REVITALIZING WIND GROWTH TO POWER THE ENERGY TRANSITION

INDIA WIND ENERGY MARKET OUTLOOK 2022-2026

mec+

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GLOBAL WIND ENERGY COUNCIL

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About MEC+

mec+

MEC+, also known as MEC Intelligence, is a specialist consulting firm focused on the wind and renewables sector for 10 years. MEC+ has a highly skilled team of consultants with 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 organisation. 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 strong commercial understanding of areas related to wind power. Working with GWEC as 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 largest global wind OEMs, utilities, oil and gas companies, Supply chain players, Equity funds, and Independent Service Providers.

For more visit insights on www.mecintelligence.com/insights. For queries write to info@mecintelligence.com in new technology innovations in onshore O&M, offshore installations, and integration with other sources such as solar, battery and hydrogen.

In India, the market is moving away from MW to MWh wherein flexibility and firmness of power will be the key proposition. Within corporate PPA market, MEC+ supports asset owners in selecting business models and offerings to win orders, backed by insight on customer's alternative and associated contracting risks.

. For further queries please visit www.mecintelligence.com or reach out at sidharth@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, policy makers and international institutions to give them transparent information about the benefits and potential of wind power, enabling them to make informed decisions about national energy policies.

The members of GWEC represent over 1,500 companies, organisations and institutions in more than 80 countries. Our members are also all of the national wind industry trade associations, from both established and emerging markets, including the world's largest markets of the US, all the European markets, India and China.

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

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

For further queries please visit www.gwec.net or contact francis.jayasurya@gwec.net.

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Abbreviations

APPC	Average Power Purchasing Cost
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
COD	Commercial Operation Date
COP	Conference of the parties
CUF	Capacity Utilisation Factor
DAM	Day-ahead Market
DISCOM	Distribution Company
EOI	Expression of Interest
EPC	Engineering, Procurement and Construction
ESG	Environment, Safety & Governance
ESS	Energy Storage System
FiT	Feed-in Tariff
GHG	Greenhouse Gases
GST	Goods and Services Tax
G-TAM	Green Term Ahead Market
GW	Gigawatt
IEA	International Energy Agency
IEX	India Energy Exchange
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
ISTS	Interstate Transmission System
kWh	Kilowatt hour
L1	Lowest price
LCOE	Levelized Cost of Energy
LiDAR	Light Detection and Ranging
m	Meter
M&A	Mergers and Acquisitions
MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
MW	Megawatt
NIWE	National Institute of Wind Energy
NPA	Non-Performing Assets
OA	Open Access
OEM	Original Equipment Manufacturer
PBG	Performance Bank Guarantee
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PSA	Power Sales Agreement
RE	Renewable Energy
RPO	Renewable Purchase Obligation
RTC	Round-the-clock
S/s	Substation
SCD	Scheduled Commissioning Date
SECI	Solar Energy Corporation of India
TAM	Term-Ahead Market
TWh	Terawatt hour
WSH	Wind/solar hybrids
WTG	Wind Turbine Generator

Foreword

As the world and India continue to recover from the global pandemic, recent events have brought into even sharper focus the twin issues of clean energy transition and energy security. Emissions rose to new record levels in 2021 and global temperatures continue to rise, while the Russian invasion of Ukraine in early 2022 has exacerbated inflation in the renewables supply chain, and sharpened already acute supply chain challenges in the global wind industry.

This is at a time when the world is at crossroads. There is a narrow window of opportunity to halt irreversible damage to the planet and its populations due to climate change. An urgent shift to clean energy is not just an option – it is the way forward for building climate resilience and boosting growth.

India will play a crucial role in defining how the aforementioned key issues are resolved in the coming years. India's power demand across all sectors will steadily rise in the coming decades. The International Energy Agency (IEA) has projected a 1.73x growth in power demand between 2019 and 2030, in the India Vision Case (IVC) scenario.[1] State governments and enterprises are prioritizing the expansion of manufacturing and renewable energy electricity to meet social, climate, and economic goals.

This indicates a critical need to accelerate the deployment of RE within this decade, which can support the Government of India's target to meet 50% of its energy needs from renewable energy sources by 2030. Recent moves to lift coal imports and reopen 100 coal mines previously considered financially unsustainable must not deter India's long-term stand for rapid decarbonization. Increasing the share of wind and solar energy in the power mix must take precedence in policymaking if India is to play a leading and constructive role in carrying out the clean energy transition and achieving long-term energy security.

While India's policy objectives are clear and ambitious, as this report outlines, wind growth in the fourth-largest onshore wind market in the world has slowed down in recent years, largely due to the impacts of the COVID-19 pandemic, supply chain challenges, and legacy issues around land and grid availability.

In order to avert the socioeconomic and environmental costs of delaying renewable energy deployment and achieve the government's commitment to scale total wind

1 https://www.iea.org/reports/india-energy-outlook-2021

Ben Backwell

CEO, Global Wind Energy Council

capacity from 40 GW in 2021 to 140 GW by 2030, India's wind industry demands an urgent overhaul. There are several key actions that this report highlights to unlock the full potential of wind resources in India in this decade:

1. **National and state governments must strengthen consensus and coordination** among various agencies to produce a consistent and aligned market roadmap. This will help to clarify target volumes and schedules of procurement, grid balancing needs, and the composition and conditions for new tenders. It is beyond doubt that innovative mechanisms to stabilise procurement and revenue must be urgently introduced to ensure sustainable tariffs and advance the commercial viability of awarded projects.

2. **Promote technology exchange and alignment with the global wind supply chain,** in order to create export-oriented opportunities for the Indian manufacturing base. This should include reconsideration of taxes and concessions on components that need to be imported, as well as engagement with intergovernmental and industry bodies to secure strategic stockpiles of commodities and critical materials required for large-scale wind growth.

3. **Repowering offers an efficient pathway for India to maximize productivity and socioeconomic benefits from sites already designated for wind power production**. Policymakers should assess the annual volume of wind capacity nearing the end of its lifetime and enable repowering via regulatory fast tracks. Asset owners should be able to undertake repowering before the end of the project lifetime, as there may be wider cost efficiencies and socioeconomic gains associated with upgrading technology at an earlier stage.

4. **Address the legacy challenges which have disrupted the development of wind energy,** including DISCOM payment delays and risks, the inadequacy of grid and transmission infrastructure, and changes in state land policies that have made land acquisition a barrier to development. Recent policy interventions to resolve the issue of pending payments are a welcome step.

5. **Implement an enabling environment for the successful realization of offshore wind and develop comprehensive state offshore wind development roadmaps,** which can capitalise on the enormous resource potential in Gujarat and Tamil Nadu. The MNRE has shared an ambitious capacity bidding trajectory for offshore wind through 2030. Planning should include integration of offshore wind into state's long-term energy, socioeconomic growth and decarbonization plans.

As we look ahead to the next five years, demand in central auctions for hybrid projects and RTC tenders is giving new prominence to cost-competitive and high-productivity wind generation. The demand for reliable green electricity from the C&I segment is also rising exponentially, with companies and PSUs making firm commitments to renewable energy. Recent policy interventions by the central and state governments also reflect a ray of hope. But more decisive action is needed to revitalize India's wind market and guard against prevailing challenges. It is imperative for high wind potential states to evaluate the performance of their existing support mechanisms to boost the deployment of standalone and hybrid utility-scale renewable energy solutions.

I believe there are three broad opportunities ahead: **dialogue** to drive consensus-building between centre and states, **delivery** to match timelines and regulations to India's targets, and the opportunity to build India as the **destination** for global wind manufacturers and suppliers.

I convey my heartiest congratulations to the GWEC and MEC+ teams for this very timely and important publication and extend GWEC's support to the Government of India to achieve its vision of the transition.

Foreword

The renewable energy sector has gone through turbulence over the past two years as the pandemic wreaked havoc on lives and economies. Yet, despite facing many challenges, the sector has bounced back due to the continuous support from the Government of India, which has been proactive and has not allowed the pandemic to derail the renewable energy growth story.

Facts speak for themselves. For instance, India now has achieved a current RE installed capacity of around 160 GW, including large hydro. This is inspiring but more—much more—needs to be done. The pandemic and its consequences—and now the unfortunate Russia-Ukraine war and its fallout on energy markets—only strengthens one's deep-held belief that it is more imperative for the world to adopt sustainable means to achieve a holistic clean energy transition and develop energy security via renewables.

For its part, India has clearly reiterated its commitment to the clean energy shift with Hon'ble Prime Minister Narendra Modi announcing an ambitious non-fossil fuel installed electricity capacity target of 500 GW by 2030 and for India to become a net–zero economy by 2070, at COP26 last year. In addition, India's target to meet 50% of its electricity requirements from renewable energy sources by 2030 shows New Delhi's leadership in the titanic global battle against climate change: This goal itself will reduce the emissions intensity of India's economy by 45% and cut a billion tonnes of CO2.

According to the IEA, India has already overachieved in meeting its commitment made at the COP21 summit in Paris in 2015 by ensuring 40% of its power capacity is already from non-fossil fuels; almost nine years ahead of its pledge. This has seen the share of solar and wind in India's energy mix grow phenomenally. Going forward, fully unlocking wind potential for power generation will be crucial for the success of India's, and the world's, global energy transformation. The total wind power capacity in the country increased at a CAGR of 17.5% to 40.4 GW in March 2022 from just 1167 MW in 2000.

As outlined in this edition of the India Outlook, India needs to look beyond the expansion of onshore wind energy to explore complementary pathways in offshore wind, green energy storage, and the use of wind energy for fuelling electric vehicles, as well as in the production of green hydrogen. The recent announcement by the Government to India to aim for 37 GW of Offshore Wind capacity addition by 2030 will strengthen the

Sumant Sinha

Chairperson GWEC India and Founder, Chairman and CEO, ReNew Power Private Limited

sector and contribute notably to the country's 500 GW target.

Given this backdrop, innovative strategies are needed to mitigate issues faced by the wind sector around infrastructure access and availability such as land acquisition and questions about the grid resource availability and financial health of ailing DISCOMs. Identification of high-impact opportunities—offshore wind, as well as aligning the wind sector to complement 'Aatmanirbhar Bharat'—must be prioritized by the Central and state governments. This will accelerate wind deployment in a sustainable manner to quicken the pace of India's transition, which is a must if we are to hit our climate goals.

This edition of India Outlook rightly emphasizes the need for greater clarity about the energy transition, building energy security, and refining the respective roadmaps of the Central and state governments for the wind energy sector. This report is also an admirable effort towards bringing together key wind sector stakeholders to create a greater consensus on priorities that will boost both India's Nationally Determined Contributions through larger deployment of wind capacity, as well as GDP growth via enhanced private sector participation. I congratulate GWEC India and our MEC+ colleagues for this very important and thought-provoking publication.

Foreword

India's power market is undergoing change at a rapid pace. There have been series of announcements from the government that, if implemented, can make any long term forecast redundant. This report was prepared during the period of March 2021 to May 2022. Since then, the government has already announced new RPO trajectory, Green Open Access Rules, General network access rules, strategy for offshore wind, policy on supporting the build out of hydrogen infrastructure. The government is also likely to table the Electricity (Amendment) Bill 2022 in the monsoon session of the parliament. Although these changes impact the overall headline potential of installations, the year-to-year installations are subject to the pipeline in place, its development in short term, and how various stakeholders interact to bring the installations to the market.

India's track record has indicated that the wind installation market is a lumpy market. For time-bound execution of pipeline projects, grid, land, regulations, and demand need to align. A considerable momentum has been built in the pipeline since 2017-2018. However, inordinate delays in project execution have challenged the assumptions of developers. These have been caused by delays in signing the power supply agreements, delays in securing land, and delays in getting the grid augmented at the right level. Although steps have been taken to resolve these issues, which could have led to the installations taking off once again – the industry now faces supply pressures. The combined pressure of extremely competitive bidding levels and rapid inflation have put many projects in the pipeline at risk. This can potentially derail the installations again.

Despite all the challenges – wind's position as a complement to solar got stronger in 2021. Wind solar hybrid project PPAs have been on the rise, especially within corporate procurement contracts. Additionally, DISCOMs are likely to shift towards a combination of wind and storage to meet their peak requirements. India as a supply hub for wind OEMs has also gotten stronger with larger turbines being supplied out of the country as well as new players emerging in the market for domestic supply.

Our method of forecasts relies on project by project counting of pipeline status and the changes in budgets available for procurement of power with utilities. This year's report uses our 2021 expectations of pipeline build out as a starting point and goes into the reasons and themes that impacted installations. It then takes those lessons to direct on what to expect in the years ahead to indicate how the project pipeline will actualize in the forecast period.

Sidharth Jain

Founder and CEO, MEC+

The report is divided into four sections:

1. **Section I:** India's wind energy sector background – Briefly describes the historical development and targets in the market. Highlights impact on role of wind due to key policy announcements by government
2. **Section II:** Wind competitiveness – Compares the generation costs from wind, round the clock power solutions and other dominant electricity generation sources in India, today and in future. Highlights the supply chain issues impacting generation cost of wind.
3. **Section III:** Current wind market activity – Discusses progress on wind project installations along with challenges in deployment. Also, evolution in tender conditions with auction activity of wind and hybrids in 2021- 2022 are highlighted
4. **Section IV:** Future Installations – Describes drivers and inhibitors in each market segment (Central activity, State activity and C&I) and their impact on installations till 2026, along with MEC+ forecasts

Happy reading!

Executive Summary

The decarbonization of India's power sector, including the phaseout of coal and fossil fuels and the acceleration of renewable energy (RE), will be a key factor for India's overall energy transition. Power generation is a major source of greenhouse gas (GHG) emissions in the country, comprising ~56% of India's total emissions[2]. India's power demand is further expected to grow at 6% yearly towards 2030, driven by economic growth, which will continue to drive emissions upward without rapid displacement of fossil fuels by RE.

Over the last decade, India's RE capacity has expanded by more than 5 times, as the country moves toward long-term plans for decarbonization of the power sector. The Government of India reinstated its long-term commitment to clean energy at COP26 in November 2021, announcing a pledge to reach net zero emissions by 2070 and a 500 GW RE generation target by 2030. This builds on top of the current RE target of 175 GW by 2022.

Wind power makes up a major share of the RE generation mix in India, with 37.7%[3] (40.1 GW) of cumulative installed RE capacity as of March 2022. The country is home to high potential of 302 GW technical onshore wind resource at 100m height and 695 GW technical onshore wind resource at 120m. In offshore wind, India is home to 174 GW of technical resource across fixed-bottom and floating potential, mainly off the coasts of Gujarat and Tamil Nadu. Together with cost-competitiveness and resource complementarity for round-the-clock (RTC) solutions, this makes wind energy a critical link in India's power sector transition.

A slowdown in recent wind growth

In spite of the high potential, the wind industry installations have slowed down in India. In our Market Outlook to 2025 last year[4], we anticipated 2.3 GW of wind installations in 2021 owing to a large pipeline and multiple policy interventions to ease execution bottlenecks. However, wind project activity was lower than expected in 2021 with 1.45 GW of wind installations. Project activity was impacted by delays, due to the second wave of COVID-19 and supply chain-related disruptions. To counter these disruptions, MNRE granted a blanket timeline extension for 7.5 half months after scheduled commissioning date (SCD) for projects with power purchase agreements (PPAs) signed before June 2021, which pushed SCD of 0.7 GW projects to 2022.

