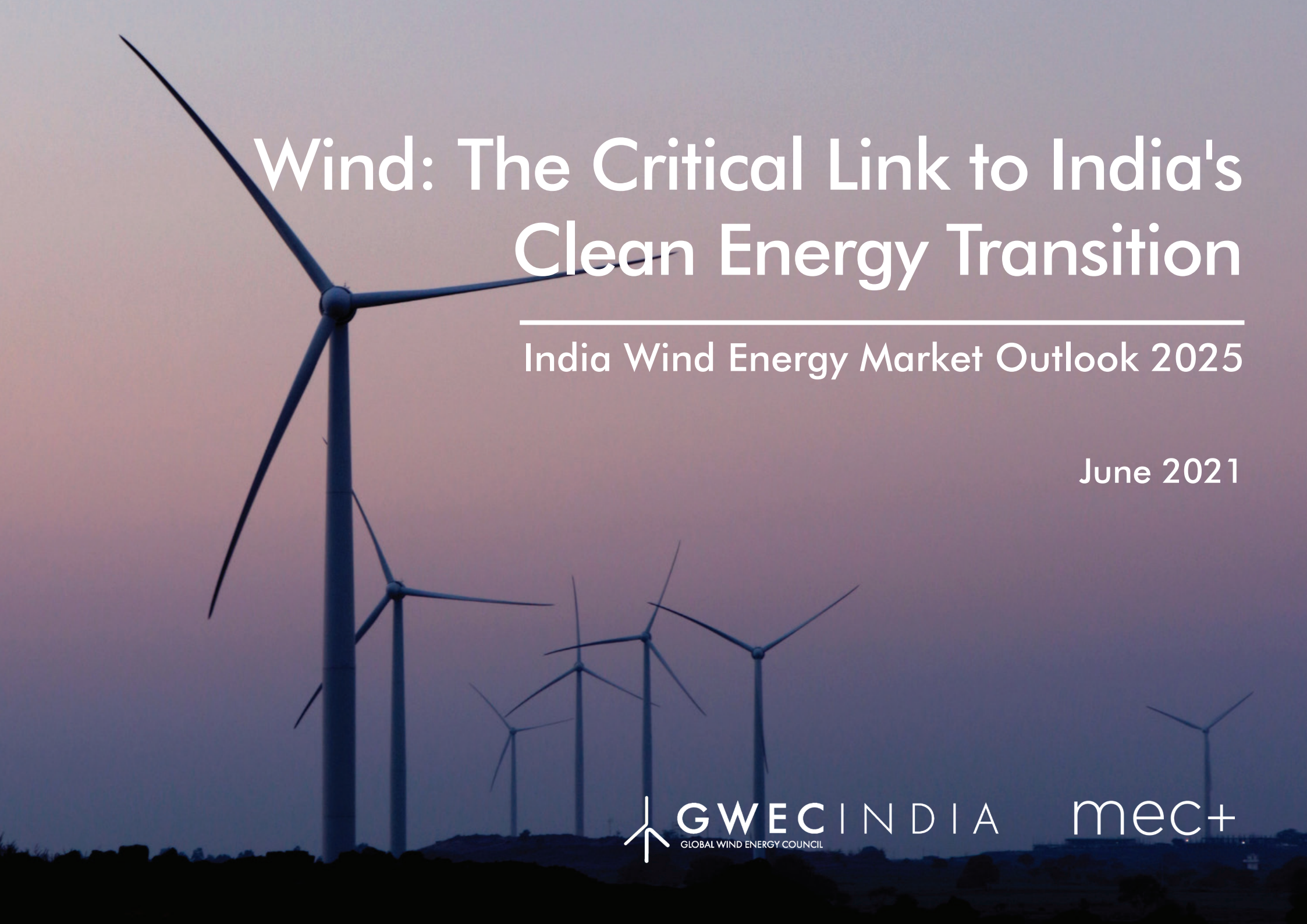

Wind: The Critical Link to India's Clean Energy Transition

India Wind Energy Market Outlook 2025

June 2021

GWEC INDIA
GLOBAL WIND ENERGY COUNCIL

mec+

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GWEC

About GWEC India

The Global Wind Energy Council (GWEC) is the global trade association for the wind power industry representing over 1,500 companies, organisations, and institutions in more than 80 countries. 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.

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.

GWEC India's focus is on convening the many voices across the private sector to speak as one on key issues, and on unifying the wind industry on a common strategy which focuses resources on those high-potential markets where it can build volume and scale expeditiously. By encouraging greater collaboration and engagement, GWEC India will support the wind sector to clear its present-day roadblocks and deliver on its vast potential by 2022, 2030 and beyond.

