on the paid duties for exported materials. The lengthy documentation process and multi-level clearance prolong the process and impact working capital. To avoid this challenge, actors, especially of smaller components such as electronics, have resorted to the government's Bonded Warehouse scheme, the long-term visibility of which is an issue.

In addition to internal factors that require revision, external threats are also emerging, from heightened geopolitical tensions, a trend towards reshoring or "de-risking" from market concentration, and a series of schemes in the US and EU designed to attract incentives in upstream and downstream domestic manufacturing.

Amid this context, India needs to adopt strategic thinking towards export opportunities. Areas of consideration include:

- **Castings:** Although currently, capabilities for large machine casting manufacturing in India are limited, the labour-intensive process and the high ESG risks linked to the foundry process used in forging castings make it a fit for the US and EU markets.
- **Gearboxes:** Like castings, gearbox manufacturing is also a labour-intensive process, making it expensive to do in high labour-cost countries like the US and EU. Globally, gearboxes are manufactured centrally and exported. With Western OEMs looking for a 'China plus One' strategy in diversifying their supply base, this can be a suitable segment of focus.

64 By GWEC's – Global Wind Report 2023

Recently, Flender expanded its base in India and Nanjing High Speed Gear Box Manufacturing Company Limited established its manufacturing plant in India.

- **Blades:** India has been exporting a significant number of manufactured blades, especially to the US market. The ability to produce blades up to 80 metres long, and existing facilities for manufacturing, create opportunity. However, the freight cost of large components are challenging. Like castings and gearboxes, the 'China plus One' strategy and diversification are critical for OEMs.
- **Assembled nacelle units:** Export incentives in India and practically zero import duty on the exported goods make India an attractive location for the assembly of WTG nacelles. This strategy is being used by multiple Western OEMs including Vestas, SGRE, Nordex, and Enercon.

For the above segments, OEMs focus on diversification from China while keeping costs low, creating high export attractiveness for Indian units. In other areas, such as towers and power electronics, high automation in manufacturing and reshoring sentiments will likely reduce dependence on imports in the US and EU. For generators, access to REEs will be a key determining factor for whether China continues to supply the world.

It should be noted that overall opportunities are subject to changes in policy regimes in the US and EU on import duties and taxies, or shifts in protective tactics such as anti-dumping investigations and countervailing duties (as seen in the case of India towers). India must focus on securing long-term associations and relationships for mutual benefit with its trading partners.

Recommendations for policymakers to seize growth opportunities

As India pushes towards its 2030 renewable energy goal and its long-term target of net zero by 2070, wind power is poised propel the country's economic growth and clean energy transition. This momentum can only be strengthened if the government of India undertakes a holistic strategy to shore up large-scale investment in the domestic market while accentuating its comparative advantages for the global export market.

The following measures are recommended:

Domestic market:

1. **Enable the green open access market for the C&I segment**: After the notification of the Green Open Access Rules by the central government, only a few states such as West Bengal, Karnataka, and Punjab have adjusted their respective policy frameworks in support. Obstacles for green open access subsist, such as reliability charges, limiting provisions for power banking, power wheeling and transmission charges, all of which make green power consumption through open access expensive, compared to other grid-based options routed through the DISCOMs. Central and state governments must build consensus with DISCOMs for enabling an economic route for the C&I segment to access green electricity. This must be accompanied by regular monitoring and reporting of progress, including progress in increasing the open access consumer base and units consumed.
2. **Implement a robust bidding mechanism for procurement of wind power:** The central government's **"**Guidelines for Tariff Based Competitive Bidding Process for Procurement Power from Grid Connected Wind Power Projects'' notified in July 2023 provides for a single-stage, two-part (Technical Bid & Financial Bid) bidding process. However, it also supports the adoption of an e-reverse auction mechanism by the procurer/ intermediate procurer at their discretion. The latter inclusion may incline procurement towards downward price pressure and extreme tariff reductions in subsequent rounds of tenders, counteracting the purpose of the new guidelines which seek to curtail the volume-seeking behaviour of bidders who later surrender the awarded volume. Adequate checks and balances must be introduced to ensure challenges that have slowed down wind growth in the past are not reintroduced.
3. **Prioritise the resolution of operational and grid-related challenges**: Central and state governments have made

progress in addressing obstacles to wind growth, but operational challenges still persist, such as availability of land, conversion of land, and right of way-related issues. Prioritisation of non-ISTS projects by states such as Gujarat and congestion due to growing grid demand in states such as Karnataka have further slowed progress. Support for both ISTS and non-ISTS projects by state governments through a win-win partnership among key stakeholders would further accelerate efforts towards the country's wind energy targets.