2 "India- Third Biennial Update Report to The United Nations Framework Convention on Climate Change" : Ministry of Environment, Forest and Climate Change, Government of India, 2021

3 As on March 2022 as per CEA monthly installed capacity report

4 https://gwec.net/india-wind-energy-market-outlook-2025/

The slowdown has been witnessed since the advent of the auction regime in 2017 to award tenders. The new scheme led to large orders but highly competitive bids. Subsequently, the market has concentrated wind projects around a few substations of Gujarat and Tamil Nadu, which were home to the strongest resource potential and lowest cost of land. This created bottlenecks and slowed down project activity. In the meanwhile, the cost of solar based power continued to go down – creating a wider gap with wind-based energy and hence delays in signing of Power Supply Agreements for already auctioned projects.

Renewed appetite for wind investment amid evolving market dynamics and move to hybrid projects

The Government of India made multiple interventions to resolve the current impasse in the industry by improving tender conditions and introducing tenders for hybrid projects during 2021. 2021 saw activity in tenders across the three market segments – central, state, and corporate market for wind and hybrid projects.

In 2021, the Solar Energy Corporation of India (SECI) awarded 2.4 GW of standalone wind tenders, which were oversubscribed in contrast with the past 2 years, when the subscribed volumes for standalone wind tenders were 50-80%. In 2022, 1.1 GW standalone wind tender of tranche XII was awarded. During period of January 2021 to date of report publishing, 1.65 GW of standalone wind tenders are issued but yet to be awarded.

During period of 2021 to date of publishing of report, SECI awarded 2.65 GW of wind/solar hybrid (WSH) tenders which were oversubscribed in line with WSH tenders in 2020. Also, during this period 0.6 GW WSH tender (0.15 GW wind component) issued by NTPC is yet to be awarded. The announcement of waivers to open access (OA) charges as part of WSH policies by some states, along with ISTS waivers by the Ministry of Power (MoP), has piqued the interest of developers in WSH projects.

The evolution of tender conditions as per changing market scenarios has led to renewed interest of developers in wind and WSH auctions. Some key changes to tender conditions in latest auctions included the specification

of procurers before the auction, diversification of land and grid from Gujarat and Tamil Nadu, removal of tariff caps and encouragement of repowering of exiting projects.

During 2021 to date of report publishing, Gujarat has awarded 0.5 GW of standalone wind capacity and Maharashtra has awarded 0.3 GW standalone wind and 0.5 GW WSH capacities. Additionally, 0.5 GW (0.25 GW wind component) assured peak power tender of Gujarat and 0.8 GW (0.15 GW wind component) WSH tender of RUMSL-Madhya Pradesh are issued but yet to be awarded. This is in contrast with muted activity observed in state auctions during 2020.

Hybrid projects driving the pipeline

India currently has a pipeline of 13.4 GW in central and state markets, which is expected to drive installations until 2024 in the market. The market post-2024 is likely to be driven by new capacity awarded to wind, majorly in hybrid formats. The linking of utility-scale wind and solar technology will be a crucial lever for volumes in 2024-25. Notification of new tenders and price competitiveness of hybrid tenders will remain crucial for the growth of hybrid volume.

New and legacy supply chain challenges lead to a lower base case

Foreign and domestic turbine original equipment manufacturers (OEMs) are facing cost pressures due to cost inflation of related raw materials and critical wind turbine components, such as steel and nickel. Supply chain disruptions caused by the pandemic, followed by the geopolitical tensions from the invasion of Ukraine, have led to an increase in global logistics costs. Finally, a recent surge in Goods and Services Tax (GST) has further aggravated turbine costs.

In tandem with legacy infrastructure challenges related to grid availability and land allocation proving to be persistent, the challenging supply chain scenario is likely to impact the existing pipeline.

Further project cancellations of ~ 2GW in central projects are expected in the base case, as the focus on low-cost bidding (L1 prices) in the current tender design has left no room to absorb inflationary pressure on wind projects. This emerging supply chain scenario will restrict the current pipeline of central and state markets to 11.4 GW in the base case.

Achieving an ambitious scenario of wind growth by 2026

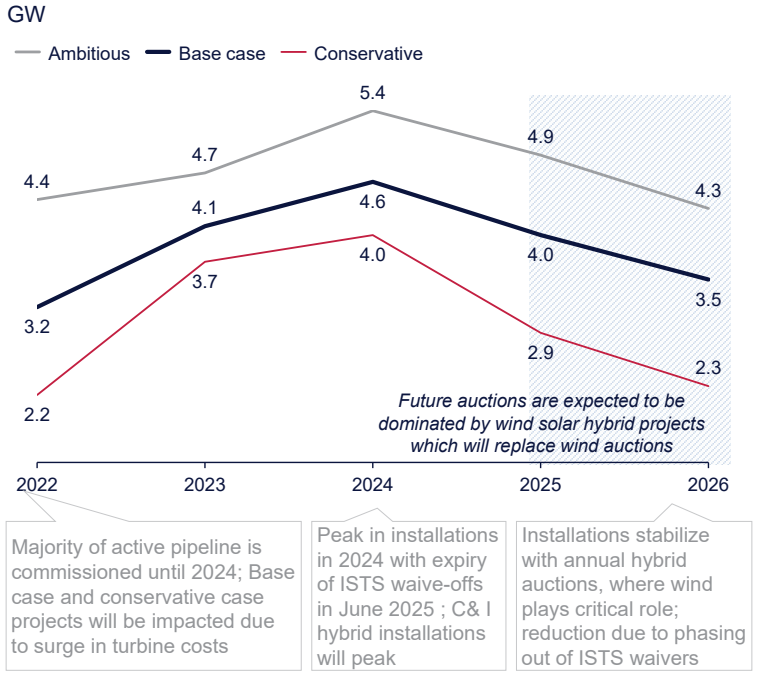
The major driver for future installations is the renewable purchase obligations (RPO) notified by the central and the state government in India. Until June 2022, the RPO trajectory by the central government was until the financial year 2022. In July, MoP announced a new trajectory till 2030 with separate wind RPO to carve out additional demand for wind technology. This is a welcome move to provide focus on the Wind related procurement in India. The forecast will be dependent on the response of states to new MoP RPO trajectory. The current forecast in this report is based on the way the states have been adopting the central government RPO in their planning. Our initial estimates on the impact of new RPO trajectory indicates that if these are implemented by states as intended it will reduce the base market outlook scenarios by ~2%. (See Note box 04)

Considering the current patterns in which state utilities are procuring RPO, over 2022-26, India is expected

to install nearly 19.4 GW of wind capacity, 76% of which will come from central tenders, followed by state utility markets and lastly corporate procurement.

In the conservative scenario, net volume installations dip to 15 GW as the existing pipeline shrinks due to the impact of supply chain scenario and new auctions being limited or sporadic. However, in an ambitious scenario, nearly 23.7 GW of volumes are installed over the next five years, driven mostly by high demand for price-competitive hybrid auctions across India, as well as an easing of supply chain challenges allowing complete and on-time actualization of the current pipeline.

Figure 1. Y-o-Y new wind installations in India 2022-26[5]



Installations 2022-26	Scenario definitions
23.7 GW	Active pipeline has no impact of surge in turbine costs and is commissioned by 2024; Remaining demand of state DISCOMs is fulfilled by new annual auctions of ~9 GW for hybrid till 2024; C&I installations for wind and hybrid scale with supportive central policies by 2026
19.4 GW	Active pipeline impacted with ~10% rise in turbine costs making projects of tariffs below INR 2.7/kWh unfeasible; remaining demand of state DISCOMs is fulfilled by new annual auctions of ~6 GW for hybrid till 2024; C&I installations regain pre-2019 levels for wind and ~1 GW annual hybrid installations expected from 2024 - 2026
15.0 GW	Active pipeline impacted with more than ~18% rise in turbine costs making projects of tariffs below INR 2.8/kWh unfeasible; remaining demand of state DISCOMs is fulfilled through new annual auctions of ~ 4 GW for hybrid; C & I growth is constant fairly driven by annual hybrid installations of ~ 0.5 GW from 2024 - 2026

Note: As per calendar years; Wind component of hybrid projects have been considered as a part of forecast; wind component of 0.4 GW RTC I, 0.25 GW RTC II and 1.2 GW peak power tenders have been included in the forecast; Tenders issued by PSUs have not been considered in forecast
Source: State ARRs; RPO documents; PGCIL; NTC and RTC Meeting minutes; credit rating report; CEA; SECI; MEC+ analysis

5 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated as per S & P Global quarterly report with ~18-20% hike in turbine costs as pessimistic case in 2021-2022 in comparison with 2020. As per IEA estimates, 10-25% increase is visible in wind turbine costs depending on country and region.

Towards 2030, the wind market offers multiple green shoots including offshore wind procurement, onshore wind repowering frameworks and the development of a robust wind export hub in India to serve the Asia-Pacific region, which can ease some of the cost challenges for OEMs in the country. As well, there is large untapped potential of the largest commercial and industrial (C&I) consumers and companies with RE100 commitments in India, which could unlock further RE demand within certain states.

To unlock the full potential of wind resource in India, we recommend the following actions:

1. **National and state governments must strengthen consensus and coordination** among various agencies to produce a consistent and aligned market roadmap. This can help to clarify target volumes and schedules of procurement, grid balancing needs and the composition and conditions for new tenders.

2. **Promote technology exchange and alignment to the global wind supply chain,** in order to create export-oriented opportunities for the Indian manufacturing base. This could include reconsideration of taxes and concessions on components which need to be imported, as well as working with intergovernmental and industry bodies to secure strategic stockpiles of commodities and critical materials required for large-scale wind growth.

3. **Repowering offers an efficient pathway for India to maximize productivity and socioeconomic benefits from sites already designated for onshore wind power production**. Policymakers should assess the annual volume of wind capacity nearing end of lifetime and enable repowering via regulatory fast tracks. Asset owners should be able to undertake repowering before the end of project lifetime, as there may be wider cost efficiencies and socioeconomic gains associated with upgrading technology at an earlier stage.

4. **Address the legacy challenges which have disrupted development of wind energy,** including DISCOM payment delays and risks, inadequacy of grid and transmission infrastructure and changes in state land policies which have made land acquisition a barrier to development.

5. **Finalise and implement offshore wind development roadmaps,** which can capitalise on the enormous resource potential in Gujarat and Tamil Nadu. This should include implementation of plans to absorb capacities that are likely to be added as part of the 37 GW offshore wind tender trajectory notified the government. Also, elements constituting necessary enabling environment must be identified and rolled out.

1. India's wind energy sector: Background

Wind will play an important role in the global power sector transition to achieve net-zero goals

The global power sector is witnessing a momentous transformation as the world moves towards a decarbonised future. COP26 in November 2021 was a milestone event where 151 countries announced decarbonisation goals and commitments to achieve carbon neutrality by 2050 and keep global warming within 1.5°C. With 25% of GHG emissions in 2020 originating from the power sector[6], the shift to renewable electricity, widescale electrification, energy efficiency and other measures are key drivers of the transition.

Global RE installations have increased at a rapid pace, with a growth rate of 14.3% over the past decade[7]. At 837 GW[8] cumulative installed capacity as of 2021, wind energy accounts for ~26% of total global RE installations. Wind energy will play a key role in the achievement of net zero targets by 2050, as per International Renewable Energy Agency (IRENA) and International Energy Agency (IEA) roadmaps for a 1.5°C pathway published last year, with wind energy being the major electricity generation source with roughly 8000 GW proposed installations by 2050[9].

The GHG emissions scenario in India follows the global trend, as power generation is the major source of emissions, contributing to ~56% of India's total emissions[10]. With national power demand expected to grow at a CAGR of 6% from 1,276 TWh in 2021 to 2,172 TWh by 2030, India needs to prepare for decarbonisation of the power sector to meet its transition goals[11]. RE remains the central axis of energy supply planning to meet increasing demand and cross-sector decarbonisation needs in India.

Over the last decade, India's RE capacity has expanded by more than 5 times, as the country moves toward long-term plans for decarbonization of the power sector. India reinstated its commitment to clean energy at COP26 in 2021, with the Prime minister announcing Panchamrit, or five firm targets to meet by 2030. This included a target of 500 GW of non-fossil fuel-based electricity generation capacity, meeting 50% of energy requirements from renewables, reduction of 1 billion tonnes emissions from 2021 and reduction of carbon intensity of the economy by 45%. Also, a long-term commitment to achieve net zero emissions by 2070 was announced.

High resource potential makes wind energy a key source for India's power sector transition

India has over two decades of experience in harnessing power through grid-connected wind energy. Between 2010-2011 and 2019-2020, wind energy in India experienced a CAGR of 11.39% while overall installed electricity capacity witnessed a CAGR of

6 Emissions by Sector; "Greenhouse Gas Emissions from Energy: Overview": IEA

7 "Renewable Capacity Statistics 2021": IRENA
8 "GLOBAL WIND REPORT 2022":GWEC
9 "Net Zero by 2050 Roadmap": IEA; "World Energy Transitions Outlook": IRENA

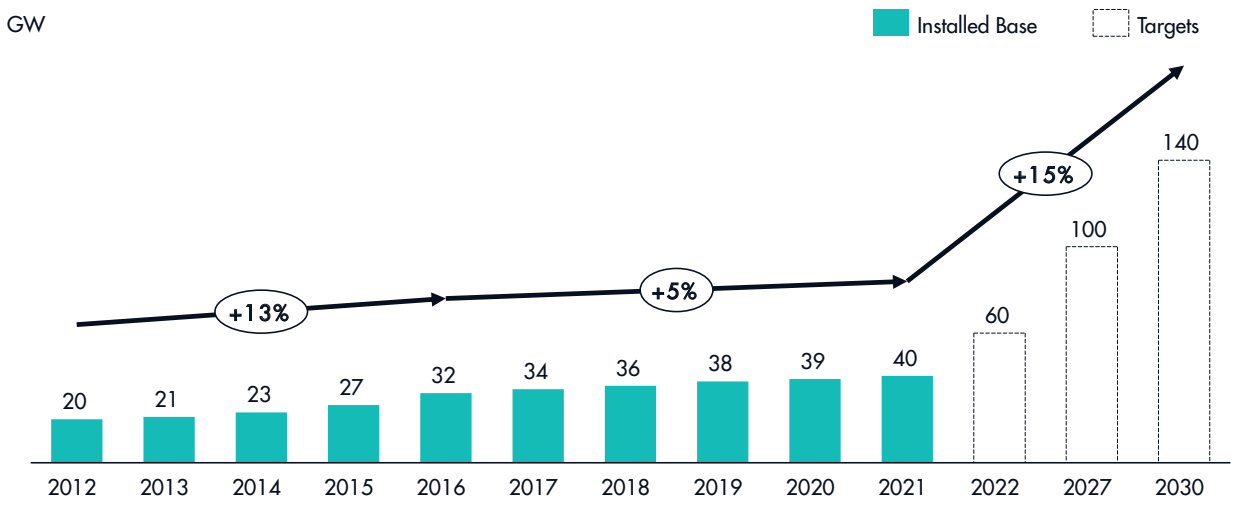
10 "India- Third Biennial Update Report to The United Nations Framework Convention on Climate Change" : Ministry of Environment, Forest and Climate Change, Government of India,2021
11 As per the India Vision Case in the International Energy Agency's India Energy Outlook 2021

8.78%[12]. Wind power continues to be a major constituent of India's power generation mix and constitutes 37.7%[13] (40.1 GW) of cumulative installed RE capacity, as of March 2022. India contributes 5.1%[14] to total global onshore wind installations, making it the world's fourth-largest onshore wind market.