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

@GWECGlobalWind Global Wind Energy Council

About MEC+

MEC+, also known as MEC Intelligence, is a specialist consulting firm focused on the wind and renewables sector for 10 years and is based out of India and Denmark. Our clients include largest global wind OEMs, European utilities, Global Supply chain players, Equity funds, and Independent Service Providers.

MEC+ has expertise in guiding senior management on new technology and market opportunities. The company has delivered insights on some of the largest M&A deals in India, hi-tech innovation and technology roadmaps for global supply chain players, and strategic planning for profitable growth across multiple businesses.

MEC+ has been supporting asset owners to participate in the evolving landscape of the electricity market in India. 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.

MEC+ helps OEMs build technology roadmaps, tap both Utility and C&I demand, develop launching plans of new products and services.

For Supply Chain, MEC+ supports in developing business case for localisation, developing strategy to get into new areas such as hybrid plants, storage projects.

Within Investors and Utilities clients, MEC+ facilitates M&A targets identification, conducting commercial due diligence, building KPIs for securing sales and managing the risks in strategy implementation.

Within OW, MEC+ has in-depth understanding both economic and regulatory pathways. For further queries please visit www.mecintelligence.com or reach out at sidharth@mecintelligence.com

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ABBREVIATIONS

AP	Andhra Pradesh
APPC	Average Power Purchasing Cost
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
COD	Commercial Operation Date
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
FOWIND	Facilitating Offshore Wind in India
GTAM	Green Term Ahead Market
GW	Gigawatt
IPP	Independent Power Producer
ISTS	Interstate Transmission System
LCoE	Levelized Cost of Energy
LiDAR	Light Detection and Ranging
M&A	Mergers and Acquisitions
MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
MW	Megawatt
NDC	Nationally Determined Contribution
NIWE	National Institute for Wind Energy
NOC	No Objection Certificate
OA	Open Access
OEM	Original Equipment Manufacturer
PLF	Plat Load Factor
PPA	Power Purchase Agreement
PSA	Power Sales Agreement
RE	Renewable Energy
RPO	Renewable Purchase Obligation
RTC	Round-the-clock
S/s	Substation
SECI	Solar Energy Corporation of India
TAM	Term-Ahead Market
WTG	Wind Turbine Generator

FOREWORD

Ben Backwell

CEO, Global Wind Energy Council

Even as the pandemic has continued to grip the world, with tragic consequences for India among other nations, the government of India continues to boost confidence in climate action through a firm commitment to clean energy transition. Over the recent period, the government has established a series of strategic bilateral partnerships that fuel national, regional, and global low carbon growth, while Climate Transparency Report 2020 reported India as the only G20 nation which is on track to achieve the targets under the Paris Agreement. The COVID-19 lockdown resulted in a challenging year for both wind and solar energy, and saw wind installations of 1.1 GW – compared to 2.3 GW in 2019, resulting in a cumulative installed grid-connected wind power generation capacity of 39.2 GW.

However, the government has initiated a series of steps to attract further investment into the wind energy sector – promoting a growing integration of policies with its overarching Atmanirbhar Bharat Abhiyan (Self-reliant India campaign), and addressing market, planning, and grid bottlenecks.

India has several reasons to continue to accelerate and enhance the development of wind energy. First, as per the National Institute of Wind Energy (NIWE) and the World Bank Group, the country has an estimated 300 GW onshore and 195 GW of fixed and floating offshore wind generation potential. Second, the country has set a target of 140 GW installed wind power capacity by 2030. Third, with an existing 10 GW of annual wind turbine manufacturing capacity and 70-80% indigenization achieved, the wind sector strongly complements the government's initiatives for jobs creation and a self-reliant India. Fourth, wind and solar projects are highly complementary and will eventually create a robust and carbon-free power grid. Finally, with an existing capacity utilization factor in the range of 35%-40%, growing availability of higher capacity wind turbines, and the likelihood of a further 16% decline in the cost of wind by 2025, it is evident that wind development is only going to become more attractive in the coming years.

Harnessing wind potential directly feeds to energy security and growing electricity demand across all sectors of the economy. The Ministry of New and Renewable Energy must be congratulated for provisions such as central auctions, hybrid wind-solar projects, and blended power that have improved market sentiments. Our ambitious case projection in this report indicates a cumulative installed wind capacity of 62.9 GW in 2025. However, the center and the states will have to work more closely to address challenges that have slowed progress in the past. Innovative solutions are needed for curtailing land and transmission infrastructure-related issues. Similarly, payment timelines will have to be streamlined. Addressing these will further bring down the tariff and improve India's economic competitiveness. A consistent pipeline of projects is vital to increase competition, and build bankable clean energy assets at much lower costs in comparison to the future costs that will be incurred if progress is not made at the required rate.