4. **Ensure compliance of the wind RPO**: Several states have proactively notified a wind RPO to support the uptake of wind power. While this is a welcome step, there must be policy measures to ensure compliance. For defaults or non-compliance, policymakers should consider a suitable penalty measure. Regulatory commissions should make specific effort to avoid instances where the wind RPO has been allowed to be met by another technology RPO. The commission should carefully consider the efforts made by DISCOMs to meet the wind RPO before granting such substitutions. Most importantly, the RPO trajectories set by states must aggregate to overall targets of the country and this must be supported through alignment between the central and state governments on the RPO calculation methodology.
5. **Plan a logistics corridor**: The movement of wind project machinery and equipment requires access to adequate surface transport infrastructure. During the course of project implementation and equipment shipment, sufficiently planned corridors would help to reduce the time and cost spent on transportation and logistics, and hence reduce overall project costs that would be passed onto the consumer. The creation of adequate infrastructure might also support repowering of existing units with new higher capacity and larger turbines and blades.
6. **Consider indexation to mitigate commodity price shocks**: In recent years, an expected surge in commodity prices led to challenges in the economic viability of awarded projects in India and globally. Price volatility in steel, copper, aluminium, and other materials critical to wind energy can significantly impact CAPEX of projects. Policymakers should consider accounting for commodity price fluctuation in bidding guidelines and PPA documents, and introduce a robust mechanism such as indexation to safeguard mutual interests in the timely and cost-efficient commissioning of projects.
7. **Promote domestic innovation in wind manufacturing:** At present, wind turbine prototypes are primarily developed and tested outside India. Measures to encourage domestic prototype development, testing, research and development (R&D), such as innovation grants, may help to boost local investment in the supply chain and support the scale-up of wind manufacturing in India.

Export market:

1. **Ease documentation and approvals for the duty drawback scheme**: In consultation with wind sector stakeholders, policymakers should consider measures to facilitate greater convenience and ease with regards to documentation and approvals required for availing the duty drawback scheme. This may help to release capital and resources which is often held up by this segment of the project lifecycle, and accelerate project timelines and deliverability.
2. **Leverage Free Trade Agreements (FTAs) to strengthen the position in the wind exports market**: India currently has FTAs with the US, Australia and the UAE, and is undertaking negotiations to secure an FTA with the Gulf Cooperation Council, the UK and EU. In the context of these agreements, the central and state governments may consider the design and implementation of wind exports corridors to support enhanced logistics support and lower trade barriers for domestic manufacturers.

3. **Introduce a targeted production linked incentive (PLI) scheme for the wind sector**: While India has a strong wind manufacturing base, there are areas where a greater push is required to further support manufacturing for both domestic and export markets. Introducing a PLI scheme to incentivise investment in castings, gearbox, nacelle assembly and other components could increase the vertical integration of the domestic manufacturing industry. Box 3 presents a case study on hub and gearbox castings, highlighting more than 50% dependence on China for domestically used hub castings and more than 90% dependence for gearbox castings. A PLI scheme towards the component would help India in achieving self-sufficiency and reduce its fiscal deficit. Such incentives are also critical for India to upgrade manufacturing beyond sub-2 MW wind turbines and improve quality of locally supplied components for domestic and export markets.
4. **Nurture an offshore wind ecosystem**: The Government of India has notified an indicative seabed lease tender trajectory of 37 GW in this decade to harness its offshore wind potential. Offshore wind project development requires a complex ecosystem of assemblers, manufacturers, logistics specialists and supply chain players. Diversifying and expanding the local ecosystem for offshore wind would boost India's participation in offshore wind logistics in outside markets, such as Sri Lanka and South East Asia. Through suitable policy, institutional, and financial measures, such as tax holidays and duty waivers, an offshore wind ecosystem may be nurtured in the states of Gujarat and Tamil Nadu.
5. **Lower import duties on raw material and work-in-progress goods**: Wind manufacturing in the country requires the import of certain raw materials which are not manufactured or harvested in India, such as non-standard steel, permanent magnets and balsa wood. Provisioning lower import duties or even duty waivers for raw materials and certain work-in-progress goods may support a more regionally and globally competitive cost of manufacturing for India in the wind industry.