The National Institute of Wind Energy (NIWE), the autonomous research and development institution of the Indian Ministry of New and Renewable Energy (MNRE), has estimated wind power potential at 100m height as 302 GW[15] – almost 81% of the country's current installed electricity generation capacity. In offshore wind, India is home to 174 GW of technical resource across fixed-bottom and floating potential, mainly off the coasts of Gujarat and Tamil Nadu. Together with cost-competitiveness and resource complementarity for round-the-clock (RTC) solutions, this makes wind energy a critical link in India's power sector transition.

Over the last five years (2017-2021), wind energy installations have drastically slowed down to a 5% growth rate, in comparison with ~13% growth over the period of 2012-2016. During 2017-2019 a slowdown is witnessed as competitive bidding was introduced and multiple wind policy changes were implemented. Also, slowdown in 2020-2021 is due to the impact of the first and second waves of the COVID-19 pandemic and wind supply chain disruptions during monsoon season.

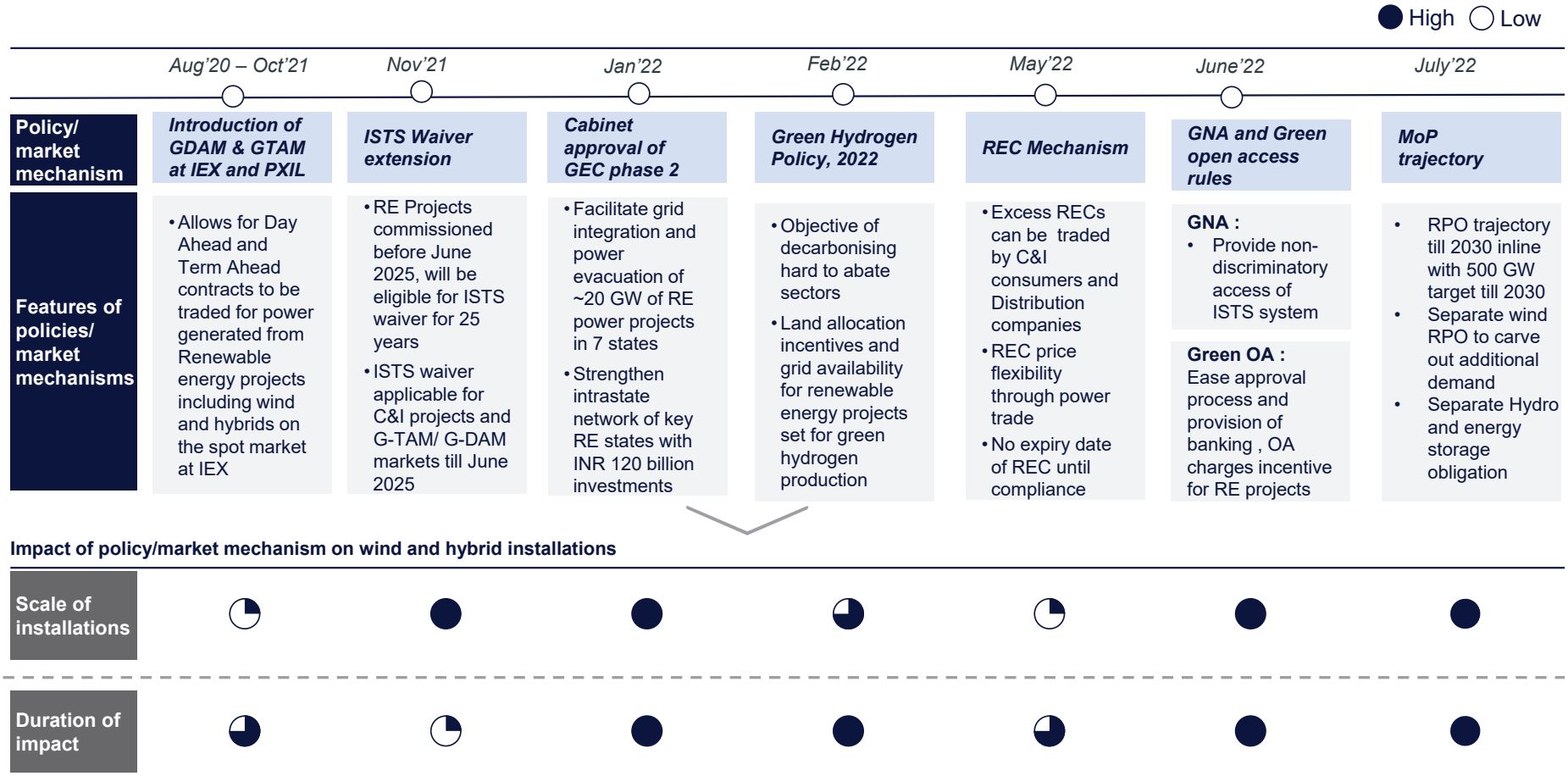
Figure 2. Total wind capacity in India to 2030



To revive growth in the wind market and promote RE, the Indian government announced new policies and market mechanisms in 2021. In July 2022, MoP has announced RPO trajectory till 2030 to showcase roadmap for achieving target of 500 GW of renewable generation capacity.

12 Based on CEA's Growth of Electricity Sector in India from 1947-2020
13 As on March 2022 as per CEA monthly installed capacity report
14 "GLOBAL WIND REPORT 2022":GWEC
15 "India's Wind Potential Atlas": NIWE

Figure 3. Recent central policy announcements and their impact



Note: 'Scale of Installations' refers to impact on wind and hybrid installations due to policy; 'Duration of Impact' refers to long/medium/short term impact of policy;
Source: MNRE; Newspaper articles; MEC+ analysis

These recent policy announcements will favour a gradual shift of RE installations from standalone wind and solar projects to hybrid installations in the medium term for central auctions and the C&I segment.

2. Wind resource competitiveness

Cost competitiveness and resource complementarity for RTC solutions make wind an attractive resource in comparison with conventional sources

Wind is an attractive, cost-competitive, and utility-scale resource in India, despite current supply chain challenges. On average, wind LCOE is 40% lower than most coal plants operating in the country, providing much needed renewable electricity at affordable rates[16].

Our earlier projections envisaged wind LCOE to reach INR 2.6/kWh by 2022. However, LCOE price in 2022 is expected to be in the range of INR 2.8-3.3/kWh, owing to the following key reasons:

- **Surge in commodity prices:** Turbine OEMs are facing cost pressures due to cost inflation of related raw materials and critical wind turbine components. Steel is a major component used in turbine manufacturing. The resurgence of steel demand from the pandemic, shipping disruptions and increased power outages in mainland China have led to an increase in commodity prices inclusive of steel, with expected prices to be 25-30% higher than 2021, which was still higher than the previous years.
- **Supply chain disruptions:** Supply chain instability caused by the pandemic and the impact of the invasion of Ukraine have led to availability issues of cargo ships and a spike in fuel costs, resulting in an increase in logistics prices.
- **Increase in tax rates:** Surge in GST rates for wind components manufacturing from 5% to 12%, and the elimination or revision of Customised Custom Duty Concession benefits has increased upward pressure on wind LCOE.
- **Legacy challenges:** Legacy challenges such as unavailability of adequate power evacuation and transmission infrastructure, delays in clearances and permits and land acquisition among others continue to push project implementation costs at higher level.

While the wind turbine prices has increased by ~12-18%[17], coal prices have surged by more than 75%[18] over 2021-22. So, the cost differential between renewables and coal power plants is expected to remain the same towards 2026, as wind turbine technology is expected to improve in India with the launch of more efficient and advanced models by turbine OEMs, decreasing the per MW CAPEX (see figure 4).

Solar shall remain a cost-competitive and complementary resource alongside wind towards 2026. As wind has stronger capacity utilization factors (CUFs), a more consistent daily generation profile, lower societal costs, lower marginal costs for dispatch and lower balancing costs, wind is an attractive proposition as a standalone solution over solar in many conditions.

16 Referencing coal-based plants typically located 500 km from domestic coal mines but using domestic coal as fuel.

17 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated as per S & P Global quarterly report with ~18-20% hike in turbine costs as pessimistic case in 2021-2022 in comparison with 2020. As per IEA estimates, and IEA Renewables report 10-25% increase is visible in wind turbine costs depending on country and region.

18 Representative price comparison over 2021-2022 by Ministry of Coal

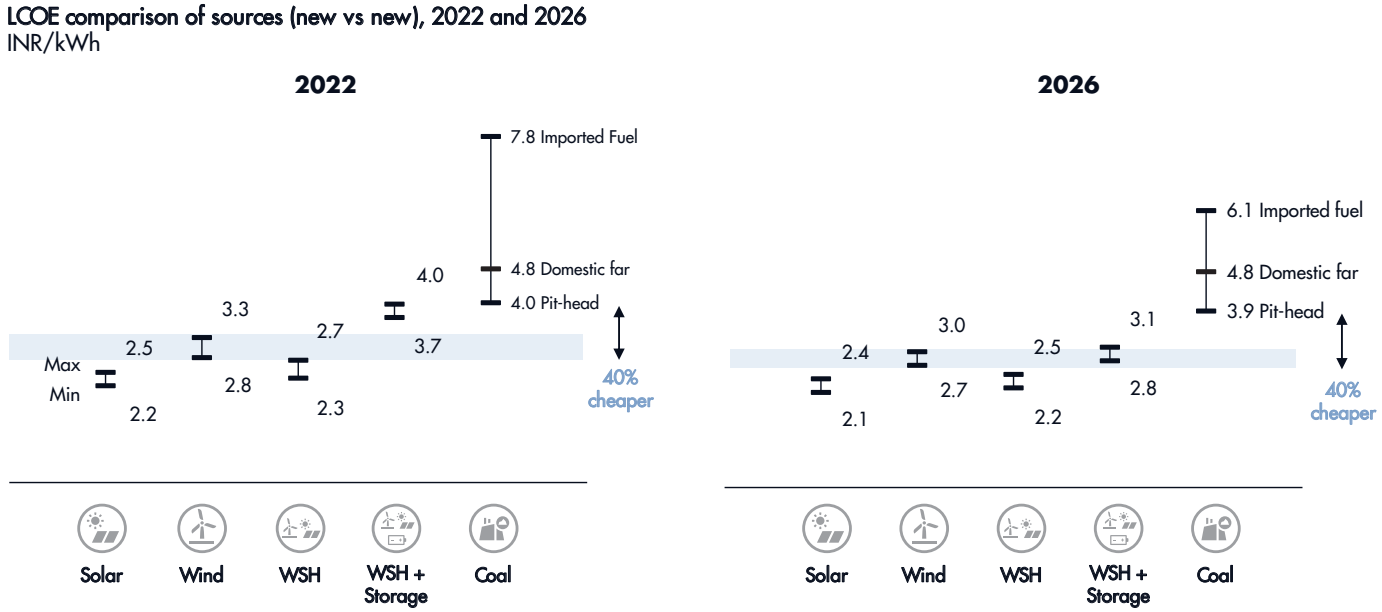
Wind and solar together have complementary generation profiles in terms of the time of the day and seasonality. In all seven high wind potential states, solar resource availability is also high. Hence, wind and solar hybrid projects bring greater benefit to the consumer in terms of substituting 55-70% of grid power in comparison with 40-45% CUF of standalone wind[19].

When comparing LCOE of all sources of power generation in 2022, wind is the second-cheapest renewable energy source in the range INR 2.8-3.3/kWh, which is 40% lower than conventional sources of energy. This is followed by WSH having an LCOE between standalone solar and wind sources in the range of INR 2.8-3.3/kWh in 2022 – this is further expected to fall by 2026 in line with the reduction in wind prices. (See Figure 4)

WSH coupled with battery storage provides RTC solution for consumers (see Note Box 1). As of 2022, high battery costs mean this solution still needs to gain in competitiveness compared to conventional sources. However, WSHs with battery storage solutions are comparable to conventional sources with LCOE in the range of INR 3.7-4.0/kWh. By 2026, the viability of this round the clock solution (WSH + storage) will depend on the reduction of battery storage prices (see Note Box 2).

19 MEC+ estimates based on existing hybrid project

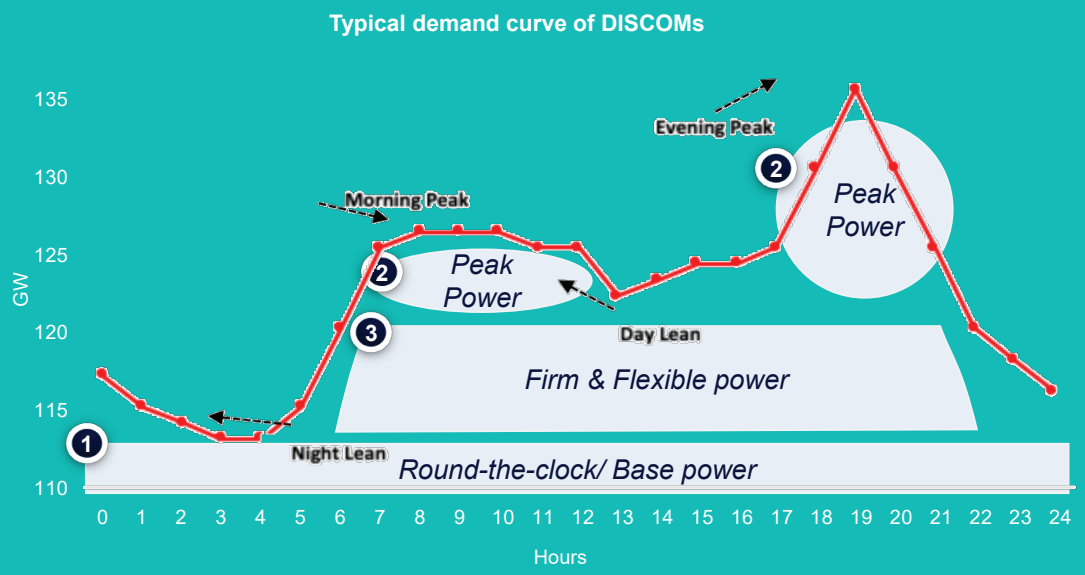
Figure 4. Renewables LCOE - 2022 and 2026



Note: Wind and solar LCoE calculations done at 12% internal rate of return, and coal calculations done at 14% return on equity. Developer assumptions for WSH + Storage: IRR – 12%, Solar – 25% CUF, Wind – 40% CUF
Does not include transmission and distribution charges for any source
Pit-head are coal plants using domestic coal and located near the mine; domestic far plants also use domestic coal but are located far from the mine (~500 km); Imported fuel plants make use of imported Australian coal
New vs New: Implies comparison of new coal being commissioned in 2020 and 2025 with wind and solar commissioning in same years
Source: CEEW; BNEF; Lazard; MEC+ analysis

Note Box 1: Procurement of Round the Clock (RTC) Power

Figure 5. Requirement of round the clock base power



DISCOM Needs

Round the clock power

- Base power supply running majority time of the day to serve night lean; generating 24 X7
- CUF requirements:
  - Annual: 75-80%
  - Monthly: 75-70%
  - Hourly: 60-70%
- Replacement of Thermal power generation to a large extension, operating at CUFs above 50-60% annually

Need for RTC power

Distribution companies (DISCOMs) require sources of 24/7 power supply for efficient supply planning. Due to variability in generation, standalone RE sources are unable to provide RTC power, so they are currently dependent on conventional sources such as coal to meet RTC power requirements.

Also, DISCOMs require a firm and consistent supply of RE power to maintain grid stability, so there needs to be a balancing power which can offset variability of renewables. Combining RE with other renewable or conventional sources such as energy storage systems (ESS), wind/solar, thermal, or hydro is required for 24/7 power supply.