GWEC firmly believes that India's on-going COVID19 crisis will be contained soon. Meanwhile, this period gives ample reasons to plan for a green recovery through an enhanced share of wind assets in India's electricity mix. While new onshore installations will continue to increase, offshore wind and repowering of aging low-capacity wind assets are high-impact, high-opportunity areas. This demands the implementation of best practices, the rollout of innovative policy and financial instruments by the government, and concerted efforts of all stakeholders. GWEC's flagship India Wind Energy Market Outlook 2025 is part of the wind industry's continuing effort in that direction.

FOREWORD

Sumant Sinha
Chairperson, GWEC India

The evolving Indian energy market will be key to the success of the world's future energy technologies. India has already undertaken a forward-looking approach by aiming to mainstream renewable energy in the country. With 94 GW of installed renewable energy capacity, almost 10% of the gross electricity generated from utilities came from clean energy sources during the financial year 2019-2020, higher than previous years. As per the Power and New & Renewable Energy Minister Shri R K Singh, the overall non-fossil fuel installed generation capacity will be about 60% by 2030 as India strives to achieve its target of 450 GW of installed renewable energy capacity by that year. Wind constitutes 31% or 140 GW of this target. However, the huge push for the expansion of wind and solar doesn't stem from evolving energy needs alone, it can also be attributed to the larger fight against climate change.

To ensure abatement of climate change, taking cognizance of the IPCC (Intergovernmental Panel on Climate Change) reports, and numerous other national, regional, and global shreds of evidence, swift action in terms of curtailing the use of conventional energy appear inevitable. The energy sector contributes to 73% of India's greenhouse gas emissions and 43% of the energy sector's contributions come from power generation.

In a very recently published net-zero roadmap, the International Energy Agency has emphasized scaling up the deployment of solar and wind energy in this decade globally. In India, this is also important because both these energy sources along with utility-scale battery capacity will play a pivotal role in grid stabilization, ensuring reliable supply, and meeting peak power requirements. Wind and solar are complementary in generation profiles in terms of the time of the day and seasonality and thus together the two of them can overcome intermittency issues. Wind Power has a higher capacity utilisation factor than solar power and can be combined with solar to improve the overall utilisation of the plants. Wind turbines also have the ability to balance loads and support grid stability despite fluctuating energy demands. Thus, there is a very strong case to develop wind assets as well as hybrid power plants. While concerted efforts of all stakeholders and higher participation of the private sector are important, an enabling environment that is continuously evolving is also of paramount importance.

Globally ranked 4th in terms of wind power capacity, India has a huge untapped potential for wind generation and manufacturing. As per the ambitious case estimates in this edition of the India Outlook, the existing pipeline of wind projects and innovative policy for hybrid wind-solar installations are likely to drive the realization of 24.4 GW of installed wind capacity between 2021 and 2025. Innovative strategies will have to be rolled out to mitigate existing challenges around infrastructure such as land and grid resources and the poor financial health of the DISCOMs. Identification of high-impact opportunities — such as offshore wind and leveraging wind sector to complement 'Aatmanirbhar Bharat' while advancing support to

domestic and global wind deployment, must be prioritized by the central and the state governments.

This edition lays stress on the need for greater clarity between the climate action and energy plans of the central as well as the state governments and their respective renewable energy roadmaps. This work is also an effort towards bringing together key wind sector stakeholders for building a greater consensus on priorities that will give a boost to both — India's Nationally Determined Contributions and the GDP through enhanced participation of the private sector. I congratulate GWEC India and the MEC+ colleagues for this very important publication.

FOREWORD

Sidharth Jain
Founder and CEO, MEC+

India's renewable market continued to advance in 2020 in spite of the pandemic. New tenders, new concepts, new capital, and new policies emerged throughout the year even though installations and execution were hit. The key message from the shift is the establishment of wind as the critical link in the clean energy transition for the country. This report has been developed with an aim to consolidate the developments and build a perspective on growth from the point of view of the wind sector, in current and future role.

As we release the outlook for this year the second wave of the Coronavirus has hit India. In the 2020 outlook, released in March - just at the time lockdown started, a net impact of 1 GW on wind installations was estimated. The lockdowns were more severe, and ~2 GW got delayed or cancelled. The pipeline from auctions since 2017 is strong and is expected to come online in the next two years. But as new waves hit India– a delay in installation is certain, but whether it will be lower than the report's conservative scenario remains to be seen.