Appendix

As countries seek to reduce concentration risk in clean energy supply chains, they are introducing policy schemes and economic incentives to shore up domestic manufacturing and production. Two recent examples include the IRA in the US and the Green Deal Industrial Plan in the EU:

IRA in the US

In August 2022, the Biden administration launched a comprehensive landmark Federal Law called the **Inflation Reduction Act,** which aims to curb inflation by reducing the deficit and investing in domestic energy production while promoting clean energy.

Previously, policy uncertainty, including the impending expiration of the production tax credit (PTC), had put much of the wind industry's supply chain at risk. However, the IRA extended the PTC and investment tax credit (ITC) for wind and solar through 2024, before transitioning to a technology-neutral tax credit that will remain in place until 2032 or when power sector emissions fall to 75% of 2022 levels, whichever is later.

The main goal of the IRA is to develop and secure supply chains to insulate the US from geopolitical and logistic risks for these clean energy components, by stimulating domestic manufacturing and achieving cost-competitiveness through economies of scale. Key provisions include:

- **Advanced manufacturing production**[65]: Tax credits for domestic production and sale of qualifying wind components such as wind turbine blades (2 cents), nacelles (5 cents), and towers (3 cents) for the total rated capacity (expressed on a per watt basis) of the completed wind turbine; and a 10% credit for critical minerals production. With AMPC in place, these parts could cut manufacturing costs by 10-30%. In combination with tariffs on some imports, domestic manufacturing could be on a cost-competitive footing with imported equipment.
- **Qualified advanced energy project**[66]: Investment tax credits of 6% (Base rate) or 30% (alternative rate satisfying conditions) for a new category of projects: those that re-equip, expand, or build qualified domestic manufacturing or industrial facilities to assist in the production or recycling of renewable energy property.
- **Domestic content**[67]: Additional tax credits above the base ITC for qualified advanced energy projects if the project uses certain components produced in the US (domestic content threshold is 40% for projects installed before 2025, or 20% in the case of offshore wind, and rises to 55% after 2026, for offshore wind after 2027).

Green Deal Industrial Plan in the EU

In March 2023, the EU launched its Green Deal Industrial Plan with two important pieces of legislation which could support its broader energy transition and supply chain resilience goals.

First, the **Net Zero Industry Act** targets the increase in manufacturing capacity of net zero technologies in

65 Advanced manufacturing production policy by the United States of America (Page no. 153)

66 Qualified Energy Project credit by authenticated U.S. Government information (Page no. 174)

67 Domestic content by U.S. Government information (Page no. 171)

the EU and supports investment in this field. These technologies include solar PV and solar thermal, onshore and **offshore renewable energy,** battery/storage, heat pumps and geothermal energy, electrolysers and fuel cells, sustainable biogas/biomethane, carbon capture and storage and grids.

The act focuses on simplifying the permitting processes for new factories and upcoming wind projects. It also identifies strategic dependencies across supply chains and proposes actions to remove existing bottlenecks and increase supply chain resilience.

Second is the **Critical Raw Materials Act**, which aims to improve sourcing of materials used in batteries, solar panels, wind turbines and digital technologies. The act explores opportunities for mining and processing more raw materials in Europe while forging new trade deals with partners that can diversify supply routes. It also emphasises the importance of recycling and reusing key materials to help increase the resilience of Europe's supply chains.

The Act sets benchmarks for domestic capacities along the raw material supply chain by 2030[68]:

- At least 10% of the EU's annual consumption for extraction,
- At least 40% of the EU's annual consumption for processing,
- At least 15% of the EU's annual consumption for recycling,
- Not more than 65% of the Union's annual consumption of each strategic raw material at any relevant stage of processing from a single third country.

Unlike the incentive-based approach for the IRA, which earmarks USD 367 billion for incentive instruments to promote domestic manufacturing, the EU launched more goal-oriented policies aimed at speeding up permitting for wind projects and promoting extraction and processing of raw materials in the EU.

Other markets leading in onshore wind installations, such as the UK, Poland, Japan, South Korea, and Taiwan, are in the process of creating policies aimed to stabilise and domesticise their onshore wind supply chain. These include efforts to set LCRs (Local Content Requirements) of at least 50% or more by 2030, as well as more rigid approaches such as prescriptive lists of components for localised production.

68 CRMA goals from GWEC Global Wind Report 2023

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