RTC power - Market activity

In Oct 2021 the second RTC tender (RE bundled with Thermal) was auctioned. Despite full subscription, 0.25 GW was awarded due to inability of winners to match L1 bid levels, as needed by the tender terms. The remaining 2.25 GW capacity is to be reauctioned in 2022 with revised provisions. The tender is subsequent to the RTC-I tender of 0.4 GW and assured peak-power tender of 1.2 GW awarded in 2020.

With the high LCOE costs of ESS storage solutions, currently India sees the majority of RTC blending of RE with thermal projects. Declining ESS costs in the future will enable RTC tenders and projects to source 100% of energy from RE sources.

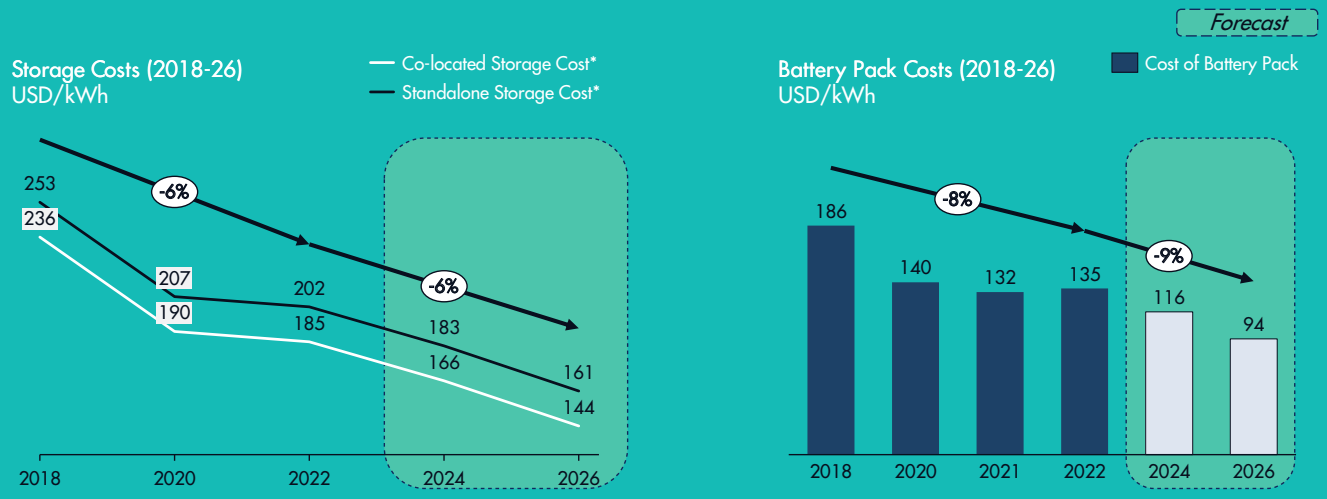
Note Box 2: Decline in battery costs by 2026

Lithium-Ion battery pack prices, which were $186/kWh in 2018, have decreased sharply at a CAGR of -8% to $132/kWh in 2021. Contrary to the trend, battery pack costs increased slightly to $135/kWh in 2022, driven by the increased costs of key raw materials like electrolytes and rising commodity prices are putting pressure on the storage industry.

However, in the medium to long-term battery pack costs are expected to decline at a CAGR of -9% until 2026 and dip below the $100/kWh mark in the year. This will lead to decline in co-located storage costs at a CAGR of -6% until 2026.

The expected fall in battery prices by 2026 would make WSH combined with storage a viable proposition in comparison with conventional generation sources for RTC power generation.

Figure 6. Storage and Battery Pack costs forecast in India (2022-26)



*Note: *includes cost of Battery Pack, BoS Hardware, BoS Inverter, Soft costs, EPC*
Source: "Estimating the Cost of Grid-Scale Lithium-Ion Battery Storage in India" Berkely Lab; Bloomberg NEF; MEC+ analysis

3. Current wind market activity

Project and market activity was challenged by the second wave of the COVID-19 pandemic, but recovered in H2 2021

i. Project Activity

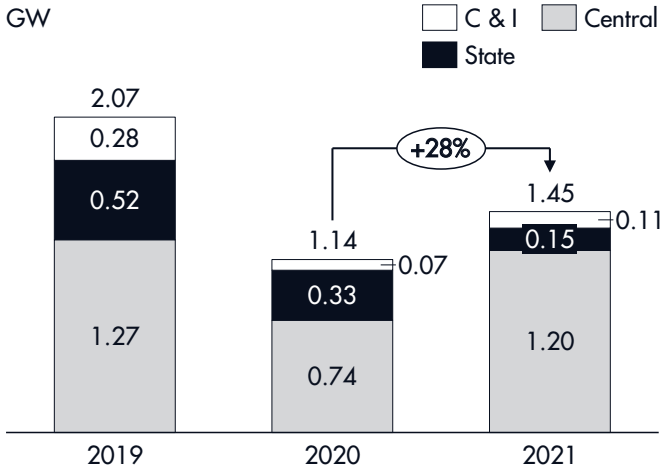
Wind project activity in India was lower than expected in 2021, with 1.45 GW of wind installations despite a large, expected pipeline of 2.3 GW. Delays caused by the second wave of the COVID-19 pandemic and supply chain-related disruptions led to a slowdown in projects commissioned during 2021.

Wind installations were driven by central auction capacities with more than 80% (1.2 GW) of projects commissioned in 2021. The remaining 0.25 GW projects were commissioned from state tenders and C&I segments (see figure 7). SECI Tranche II, III, IV and VI auctions which took place during 2017-2019 constituted 1.2 GW of central auction wind energy projects. Gujarat state projects constituted ~0.15 GW capacity and ~0.1 GW capacity came from C&I installations in 2021.

Growth slowdown due to delays and cancellations

At the beginning of 2021, we expected 14 projects of nearly 2.3 GW of wind capacity to come online within the year. However, 3 projects of ~0.7 GW have been delayed to 2022. These were delayed due to the second wave of the COVID-19 pandemic and wind supply chain disruptions due to heavy monsoons in 2021[20]. To counter these issues in addition to delays caused by first wave, the MNRE granted a blanket

Figure 7. Y-o-Y Wind installations (2019-21)



20 "Time-extension in Scheduled Commissioning Date of Wind Energy Projects considering disruption due to post-COVID supply chain and monsoon related disruptions": MNRE order; dtd. March 17, 2022.

timeline extension of 7.5 months[21] to all projects which signed PPAs before June 2021.

As on date of report publishing, ~8.4 GW projects from state and central auctions have signed PSAs. Around ~6.4 GW of central projects are under construction stage with PSAs already signed by states. Out of these projects, ~3.6 GW are expected to be installed in 2022 and ~1 GW in 2023, in case the ongoing supply chain challenges do not worsen. Similarly, ~1.8 GW of state projects are under construction and expected to come online by 2025.

The highly competitive bids seen in previous SECI tranches have led to concentration of wind projects in a few substations of Gujarat and Tamil Nadu, as they have the highest resource potential and lowest cost of land. But concentration in these two states has led to significant delays and associated cost over-runs. This can be seen through delays in commissioning of Bhuj II, Jam Khambhaliya and Tirunelveli extension projects in 2021. Also, the impact of the COVID-19 pandemic is reported to be higher on existing pipeline projects as delays in grid availability impact multiple projects. The projects which have been impacted in 2021 include a central auction project under SECI VI of ~0.3 GW and a state auction project of ~0.1 GW in Gujarat. Further, the only remaining central auction project under SECI V has been delayed due to grid availability issues. On the positive side, no central and state projects have faced cancellations in 2021.

Going forward, a further 1.2 GW projects with SCD in 2023, including ~0.6 GW of central auction projects under SECI tranche IV & VI and ~0.6 GW of state projects in Tamil Nadu and Maharashtra are expected to be delayed. The reasons for uncertainty can be attributed to land allocation challenges and delays in grid availability[22]. T

Further project cancellations are expected in the existing project pipeline as the focus on low-cost bidding (L1 prices) in current tender design has left no room to absorb inflationary pressure on wind projects (see Note Box 3 regarding the impact on the existing pipeline).

21 MNRE orders on timeline extension of projects: Order1: May 2021; Order 2: March,2022

22 CERC Developer petitions for project extensions and cancellations.

ii. Market Activity

The evolution of tender conditions and support for complementarity of wind for hybrids have renewed interest for wind energy under the e-reverse auction mechanism

Central auction activity – Standalone wind projects

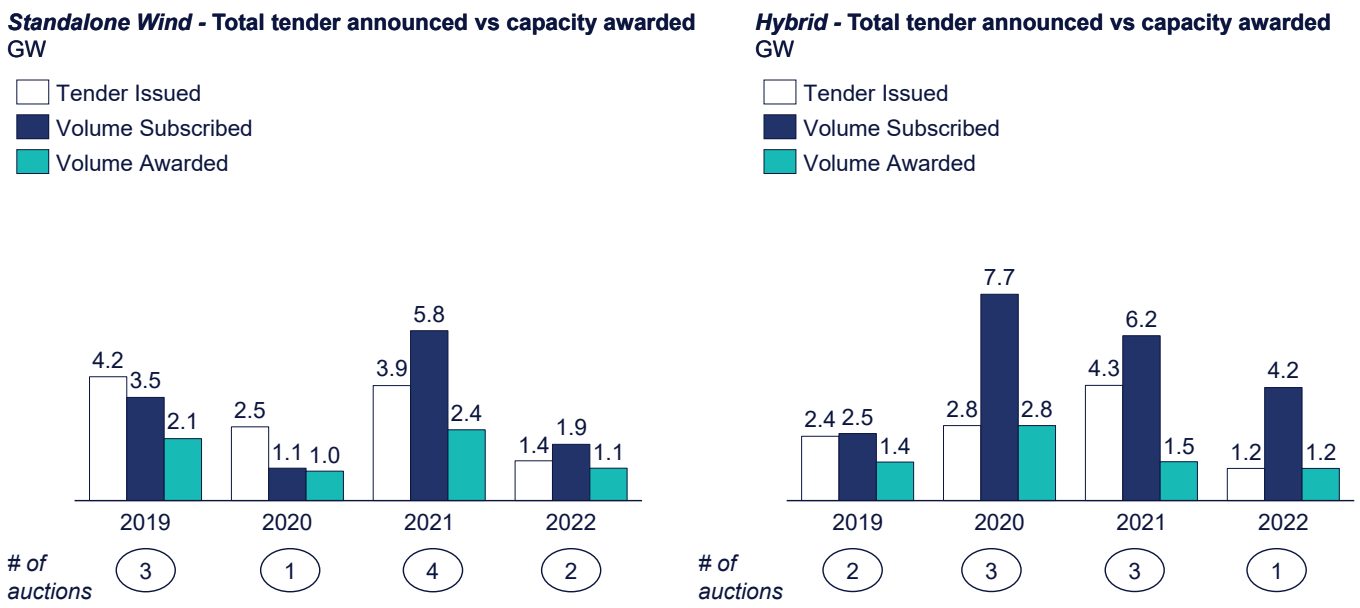
SECI's standalone wind projects have been oversubscribed in 2021, an improvement from the last two years when subscribed volumes were almost 50-80%.

In 2021, 3 tranches of SECI auctions totalling 3.6 GW and 1 auction of NTPC totalling 0.3 GW were issued for standalone wind projects; out of these, 2.4 GW was awarded under SECI tranche X & XI in 2021 and 1.1 GW was awarded under SECI tranche XII in 2022. Also in 2022, additional 1.2 GW of wind tenders under tranche XIII and 0.15 GW under NTPC were issued and was yet to be awarded at the time of report publishing.

SECI tranche X and XI tenders of 2.4 GW were oversubscribed by more than 2.5 times with a tariff range of INR 2.7-2.77/kWh, marking the revival of market activity in central standalone wind auctions. Despite, the continued oversubscription in SECI tranche XII, the awarded capacity stood at 1.1GW vs 1.2 GW tender, this was due the criteria of cut-off at L1 bid price+2% capping for discovered wind tariffs (range of INR 2.89-2.94/kWh).

SECI's standalone wind projects have been oversubscribed in 2021, an improvement from the last two years when subscribed volumes were almost 50-80%.

Figure 8. Standalone Wind & Hybrid- Total central tenders announced vs capacity awarded



Note: Total tender capacity for hybrid projects has been considered, actual wind capacity for hybrid projects might differ
Source: SECI; MNRE; MEC+ analysis

The renewed interest by developers in central auctions is primarily due to the evolution in tender conditions, as highlighted below:

- **Specification of procurer before the auction:** It is noteworthy that ~29% of the central pipeline is yet to sign a PSA with state DISCOMs. Also, out of 2.6 GW of total cancellations of central projects, ~0.3 GW central projects have been cancelled due to delay in PSA signing by states. SECI X and XI tenders specify the state DISCOM procurer of power generated, providing a level of transparency to boost developer confidence in the timely signing of back-to-back PSAs with DISCOMs. This will help to ensure the reduction of project cancellations or delays due to issues around DISCOM PSA signing.
- **Diversification of Land and Grid:** A majority of wind projects in SECI tranches I to IX have been awarded in Gujarat and Tamil Nadu. This has led to congestion in the grid at Bhuj and Tirunelveli substations. Of the 2.6 GW total cancellations of central projects, ~1.1 GW of central projects are cancelled due to land allocation issues and delays in commissioning of grid capacity before CoD. To improve the grid availability scenario, SECI tranches X and XI have started specifying land and grid details of the delivery point in the tender document before auctions. Also, the projects are in the states of Madhya Pradesh, Maharashtra, and Karnataka to avoid congestion in Gujarat and Tamil Nadu.
- **Removal of Tariff caps:** Market activity was muted over the past two years due to low tariff caps imposed by tender conditions. The removal of tariff caps during Tranche X and XI auctions resulted in increased bidding activity, as well as lower price levels of ~INR 2.7/kWh, as compared to ~INR 2.8/kWh in Tranche VII and VIII. The removal of the tariff cap can provide relief to developers in the medium term, as price increases from strenuous supply chain scenarios should be considered in future wind auctions.
- **Reduction in performance bank guarantee (PBG):** Delays in central projects have impacted the liquidity of wind developers.

Until November 2020, PBGs were in the range of 8-10% of contract value which limited liquidity. In 2021, PBGs have been reduced to 3% of contract value for all renewable tenders issued until March 31, 2023. This move will ensure the timely execution of existing projects and boost developer liquidity amid an economic slowdown and disruptions from COVID-19. Furthermore, it will lead to competitiveness in tariff rates during future central auctions.

- **Repowering of existing projects:** Repowering in central wind and hybrid auctions before 2021 was restricted to the allotted capacity during the auctions. Moreover, the sale of excess generation on repowering of a plant could only be sold to SECI at 75% of the rate prescribed in the PPA. Post-Tranche X and XI, capacity restrictions for repowering have been removed. Additionally, the obligation to sell excess generation to SECI has been removed and third-party sale of projects allowed.

The evolution of tender conditions in these changing market scenarios will lead to a positive long-term impact on demand, private-sector participation, and wind energy installations. This is visible with increased PSA signing activity after the previous report. Tranche IX and tranche X signed PSA in Dec 2021 and April 2022 respectively and pre-bid agreement with state of MP exists for tranche XI, leaving the recently awarded tranche XI as the only auctioned capacity without a PSA guarantee.

Central auction activity – Hybrid projects

Central auctions for hybrid projects have seen a surge of interest from developers due to multiple waivers announced by state and central governments.