During 2020 the most significant impact was the successful implementation of the hybrid project policy of India via successful tenders of nearly 4.5 GW. These tenders will combine wind and solar to produce higher CUF. This transition is a win/win for everyone and is likely to become the preferred route of tenders for procuring renewable power. A full section has been developed to explain the development. Another extremely important development was interventions from the government to bottlenecks on delays of signing PSA, grid bottlenecks, and land policies to speed up installations.

The demand for power from both DISCOM and Large Commercial and Industrial customers continues to grow in India. Renewable seem to be the only way forward in fulfilling demand due to their attractive economics and a de facto lack of financing for thermal projects. Renewable Purchase obligations of DISCOMs remain unfulfilled and will lead to new orders.

The corporate PPA market is growing strongly on the back of the adoption of ESG goals and is expected to transition from solar projects into hybrid projects to supply to the heavy industrial load of India. This will resurrect wind's role in these PPA and will provide the crucial link to meet the larger sustainability goals of corporates. The report takes a deep dive into the regulatory base of the Corporate PPA market and its drivers to provide readers an in-depth understanding of this new route to market.

We are both optimistic and cautious while releasing the extended outlook to 2025. The preferred method of counting all infrastructure developments, orders, budgets, pricing, and regulatory initiatives takes us at best until 2023. The outlook for the years 2024 and 2025 is driven by the fundamentals of hybrid projects and the trends in the demand side of the market. Readers must use them as directional and use the material to support their strategic initiatives and contextualise their actions.

We look forward to receiving your thoughts. Keep Safe and take care.

EXECUTIVE SUMMARY

India's wind market shows signs of recovery in the next five years, with a prominent role in hybrid

India's electricity demand is projected to grow at 9.9% yearly towards 2025 driven by its sheer size and economic growth. The demand dipped temporarily in 2020 due to Covid-19 induced lockdowns, but it not only rebounded to match the pre-COVID level[1] but ended up exceeding 2020 highs in early 2021.

Renewable energy will be the main beneficiary of this growth driven by an ambitious target for 450 GW renewable installed capacity by 2030 and the low tariffs being discovered in auctions. As of March 2021, India has 39.2 GW of installed wind power capacity and is likely to add another 20 GW over the next five years owing to cost and its role to produce round-the-clock power.

Market activity 2020

In our outlook last year, we anticipated 2020 to be a break-out year for wind installations owing to the large pipeline and after multiple policy interventions to ease execution bottlenecks. The advent of the auction regime in 2017 led to large orders but also impacted prices, evacuation availability, and land preference for the projects. In early 2020, many policy interventions took place to iron out the execution bottlenecks. The land policy in the key states of Gujarat and Tamil Nadu was streamlined, and land allocations restarted; grid infrastructure was augmented (or shortly to be completed) in critical bottleneck substations, and Power supply agreement between SECI and DISCOMs were expedited.

However, nearly six months were wiped out and the impact of COVID lockdowns was much more severe than anticipated. Only 1.1 GW was realised; and nearly 0.8 to 1 GW of capacity scheduled for commissioning in the year slipped into 2021. Also, around 1.1 GW of capacity was backed out by developers or not granted COD extensions, against the outlook of 3.3 GW.

Wind energy is emerging as a crucial link for India's green energy transition story. Policymakers experimented with multiple formats of hybrid projects to explore the complementarity of large-scale wind and solar while reducing the cost of RE integration. The year 2020 saw procurement in all three market segments – central, state, and corporate market for new hybrid projects, indicating the underlying trend. The country awarded 0.97 GW of new capacity in standalone tender and an estimated 2.3 GW of wind capacity in the wind-solar hybrid, peak-power, and round-the-clock formats at continuously attractive prices. The pricing for standalone wind tender has declined from INR3/KWh (USD 40/MWh) in 2020 to INR 2.77/kWh (USD 38/MWh) in 2021; while hybrid tenders concluded in the range of INR 2.41-2.42/kWh (USD 33/MWh). Hence, establishing a strong value proposition offered by wind energy for future tech-neutral tenders.