In 2021, two tenders of 1.8 GW were announced, out of which one WSH tender of 1.2 GW was awarded under SECI Hybrid Tranche IV and remaining 0.6GW tender issued by NTPC is yet to be awarded. Additionally in 2022, one WSH tender of 1.2 GW was awarded under SECI Hybrid Tranche V.

In 2021, the announcement of waivers to OA charges as part of WSH policies by some states. along

with ISTS waivers by MoP, drew significant interest from developers in WSH projects. This resulted in oversubscription of Tranche IV Hybrid auctions by around five times the awarded capacity. This is an increase from around three times oversubscribed capacity during the Hybrid III auctions conducted in 2020. Also, heightened competition has led to a ~3% reduction in tariffs to INR 2.34/kWh during Hybrid IV auctions in comparison with the Hybrid III central auction.

The participation of PSUs has also begun in auctions conducted by SECI, with NTPC, NLC and SJVN submitting bids for hybrid projects. Other notable activities by PSUs in the RE sector include:

1. In March 2022, NTPC floated an Expression of Interest (EOI) for shortlisting suitable land sites from Rajasthan, Maharashtra, Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh, and Madhya Pradesh to set up wind projects.
2. NTPC, ONGC, SVJN and others are greening their energy portfolios through RE targets and conversion of non-performing fossil-fuel power generation assets into RE assets.

Apart from wind and WSH tenders, RTC power tenders with storage have been released by SECI. In 2021, RTC II tender with 2.5 GW capacity was issued for thermal energy blended with RE, out of which only 0.25 GW was awarded at a tariff of INR 3.01/kWh, due to inability of other winners to match L1 prices as required by the tender document. The remaining 2.25 GW capacity is to be reauctioned in 2022 with revised provisions. Earlier SECI had successfully awarded 0.4 GW under RTC-I tender and 1.2 GW under assured peak-power supply tender in 2020.

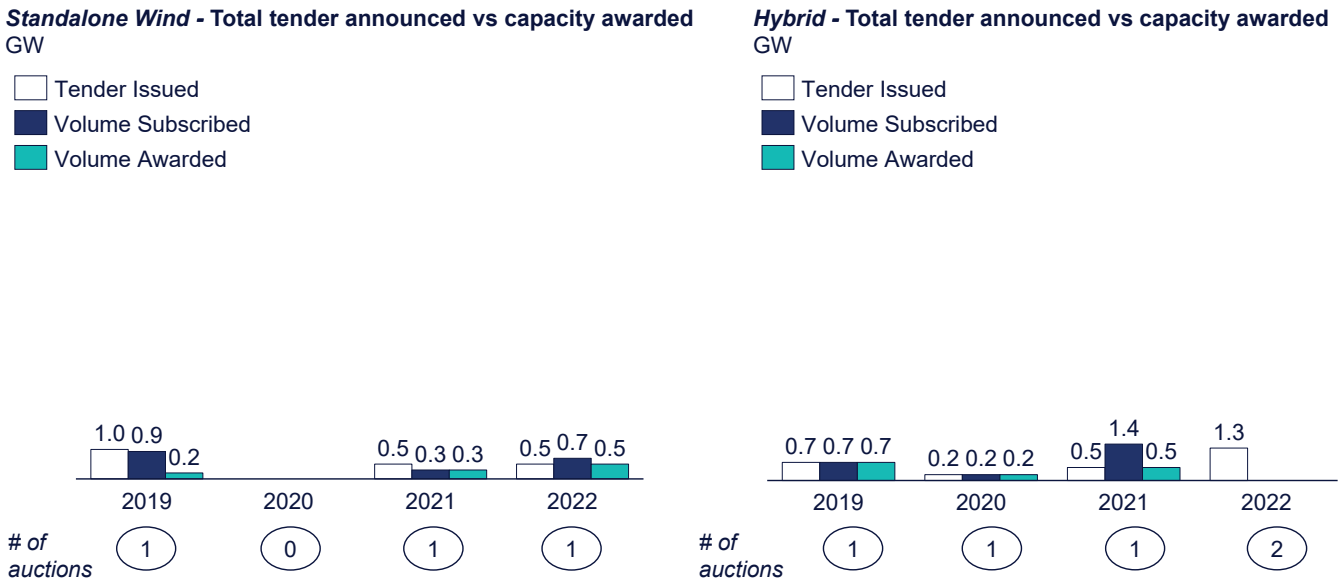
Enthusiasm towards hybrid and round-the-clock projects is translated also within off-takers, all hybrid tranches awarded to date has secured PSAs including RTC-I and Assured peak-power supply tenders, except recently awarded Hybrid tranche V and 400 MW capacity in hybrid tranche-IV.

State auction activity – Standalone wind projects

There are 7 key windy states in India, out of which 4 states (Gujarat, Madhya Pradesh, Maharashtra, and Tamil Nadu) have previously procured power through state auctions since 2017. But state auction activity in recent years has reduced due to the poor financial situation of DISCOMs; this has shifted the focus of wind procurement to central auctions for some states.

In 2021, Maharashtra issued a tender of 0.5 GW standalone wind, out of which 0.3 GW capacity was awarded at INR 3.44/kWh. Additionally, 0.5 GW was awarded by Gujarat in 2022, at a higher tariff range of INR 2.84-3.27/kWh. No other state except Maharashtra and Gujarat issued standalone wind tenders during the year. This scenario is in contrast with muted activity observed in state auctions during 2020, as no wind tenders were issued by any other state.

Figure 9. Standalone Wind & Hybrid- Total state tenders announced vs capacity awarded



Note: Total tender capacity for hybrid projects has been considered, actual wind capacity for hybrid projects might differ
Source: GUVNL, TANGEDCO; MSEDCL, MP-RUMLS, MNRE; MEC+ analysis

State auction activity – Hybrid projects

There has been renewed interest by states in 2021 for WSH auctions, compared to the drop observed during 2020 due to the COVID-19 situation. In 2021, Maharashtra issued and awarded ~0.5 GW of WSH tenders, which saw oversubscription by two times in a similar trend to central auctions. At the date of report publishing, the ~0.8 GW WSH tender issued by Madhya Pradesh and 0.5 GW issued by Gujarat for assured peak power supply are yet to be awarded. Karnataka has prioritized hybrid projects as part of its newly notified RE policy.

This shows that the evolution of tender conditions and government support for hybrid projects led to increased state auction activity during 2021-22.

4. Future wind installations (2022-2026)

A reinvigorated wind market in India building on a healthy pipeline and hybrid auctions

India is expected to install ~19.4 GW between 2022 and 2026 in the base case scenario, taking the cumulative installed base of wind power in India to 59.5 GW by 2026. These installations will be driven by central auctions, C&I, and state auctions.

In the base case scenario, central auctions are likely to contribute 14.9 GW across the existing pipeline and new auctions, while state auctions and private utilities are likely to contribute 3.1 GW. C&I will contribute ~1.4 GW installations (even though development activity is likely to be higher), driven by companies' need to shift towards RE to meet decarbonization goals and replace expensive power supply from DISCOMs.

i. Central auctions

India's wind sector underwent several positive developments in 2021 which will support installations from central auctions through 2026. A summary of the main drivers is provided in Table 1 below:

Favourable
Neutral
Unfavourable

Table 1 | Traffic- light indicator for future central wind auction segment

CHARCTERISTICS		COMMENTS
POLICY & REGULATION		The framework for tender execution is transparent and robust. Tender design changes in 2021 have ironed out issues on PSA signing and location specification.
INFRASTRUCTURE		Grid augmentation continued as per planning in 2021, with delays in the Bhuj II, Jam Khambhaliya and Tirunelveli extension projects. Due to the high concentration of central projects in substations in Gujarat and Tamil Nadu, delays in commissioning have impacted more than half the projects in the pipeline. GEC phase 2 approved by the Cabinet in 2022 will strengthen intrastate network for future projects.
DEMAND		Central government has released wind RPO for procurement of power through projects post March 2022 to carve out additional demand for wind. PSA signing has increased over past 1 year for central wind and hybrid projects indicating positive outlook of states towards wind procurement.
PROJECT EXECUTION		Land policies have been streamlined in the states of Karnataka, Gujarat, Maharashtra, Rajasthan, and Madhya Pradesh, but the ground-level impacts are yet to be observed. ISTS charges have been waived until June 2025.
PIPELINE		There was strong activity in 2021 to meet the PSA bottlenecks of central auctions. A ~9.8 GW pipeline of awarded central auction projects exists, as on date of report publishing.

Demand and economics

A key demand driver for wind installations is the non-solar Renewable Purchase Obligation (RPO). Central auctions were created as a pathway for procurement of wind by non-windy states, however, slowly certain windy states have joined in. Currently, central auction procurement is fuelled by demand majorly from 14 non-windy states[23] and three windy[24] states which procure power from central auctions.

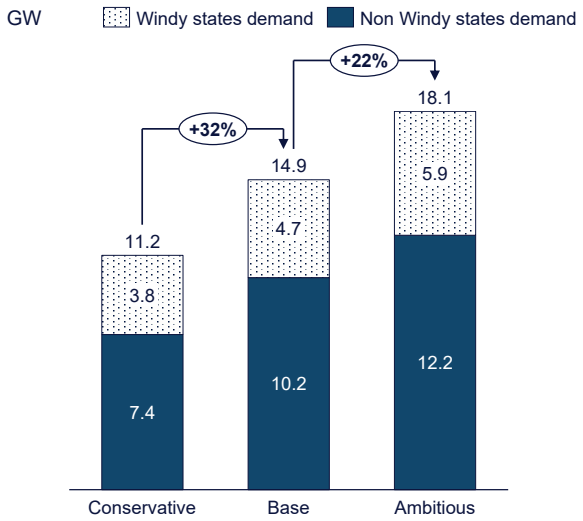
Out of these 17 states procuring power through central auctions, Odisha, Haryana, Uttar Pradesh, Madhya Pradesh, and Rajasthan have defined their RPO trajectories until 2026; for the rest of the states, it is not defined beyond 2022. This indicates that remaining states may take multiple trajectories for RPO definition towards 2026.

In July 2022, MOP came up with new trajectory until 2030. States will take time to adopt these trajectories.

23 14 non windy states are UP, Bihar, Punjab, Jharkhand, West Bengal, Haryana, Telangana, Kerala, Assam, Goa , Delhi, Odisha, Chhattisgarh and Puduchchery

24 The three windy states comprise Tamil Nadu, Madhya Pradesh, and Rajasthan. Rajasthan and MP is procuring power from central auctions due to poor wind resource and Tamil Nadu due to poor financial condition

Figure 10. New wind demand in central auctions (2022-26)



Source: MoP RPO targets; MEC+ analysis

The response of states to new RPO trajectories announced by MoP till 2030 will determine the impact on wind demand for central auctions (See Note Box 4). Going forward, there are two possibilities of RPO adoption by states, to either continue with historical run-rate of state non-solar RPOs or adopt the MoP trajectory for wind-specific RPOs towards 2030.

However, given the regulatory structure, state defined trajectories take precedence as on date. Three scenarios of central auction demand can emerge from the 14 non-windy states and 3 windy states, depending on state adoption post 2022:

- In the conservative case scenario, the states may not increase their budget, creating a demand of ~11.2 GW.
- In the base case, the RPO target is expected to vary between 6-12.5% in 2025, if states continue to increase RPO targets at respective historical rates, this would create demand for ~14.9 GW[25] of new wind procurement until 2026.
- In the ambitious case, demand for 18.1 GW is projected based on the growth at same pace as of old MoP[26] trajectory defined till 2022 (refer to figure 10).

The average power purchasing cost (APPC) across 19 states procuring power from central auctions is reported to be 30-35%[27] higher as compared to standalone wind prices in central auctions. Also, these states have APPC ~50% higher in comparison with hybrid wind projects of central auctions. Around 64-67% of demand can be met through the existing issued and awarded pipeline of central auctions.

The high demand for central auction tenders and a favourable business case in comparison with existing APPC, is reflected in a surge of PSA activity with signing of PSAs for SECI VIII, IX, X and Hybrid III & IV, between

25 RPO targets set by states & MoP until 2022 and beyond

26 No impact of new MOP trajectory of wind RPOs is incorporated in the forecast as on the date of report publishing, however, possible impact is indicated in note box 10

27 State & National APPC tariff orders 2021

December 2021 to date of report publishing.

Pipeline

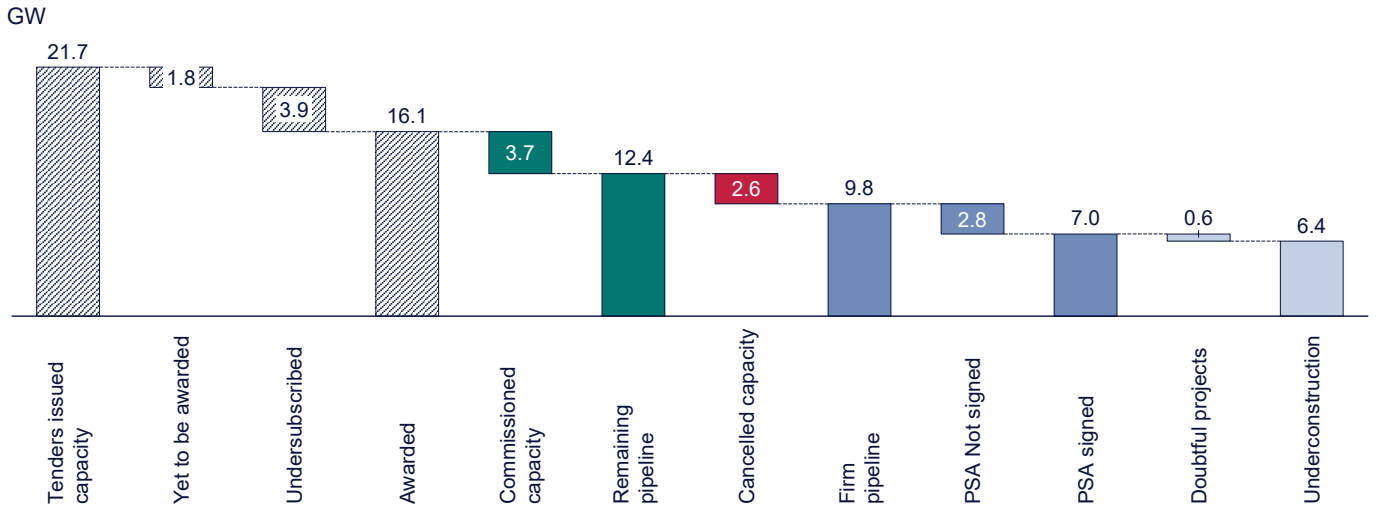
India issued ~21.7 GW of standalone wind and wind component of WSH capacities in central auctions between February 2017 to date of report publishing. Out of ~21.7 GW issued tenders, 20.3 GW standalone wind tenders were issued during this period[28], out of which 15 GW was awarded. Additionally, 6.6 GW of hybrid auctions (1.4 GW in wind) was issued in the same period, of which 5 GW of hybrid projects (1.1 GW in wind) was awarded[29]. This creates a net awarded capacity of 16.1 GW. The breakdown of the status of awarded wind volumes in central auctions is in figure 11.

Out of total 20.3 GW standalone wind capacity tenders, 1.7 GW capacity is yet to be awarded from wind tenders issued under SECI tranche XIII and NTPC tenders. Additionally, 0.6 GW hybrid tender (0.1 GW of wind component) of NTPC issued in 2021 is yet to be awarded.

Central auctions have a firm pipeline of 9.8 GW (8.8 GW wind and 1 GW wind component of hybrid) scheduled to be commissioned by 2025. As on date of publishing of report, 7 GW projects have signed PSAs with state DISCOMs. Out of 7 GW, ~0.6 GW projects with signed PSAs are at risk of delay or cancellation by the developer due to land allocation and grid availability issues. Also, 2.8 GW of pipeline projects are yet to sign a PSA with a state DISCOM, which might impact future installations.

The pipeline excludes the 2.6 GW of projects which have been cancelled by developers due to infrastructure issues and delays in the signing of PSAs by states.

Figure 11. Status of projects awarded in central auction as on date of report publishing (Wind+ Wind component of Hybrid)



Note: Pipeline does not contain RTC - I of 0.4 GW and RTC - II of 0.25 GW
Source: SECI; MNRE; MEC+ analysis

28 Pipeline data is considered as per "GWEC Market Intelligence Wind Auction Updates Q1 2022"
29 MEC+ estimates based on hybrid tender requirement for CUF and other factors.

The supply chain scenario will impact future wind installations

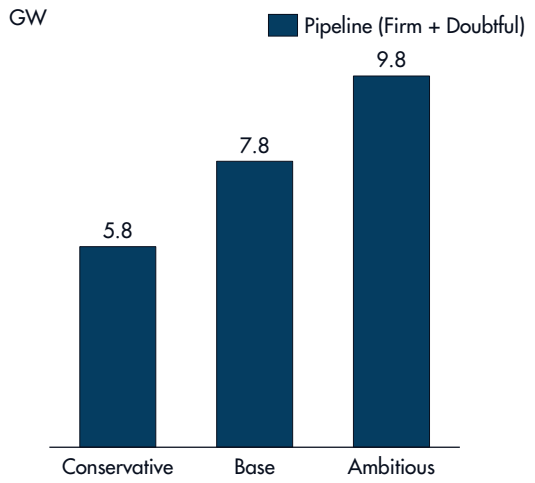
Existing central pipeline projects are highly sensitive to the evolving supply chain challenges, as turbine costs impact project viability. This scenario might take overall project cancellations to 2-4 GW for existing awarded projects (See Note Box 3).

The three scenarios for pipeline are driven by recent developments in market conditions. Wind turbine prices have increased in 2022 owing to cost pressures and supply chain issues faced by turbine OEMs. The wind turbine price surge will increase LCOE of wind projects which may impact viability of some projects in pipelines with lower auction tariffs:

- In the base case scenario, projects below INR 2.7/kWh will be unviable due to 10%[30] increase in wind turbine rates. This emerging situation may lead to ~2 GW additional cancellations in standalone wind pipeline, leaving ~ 7.8 GW of projects in pipeline.
- In the conservative case scenario, projects below INR 2.8/kWh will be unviable due to a more than 18%[31] increase in wind turbine rates which will lead to an additional 4 GW cancellations of standalone wind tenders, leaving ~5.8 GW pipeline.
- In the ambitious case, we have assumed no impact on existing pipeline from a wind turbine price surge.

As of on date of report publishing, the overall pipeline in the base case plus issued tenders until 2021 is ~9.6 GW (7.8 GW base case pipeline + 1.8 GW issued tenders) of projects with standalone wind and wind components of hybrid tenders. In addition to wind & hybrid tenders there is 1.85 GW of RTC I & II and assure peak power tender pipeline in central forecast.

Figure 12. Central auction pipeline under 3 scenarios



Note: 'Conservative Case' – Tariff cap at INR 2.8/kWh; 'Base Case' – Tariff cap at INR 2.7/kWh; 'Ambitious Case' – No Tariff cap
Source: SECI; MNRE; MEC+ analysis

Further, in the forecast period we can see reinvigoration of interest in state market. MNRE has suggested moving away from e-reverse bidding and conducting state-specific closed envelope auctions.

30 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated as per S & P Global quarterly report with ~18-20% hike in turbine costs as pessimistic case in 2021-2022 in comparison with 2020. As per IEA estimates ,and the IEA Renewables report, 10-25% increase is visible in wind turbine costs depending on country and region.

31 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated by news articles on Turbine OEM . As per IEA estimates, 10-25% increase is visible in wind turbine costs depending on country and region from 2020. Wood Mackenzie estimates 10% increase over 12 months due to increases in commodity prices, logistics costs, and COVID19-related challenges.

Note Box 3: Pipeline is highly sensitive to supply chain cost challenges

As on the date of report publishing, out of the 9.8 GW firm pipeline of wind and hybrid central projects, 1 GW is wind component of hybrid tenders, which is immune to WTG price rise due to blending with solar.

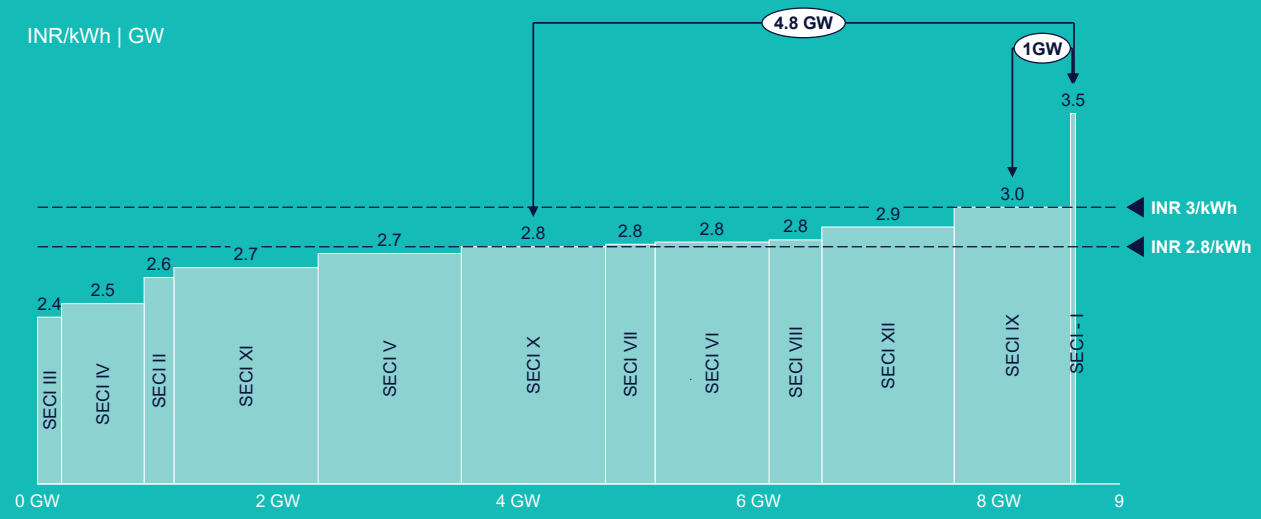
For the remaining 8.8 GW pipeline in standalone wind tenders, LCOE is expected to increase due to the surge in turbine market prices arising from cost pressures and supply chain issues in 2022. Estimates suggest LCOE today to be in range of INR 2.7/kWh, which can result in 2 GW cancellation in 8.8 GW pipeline.

Further sensitivity of wind pipeline can be illustrated from the numbers below:

- In case the LCOE increases to INR 2.8/kWh, nearly half of existing pipeline projects are cancelled or delayed, leaving a pipeline of 4.8 GW in standalone wind pipeline (which is the current conservative scenario in the report)
- However, if the LCOE rises to INR 3/kWh, would impact the viability of the existing 7.8 GW standalone wind central project pipeline with lower awarded tariffs, leaving an active pipeline of 1 GW

Envision has already announced ~1.9 GW wind turbine orders to be delivered in the first half of 2023 for Indian wind projects, making the second case unrealistic. Nonetheless, the high sensitivity of the standalone wind pipeline towards LCOE increases and supply chain conditions cannot be negated and can impact forecasts.

Figure 13. Central standalone wind pipeline Tariff & Pipeline vs LCOE Cut-off



*Note: **cut-off refers to the project tariff below which project would be deemed economically non-viable*
Source: MNRE; SECI; MEC+ analysis

Grid availability

Nearly 29 substations have been allocated to evacuate wind power in India. The auction design of previous tranches has led to concentration of wind projects to a few substations in Gujarat and Tamil Nadu. This has led to cancellations of ~1.4 GW of central auction projects due to lack of grid availability. To ensure grid availability, substation details outside Gujarat and Tamil Nadu were specified in tender documents of Tranche X and XI before the award of projects. The substations specified under Tranche X and XI were Rajgarh in Madhya Pradesh, Kallam in Maharashtra and Koppal and Gadag in Karnataka has led to developers exploring projects in states outside Gujarat and Tamil Nadu.

But current pipeline has led to congestion of projects in four substations: Bhuj I, Bhuj II, Jam Khambhaliya and Tuticorin/ Tirunelveli. Any delay in grid commissioning of these substations will impact the commissioning of more than 50% of projects in the pipeline.

As per plan, 7.5 GW project capacity was scheduled to be commissioned in 2021-2022. Out of 7.5 GW capacity, 6 GW capacity was scheduled to be commissioned by 2021 in Bhuj I (1.5 GW), Bhuj II (2GW), Jam Khambhaliya (2GW) and Tuticorin/ Tirunelveli (0.5 GW); while remaining 1.5 GW capacity was scheduled to be commissioned by 2022 in Bhuj I substation extension. However, in 2021 only Bhuj I s/s of 1.5 GW grid capacity was commissioned. The remaining 4.5 GW capacity got delayed to 2022[32] due to Right of Way (RoW), land allocation and permit and approval issues.

To develop an intrastate network, the central government has announced two phases of Green Energy Corridors (GEC). The first phase is expected to be completed by 2022. With the approval of the second phase of GEC, the grid availability scenario is expected to ease for future installations. Also, states like Karnataka allowing project developers to connect to the ISTS through the STU network will shift project installations outside Gujarat and Tamil Nadu.

32 "Report Indicating Status of Construction of Sub Stations (220 kV & Above)" March 2022; CEA

Land availability

The policy for land availability in key states has been stable in 2021. Presently, the states of Gujarat, Maharashtra, Rajasthan, and Madhya Pradesh have a dedicated land allocation policy for RE projects including wind. Andhra Pradesh has released an RE export policy in 2020, which has opened the state for siting new wind projects as land allocation for RE export projects is prioritised. Karnataka has released a new RE policy in 2022, which will ease procurement of agricultural land for RE projects and has a provision for project construction without waiting for land conversion. No land policy update is observed in Tamil Nadu region which might impact few projects in pipeline.

As per the current scenario, the land allocation process along with land use conversion permits usually takes around 6-9 months. But in a few states where land policies are not streamlined the delays in land allocation were observed up to 18-24 months. This has resulted in several petitions for timeline extensions from developers to avoid encashment of PBG which in turn leads to project cost overruns.

Land policies have been revised and the process is being streamlined in key windy states. However, the results of the execution of new land policies are yet to be seen. So, some delays may be expected in future project installations.

ii. State auctions

State auctions comprise tenders from DISCOMs in seven windy states[33]. But the scenario has changed since 2017, as only four states (Gujarat, Madhya Pradesh, Maharashtra, and Tamil Nadu) have procured power through the state auctions. The table below summarises the key drivers of the market:

33 The seven windy states comprise Gujarat, Maharashtra, Tamil Nadu, Karnataka, Madhya Pradesh, Andhra Pradesh, and Rajasthan.

Table 2 | Traffic-light indicator for state wind auction market

CHARCTERISTICS	TRAFFIC LIGHT INDICATOR	
POLICY & REGULATION		A roadmap is needed to define the volume, frequency, and composition of new tenders.
INFRASTRUCTURE		Windy states have been major procurers of wind in the last two decades and grid infrastructure is sufficiently available. GEC phase 2 approved by the Cabinet in 2022 will strengthen intrastate network for future projects.
DEMAND		RPO enforcement required by SERCs and RPO trajectory post-2022 needs to be defined.
PROJECT EXECUTION		Land policies have been streamlined in the states of Karnataka, Gujarat, Maharashtra, Rajasthan, and Madhya Pradesh, but the ground-level impacts are yet to be observed.
PIPELINE		Existing pipeline is limited at 2.1 GW of standalone wind projects, of which 0.6 GW projects are facing project delays

Favourable
Neutral
Unfavourable

The four states with high wind resource have been traditionally driving wind procurement in India through Feed-in Tariffs (FITs) since 2017. However, state-led wind procurement has declined, following the introduction of central auctions which is more attractive for project developers.

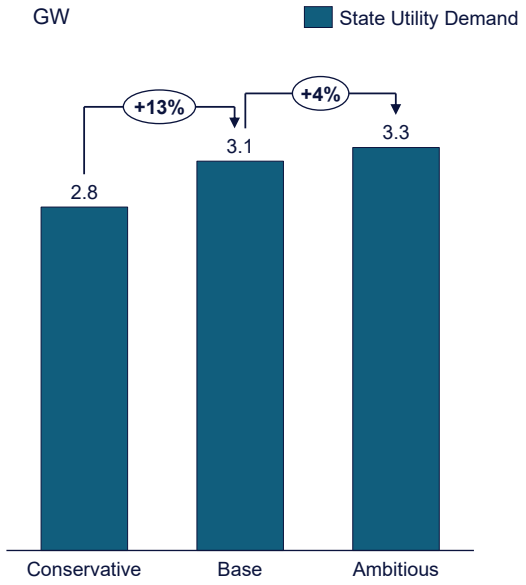
Going forward, uncertainty around wind procurement continues in the state market, even though states have pent-up RPO demand.

Demand and Economics

State DISCOMs in the four windy states (Gujarat, Maharashtra, Andhra Pradesh, and Karnataka) will procure power through their own auctions due to unmet demand. As the RPO trajectories set until 2022 were about to expire, states have adopted aggressive non-solar RPO trajectories. Two windy states (Gujarat, and Maharashtra) set RPO trajectories in 2021 through 2025, while Karnataka and Andhra Pradesh have released draft RPO trajectories till 2026.

In a base case, Gujarat and Maharashtra will continue to push on aggressive RPO targets announced till 2025. The response of states to new RPO trajectories announced by MoP till 2030 will determine the impact on wind demand for states of Karnataka and Andhra Pradesh which are yet to finalise RPO trajectories till 2026.

Figure 14. New wind demand in state auctions (2022-26)



Source: State RPO targets; MEC+ analysis

Pipeline

As on the date of report publishing, states procurement has a firm pipeline of 1.4 GW, out of which 0.8 GW is active pipeline, 0.6 GW of projects awarded in Tamil Nadu and Maharashtra back in 2017/2018 have been dormant and are unlikely to fructify, especially projects in Tamil Nadu which is likely to procure in central tenders (see section 4.1).

Further, the pipeline can expand by 0.4 GW of issued tenders in states of Gujarat and Madhya Pradesh (RUMSL[34]). This included 0.15 GW wind component of 1.25 GW WSH tender issued by Madhya Pradesh- RUMSL and 0.25 GW wind component of 0.5 GW assured peak power tender issued by Gujarat.

The status of awarded wind capacity in state auctions is indicated below in figure 15.

Figure 15. Status of projects awarded in state auctions * (Wind+ Wind component of Hybrid auctions)

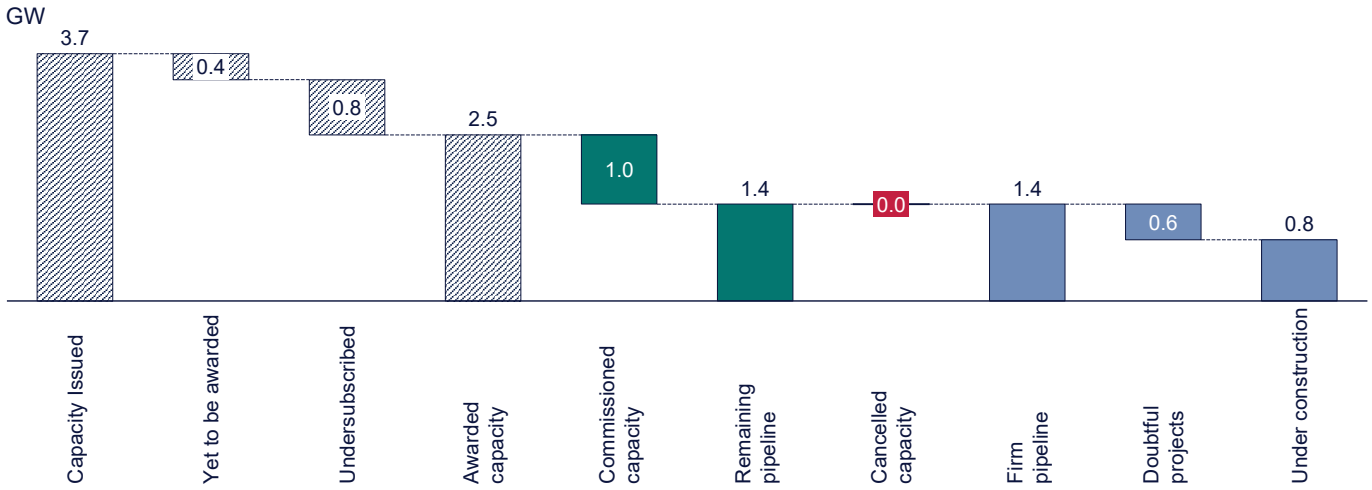
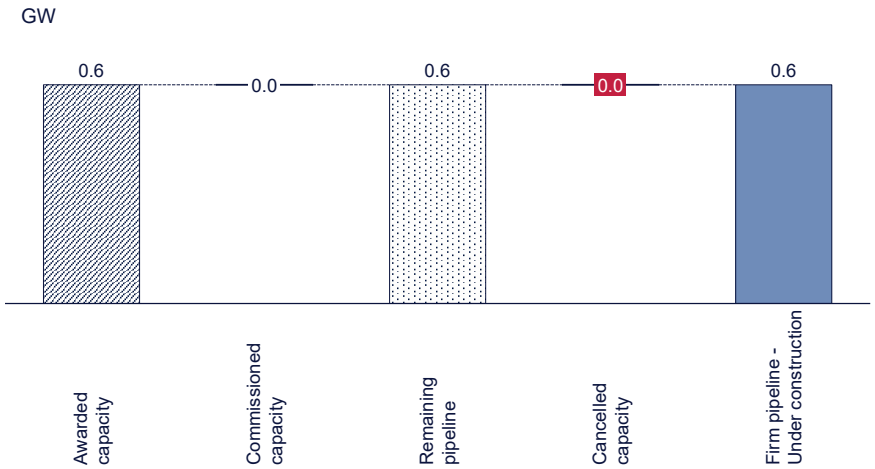


Figure 16. Status of private utility projects awarded* (Wind component of Hybrid auctions)



Additionally, Private utilities in Maharashtra have awarded WSH tenders of ~1 GW (wind component 0.6 GW) in 2020. These ~0.6 GW projects are in the construction phase.

34 State tender issued by Rewa Ultra Mega Solar Limited- RUMSL, JV of MPUVL and SECI can be considered a PSU tender

As on date of report publishing, the overall pipeline in the base case including awarded and issued tenders for state and private auctions is ~2.4 GW of projects with standalone wind and wind components of hybrids.

Grid availability

India has announced the development of an intrastate network in four key windy states as part of Green Energy Corridors (GEC). It is estimated that ~44 GW of new RE power generation evacuation will be possible through the development of two Green Energy Corridors (GEC) phases.

The first phase of GEC with project capacity evacuation of ~24 GW is under construction. The intrastate network under GEC phase 1 is due to be completed in 2022.

The second phase of GEC will help in the evacuation of ~20 GW of renewable power. MNRE announced guidelines for the second phase of GEC post-Cabinet approval in January 2022. The intrastate transmission projects in four key windy states as part of GEC phase 2 will be commissioned by 2026.

The grid availability scenario for future state projects is expected to ease as intrastate transmission networks of key windy states will be strengthened over the next five years.

Payment delays

Heightened payment risks continue to dampen state markets

Payment delays adversely impact the growth of RE in India. Due to the COVID-19 pandemic and supply chain constraints, the overall dues of DISCOMs have ballooned. The outstanding payments to RE generators increased by 73% to INR 194 billion ($2.62 billion) in December 2021, as compared to INR 112 billion ($1 billion) in December 2020[35]. Overdue amounts and increased payment cycles will create a roadblock in achieving the targets set by the central and state governments.

Gujarat is the best-performing state with least overdue amount and small payment cycles. Maharashtra and Tamil Nadu have very high overdue amounts and long payment cycles which impact developer participation in state auctions. Madhya Pradesh also has moderate overdue amounts and long payment cycles, which might impact developer payments.

Payment delays by DISCOMs coupled with lower energy generation, delays in payment receivables, lower tariffs of wind projects and land allocation issues have impacted the viability of some wind projects. ~20 MW of IREDA-financed projects from Maharashtra have filed for NPA in 2020-2021. Similarly, ~50 MW projects financed by PFC and REC from Maharashtra have filed for NPA in the same duration. These financial institutions are employing additional measures and increasing project and developer monitoring to avoid NPAs in future.

The poor financial state of DISCOMs and stringent measures from financiers will restrict developers' ability to participate in state auctions. This will shift the RPO demand of state DISCOMs in Tamil Nadu and Madhya Pradesh towards central procurement.

35 "Standing Committee on Energy (2021-22):17th Lok Sabha": MNRE

iii. C&I market

Large-scale untapped opportunity exists in C&I procurement for wind and hybrid projects

RE installations within the C&I segment was kickstarted with the growing prominence of wind technology in India. As of 2021, ~9.1 GW of C&I wind installations have taken place in India. C&I installations of standalone wind have reduced in recent years due to cost competitiveness and less maintenance of solar projects. But a need for RTC firm power through hybrid projects coupled with wind has led to a resurgence of wind installations in C&I segment.

The project size of C&I hybrid projects is in the range of 50-100 MW, thus fulfilling the RE demand of many C&I consumers. The table below summarises the key drivers of the market:

Table 3. Traffic-light indicator for C&I market

CHARCTERISTICS	TRAFFIC LIGHT INDICATOR	
POLICY & REGULATION		Inclusion of C&I projects for ISTS waivers until 2025, changes to REC mechanism and waivers for hybrid projects will promote wind installations.
INFRASTRUCTURE		Grid infrastructure is sufficiently available. Proposed General Network Access Rules (GNA) will provide ease of access to ISTS infrastructure.
DEMAND		Announcements of aggressive net-zero targets by major C&I firms until 2030, RPO compliance for captive users and cost-competitiveness of RE technologies have improved demand.
PROJECT EXECUTION		Project execution requires additional clearances as per land policy and grid connectivity agreements.
PIPELINE		Existing pipeline is limited for standalone wind projects but ~1 GW annual hybrid installations are expected post-2024 until 2026.

Favourable
Neutral
Unfavourable

Demand for wind within corporate procurement

Corporate demand for wind procurement is driven by the C&I segment's shift towards RE, growing commitments to sustainability and the associated cost savings as compared to DISCOM's power supply.

Indian companies have been preparing to scale up and implement corporate energy decarbonization strategies. 89 companies have adopted science-based targets and announced their ambitions of achieving net zero GHG emissions between 2030-2050, 29 of which have had their net zero targets validated. Some Indian corporates have also announced joining the RE100 coalition of companies committing to procurement of 100% RE electricity[36].

Additionally, Environmental, Social and Governance (ESG) factors are becoming central to corporate policies and access to international finance in India. ESG factors, when integrated into investment analysis and portfolio construction, offer investors potential long-term performance advantages, creating a preference to fund ESG-compliant companies and platforms.

Wind is expected to play a key role as the initial load requirements of C&I

36 Science Based Targets; Companies taking action; June 2022

consumers go beyond what can be met through solar. As larger volumes of solar start impacting the grid profile, integration of wind in the C&I portfolio will be the logical choice to pick up additional demand, especially in the form of WSH projects.

The waivers of OA charges announced for hybrid projects create a selective case for third-party PPAs as well. The states of Gujarat, Rajasthan, and Andhra Pradesh have released hybrid policies with waivers to OA charges for such projects. Also, ISTS waivers announced by the central government until 2025 will provide impetus to hybrid installations by the C&I segment.

Economics

With RE in a firm position as the cheapest source of grid power, C&I consumers have a strong financial incentive to switch to clean energy. Currently, electricity prices in India for C&I consumers are high, in the range of INR 6-9/kWh ($77-116/MWh). Hence, tariffs payable to the grid are higher than the landed cost of wind project for C&I consumer. The differential varies by state; however, savings can be as high as INR 3.5/kWh ($45/MWh) for captive/group captive and INR 1.5/kWh ($27/MWh) for third-party PPAs in states with incentives. The differential is calculated considering additional OA charges levied by states.

As storage prices are expected to reduce over the next five years, hybrid projects coupled with wind will increase in cost-competitiveness and provide RTC power solutions for C&I players.

Policy updates impacting wind in the C&I segment

1. Central policy updates:

Eligibility for ISTS waivers: In November 21, as per an order by MNRE, C&I projects of solar, wind and hybrid connected to interstate networks were eligible for waiver in ISTS charges for a 25-year period. This waiver is applicable for all C&I RE projects connected before June 2025. Earlier, these waivers were only applicable to projects of central auctions.

The announcement of ISTS waivers will improve economics of RE projects through connections with the interstate network. After the announcement of these waivers, major C&I consumers are allowed to connect dedicated lines for evacuation of RE to their own manufacturing plant.

GNA regulations:

General network access (GNA) is open access to ISTS connectivity. The proposed regulations provide the framework to facilitate OA power to C&I consumers, developers and DISCOMs for ISTS.

GNA allows enhancement of current connectivity to provide access to any customers located in India. Also, generators can provide scheduled power to any C&I consumer without specifying the consumer location beforehand. As part of this regulation, connectivity to ISTS for developers will be eased and C&I consumers can meet RE requirements without location constraint.

Green Open access rules:

In June 2022, CERC released green open access rules 2022 to ease the approval process and regulate charges on these transactions and enable higher green energy based open access. Green Open access has amended eligibility criteria to 100 kW from existing criteria of 1 MW, thus enabling C&I demand of Small and medium sized enterprises. Single window clearance mechanism with approvals in 15 days will help C&I consumers to cater need through green open access in a hassle-free manner.

Also, other incentives such as banking up to 30% generation and exemption of some open access charges will enable higher C&I demand for green energy based open access.

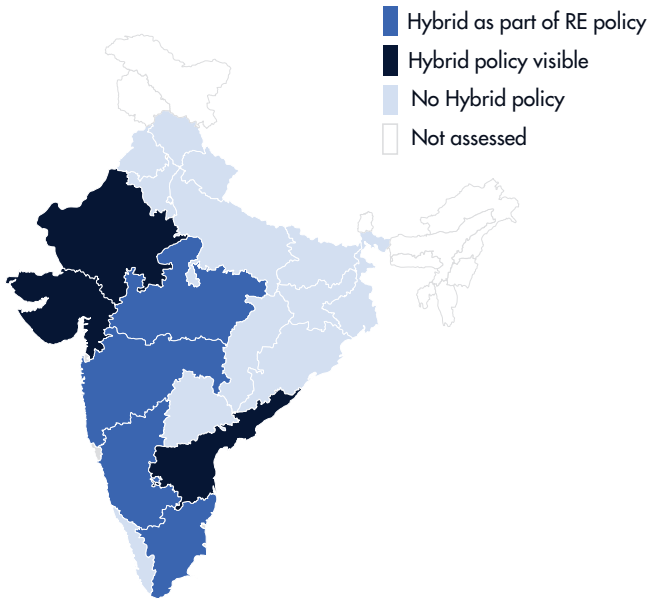
2. State policy updates:

The Government of Karnataka has recently allowed developers to connect to the ISTS network via its state transmission network.

The states of Gujarat, Rajasthan and Andhra Pradesh have dedicated hybrid policies. Rajasthan and Andhra Pradesh have partial waivers on OA charges and have provisions of banking for WSH projects. Gujarat has removed incentives on OA charges and has no banking provision for WSH projects.

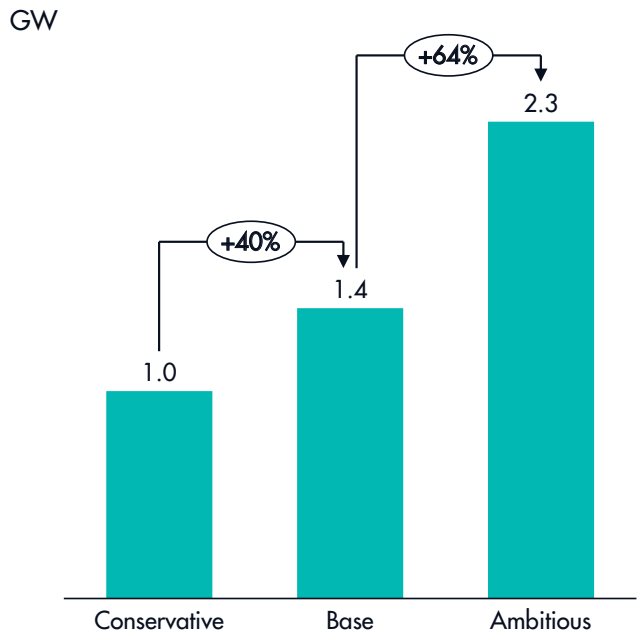
Other key windy states have included WSH as part of RE policies of states. This improved business case from central and state government support will increase C&I wind and WSH volumes.

Figure 17. Status of State hybrid policies



Source: MEC+ analysis

Figure 18. C&I forecast (2022-26)



Source: MEC+ analysis

Forecast

RE corporate procurement will continue to strengthen due to removals of regulatory barriers, business case attractiveness and sporadic support from states with charge waivers. The cumulative standalone wind market is expected to be in the range of 0.4-0.7 GW from 2022 to 2026.

C&I volumes are expected to be driven by hybrid projects where wind will play a key role. The state hybrid policies of Rajasthan, Gujarat and Andhra Pradesh are expiring by 2024, which will prompt a market rush in the coming years. Also, eligibility of C&I ISTS waivers until mid-2025 will drive a surge in C&I hybrid installations with wind components, whereby hybrid installations are expected to be in the range of 1.5-4 GW (0.6-1.6 GW wind component) from 2022 to 2026.

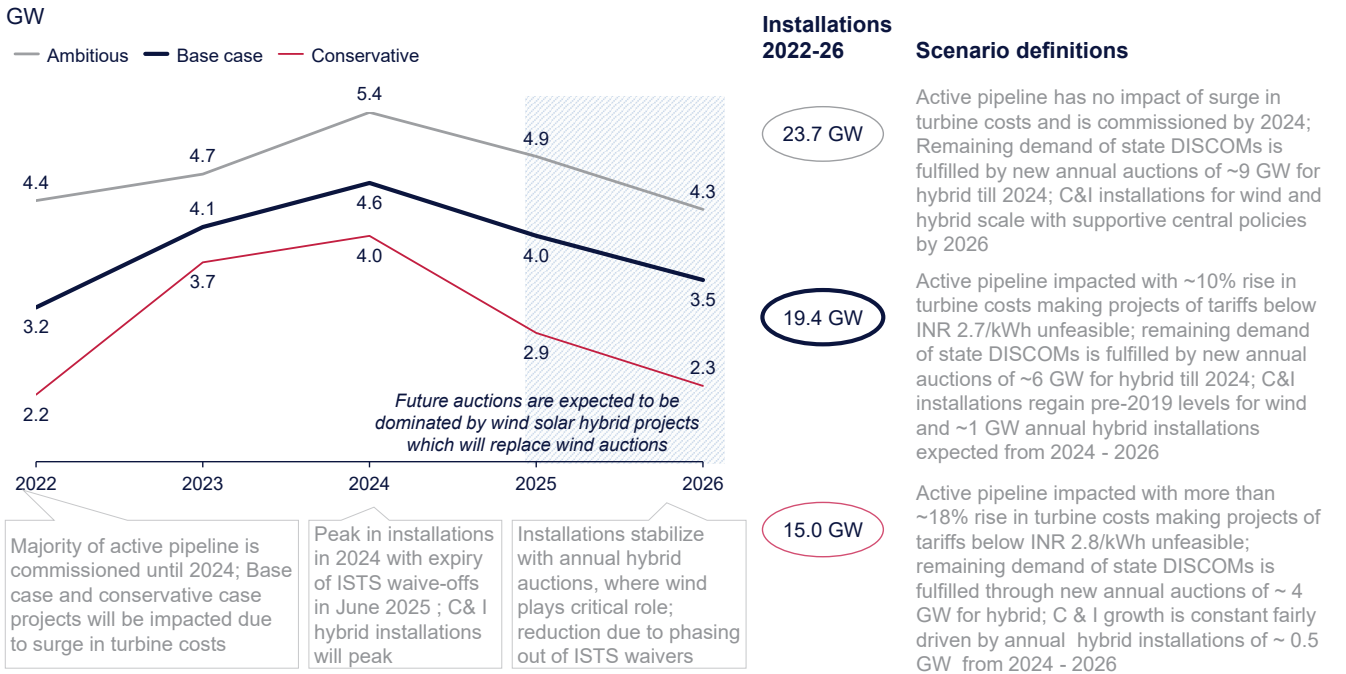
5. India wind energy forecast: 2022-2026

India is expected to install more than 19 GW of wind in the next five years, with a peak in 2024

The interplay of the three markets (central, state and C&I procurement) is expected to spur 15-23.7 GW of new wind installations between 2022 and 2026, while base case installations are anticipated to be 19.4 GW. In addition to the wide range of volume between scenarios, the market is expected to be bumpy across the next five years. A surge in installations is seen near 2025 due to the expiry of ISTS waivers on 30 June 2025.

MoP introduced RPO trajectory till 2030 with separate RPO component to be met through wind projects commissioned post March 2022. The response of states to new RPO trajectory and treatment of wind

Figure 19. Y-o-Y new wind installations in India 2022-26



Note: As per calendar years; Wind component of hybrid projects have been considered as a part of forecast; wind component of 0.4 GW RTC I, 0.25 GW RTC II and 1.2 GW peak power tenders have been included in the forecast; Tenders issued by PSUs have not been considered in forecast
Source: State ARRs; RPO documents; PGCIL; NTC and RTC Meeting minutes; credit rating report; CEA; SECI; MEC+ analysis

RPO will impact the wind outlook scenarios till 2026 (See Note box 04)

In the conservative case, 15 GW of wind is expected to be installed, with lower installations due to a more than 18%[37] surge in turbine costs as per the supply chain scenario and demand evaporation from an economic slowdown. The ambitious case sees cumulative installation of 23.7 GW from 2022 to 2026, with no impact of turbine cost surges on the existing project pipeline and increased uptake of hybrid auctions along with wind auctions.

In the base case, a forecast of 19.4 GW installations is driven by central procurement of 14.9 GW, state utilities' procurement of 3.1 GW and C&I procurement of 1.4 GW. Central procurement demand of 14.7 GW in the base case is likely to be met through the following sources:

- ~9.6 GW demand is likely to be met through ~7.8 GW of awarded central projects and 1.8 GW of wind tenders issued as of on date of report publishing which are yet to be awarded. Cancellations of ~2 GW projects in the existing pipeline of 9.8 GW central projects are considered as an impact of supply chain challenges, due to turbine cost surge of 10%[38] which leads to a central project pipeline of 7.8 GW (See Figure 12).
- Additionally, ~2 GW demand is expected to be met through RTC I auction of 0.4 GW, RTC II auction of 0.25 GW and assured peak power auctions of 1.2 GW.
- The remaining 3.3 GW demand is likely to be met through ~4.5 GW annual hybrid auctions until 2024 comprising of WSH and RTC auctions.

2.8 GW central projects, which are yet to sign a PSA, are likely to impact future project installations through central procurement.

State utilities' procurement of 3.1 GW in the base case is met through the following sources:

- 2.4 GW demand is likely to be met through issued and projects awarded by state DISCOMs as on date of publishing of report.
- The remaining 0.7 GW demand is likely to be met through 1 GW annual WSH and RTC auctions to be conducted by state DISCOMs of four windy states until 2024.

The remaining 1.4 GW demand for wind from 2022 to 2026 in the base case is expected to be driven by C&I segment:

- Standalone wind installations are expected to contribute ~0.5 GW from 2022 to 2026.
- The remaining ~0.9 GW wind volume will be met through ~2 GW hybrid installations post-2023 due to waivers by state and central governments for hybrid installations.

Hybrid auctions to drive future wind installations

Volumes in 2025 and 2026 arise from the expected new tenders at central and state level, wherein hybrid auctions will be a combination of WSH tenders and RTC power tenders. The new tenders are expected to be driven by 4-9 GW of central and state hybrid auctions annually until 2024, increasing from 4 GW of hybrid tenders from 2021-2022. Also, ~1.5-4 GW hybrid projects are expected to be installed by the C&I segment. The ambitious case assumes a higher number of hybrid auctions, while the conservative case sees limited hybrid tenders.

Overall, wind volumes over the next five years are expected to transition from standalone wind projects to growth of WSH projects across the central, state and C&I markets.

37 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated as per S & P Global quarterly report with ~18-20% hike in turbine costs as pessimistic case in 2021-2022 in comparison with 2020. estimates, and IEA Renewables report 10-25% increase is visible in turbine costs.

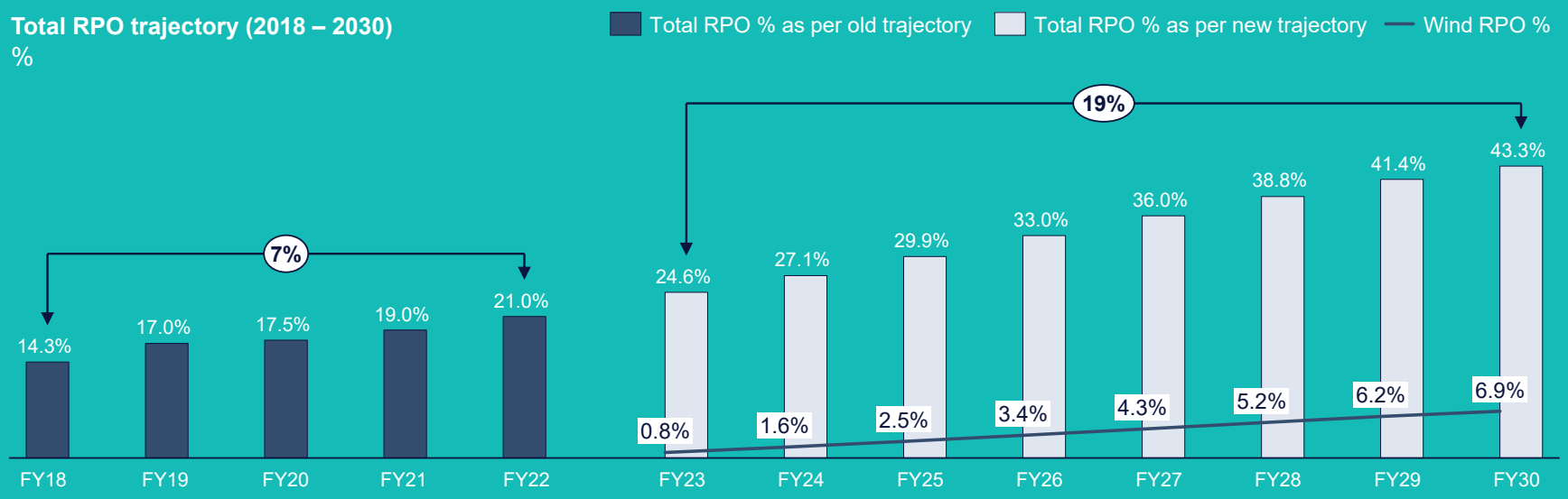
38 MEC+ insights based on primary interviews with Turbine OEMs in India. Also validated by news articles on Turbine OEM . As per IEA estimates, 10-25% increase is visible in wind turbine costs depending on country and region from 2020. Wood Mackenzie estimates 10% increase over 12 months due to increases in commodity prices, logistics costs, and coronavirus-related challenges.

Note Box 4: Impact of RPO trajectory released by MoP till 2030 on wind outlook till 2026

Background: In July 2022, MoP released a long-term growth trajectory of Renewable Purchase Obligation (RPO) and Energy Storage Obligation till 2030. Key changes in new RPO trajectory announcement are as follows:

- A separate Wind RPO trajectory from 0.81% in 2023 to 6.9% in 2030 to be met from wind power projects commissioned after 31 March 2022. All older wind projects will be part of "Other RPO" category.
- No separate trajectory for Solar RPO. Solar projects will be part of "Other RPO" category.
- From 2023, all hydro sources of power are considered as part of RPO obligation. Hydro projects which have been commissioned post 08 March 2019 will be used to fulfil HPO, rest older hydro projects will be part of "Other RPO".
- Energy storage obligation has been introduced and will be met through PSP/BESS with at least 85% of total energy stored on annual basis procured from RE (Solar/ wind) sources.

As per new wind RPO requirement announced by MoP, ~57.5 GW of India's power demand will be supplied through new wind projects from FY 2023 to FY 2030. ~ 40 GW wind projects have been installed in country till FY 2022. This will lead to cumulative wind project installations of ~ 97.5 GW till FY 2030 against a target of ~140 GW set by government. However,



hybrid project installations will oversize wind component of projects, thus providing a significant upside to ~97.5 GW wind installations till FY 2030.

New wind RPO trajectory will create a demand of ~29.6 GW wind projects considering all the states till 2026. 21 major states (14 non-windy and 7 windy states) which drive power demand in India will contribute ~20.6 GW demand till 2026 as per new wind RPO, which is less than ~21.4 GW demand (excluding C&I demand) as per existing forecast scenario with old MoP trajectory.

Impact of new RPO trajectory on forecast scenarios:

a. Conservative scenario (based on budgeted RPOs): 14 GW demand (excluding C&I demand) till 2026 will remain the same due to no bearing of the new MoP RPO trajectory.

b. Base scenario (based on state RPOs): 18 GW demand (excluding C&I demand) till 2026 in base scenario will be reduced by the states which have not released RPO trajectory till 2026 and have MoP wind requirement lesser than historical RPO trend. ~0.9 GW demand driven by Chhattisgarh, Jharkhand and Tamil Nadu is reduced leading to 17.1 GW (excluding C&I demand) demand in base scenario.

c. Aggressive scenario (based on MoP RPOs): 21.4 GW demand (excluding C&I demand) till 2026 for 21 major power consuming states in aggressive scenario is based on old MoP trajectory. The demand is reduced to 20.6 GW (excluding C&I demand) till 2026 for these states considering new wind RPO trajectory in aggressive scenario.

The revised market outlook including C&I demand based on implementation of new RPO trajectory by states will have 15 GW forecast in conservative scenario, 18.5 GW forecast in base scenario and 22.9 GW in aggressive scenario.

Response of states to implement new RPO trajectory till 2030 and treatment of Wind RPO over period of next 6 - 12 months will provide clarity on direction of wind market outlook scenario.

6. Looking towards 2030

Towards 2030, India is expected to continue pushing towards its climate goals for the Paris Agreement and Panchamrit announced during the COP26 conference. The long-term announcement of India achieving carbon neutrality by 2070 will require a significant push from the government to phase out and replace existing coal generation capacity with RE over the next four decades and reduce the current pipeline of new coal and fossil fuel capacity.

To achieve its ambitious targets, the Government of India is looking beyond the expansion of onshore wind energy to explore complementary pathways in offshore wind, green energy storage, electric vehicles, and the use of green hydrogen.

The longer-term growth drivers for India's wind market include:

- **Offshore wind:** The Ministry of New and Renewable Energy (MNRE) has released Strategy paper in July 2022, announcing trajectory to award 37 GW of offshore wind tenders towards 2030[39] in the states of Gujarat and Tamil Nadu. The paper talks about:
  - **3 models of offshore wind development in India:**
    - Model 1 (1 GW tender planned): PPA award along with exclusive lease award based on quoted tariff/VGF requirement bid for Gujarat Zone B3
    - Model 2 is further divided into model 2A and 2B. Model 2A (24 GW tenders planned) is for non-exclusive lease award on 'first-come-first-serve' basis, for consequent procurement by government through PPAs. Model 2 (no stated volume) is for non-exclusive lease award rights on 'first-come-first-serve' basis, for captive/open-access sales
    - Model 3 (12 GW of lease award) is exclusive lease award based on lease fee bid for captive/open access sales (no government backed PPA) for TN zone B, G and E
  - **Grid development in scope of PGCIL:** Across the models, the export grid (cables and OW substation) has been put into the scope of the central transmission utility or PGCIL. The move removes significant cost and risk of delay from the scope of the developer.
  - **Kick-starting the OW tenders:** Upcoming tender for 4 GW under model 3 in September and 1 GW under model 1 in December 2022; consequently, 2 GW PPA tender is planned under model 2A in 2024
    - **India as a wind export hub:** WTG OEMs and the wider wind supply chain continue to invest in a manufacturing base in India for cost-competitiveness and regional export opportunities. India is already the second-largest wind supply chain manufacturing hub in

39 Offshore Wind Energy in India (pib.gov.in); Strategy paper

the world, with further expansion supporting job creation, GDP growth, and technical excellence, in line with the government's "Make in India" initiative.

- **Repowering older wind projects:** Repowering offers an efficient pathway for India to maximize productivity and socioeconomic benefits from sites already designated for wind power production. Replacing older components with newer turbines that have larger power ratings, greater resilience to environmental elements and material upgrades can lower cost of installation and O&M across projects, resulting in fewer downtime periods and lower operational expenditures. This can in turn help to make projects more economical where procurement schemes are highly competitive, such as in Gujarat and Tamil Nadu.
    - Policymakers should proactively assess the annual volume of wind capacity nearing end of lifetime and enable repowering via regulatory fast tracks for streamlined permitting and site license extensions.
    - Asset owners should also be able to undertake repowering of wind assets before the designated end of project lifetime, as there may be wider cost efficiencies and socioeconomic gains associated with installing upgraded technology at an earlier stage.

The long-term drivers for wind continue to be strong in India, as the country shifts towards competitive technologies and low-carbon growth.

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