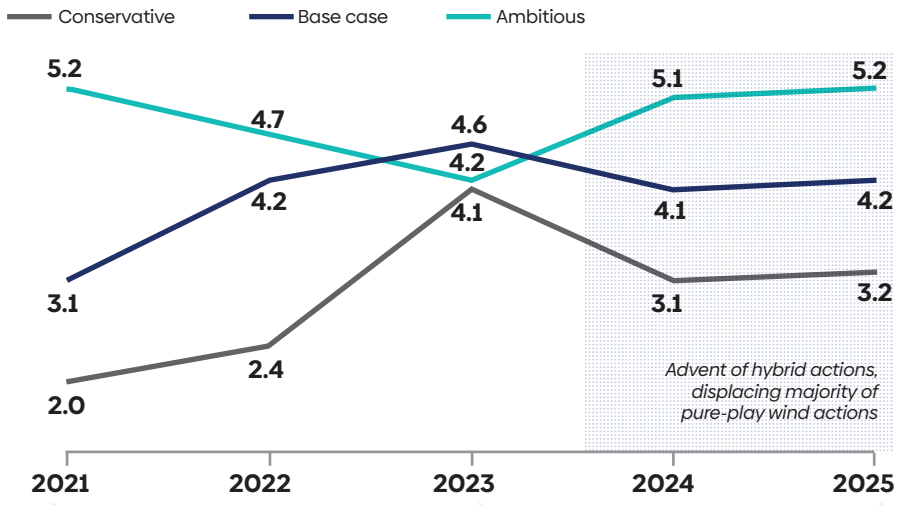
[1] https://www.business-standard.com/article/economy-policy/india-enters-new-fiscal-with-negative-power-demand-robust-growth-missing-121040100418_1.html

Market outlook

India currently has a pipeline of 10.3 GW in central and state markets, which is expected to drive installations until 2023 in the market. The market post-2023 is likely to be driven by 10 GW of new capacity awards to wind, majorly in hybrid formats. The linking of utility-scale wind and solar technology will be a crucial lever for the volumes in the years 2024-25. Notification of new tenders and pricing fitment of the hybrid tender will remain crucial for the opening of hybrid volume. It is also important that new tender notifications are based on robust RPO demand of DISCOMs and designed as per economic feasibility of wind vis-à-vis APPC.

Over 2021-25, India is expected to install nearly 20.2 GW of wind capacity, 90% of which will come from central tenders, followed by corporate procurement

FIGURE 12 | Y-O-Y NEW WIND INSTALLATIONS IN INDIA 2020-25



Majority of active pipeline is commissioned until 2022; except in conservative case due to continued land, fin. issues

Peak in installations in 2023 with expiry of ISTS waive-offs in June 2023

Installations stabilize with annual hybrid auctions, where wind plays critical role; trajectory visible from 2023 in ambitious case

Installations 2021-25	Scenario Definitions
24.4 GW	Active pipeline is commissioned by 2022; new annual auctions of 9 GW for hybrid and 1 GW for pure-play wind; C&I installations scale with increased competitiveness towards 2025
20.2 GW	Active pipeline is commissioned until 2023; new auctions scale from 4 GW hybrid and 1 GW wind to 6 GW hybrid and 1 GW wind by 2025; C&I installations regain pre-2019 levels
14.8 GW	Active pipeline contracts with cancellations and is back-loaded towards 2023; new auctions are solely hybrid technology based (5 GW p.a.) and no wind stand-alone tender

Note: As per calendar years; forecasts are inclusive of hybrid projects
Source: State ARRs; RPO documents; PGCIL; NTC and RTC Meeting minutes; credit rating report; CEA; SECI; MEC+ analysis

and lastly state markets. In the conservative scenario, net volume installation can dip to 14.8 GW in case the existing pipeline shrinks and new auctions are limited or sporadic; the COVID-19 waves in the country are likely to keep installations closer to the conservative scenario. However, in an ambitious scenario, nearly 24.4 GW of volumes can be expected in the next five years, driven mostly by high demand for price-competitive hybrid auction pan-India and to some extent by complete actualization of the current pipeline.

The corporate procurement market for renewables has started to pick up in India driven by the cost competitiveness of wind and solar as compared to DISCOM supply. Corporate PPAs supply nearly 39% of the C&I demand in India, however, less than 10% of it is from renewables. Corporate procurement of renewable energy remains a huge potential but untapped market in India. As of date, 9 GW of wind and 8.1 GW of solar (including rooftop installations) are installed in the C&I procurement category in India. Going forward, solar alone will fall short to meet the multi GW opportunity and wind development will be crucial to meet the larger sustainability goals alongside the power demand of corporates. This market is expected to contribute 0.85 to 1.7 GW of wind installations in the next five years, however, can open to be a multi-GW opportunity on the back of long-term reforms easing the approvals and procurement mechanism.

Post-2025, the market offers multiple green shoots including those of offshore wind, repowering, and developing India as a wind export hub, as well as the largely untapped potential of the largest C&I consumers in India.

To unlock the full potential of wind energy, the government can strengthen consensus and coordination among agencies with a consistent and aligned market roadmap, clarifying volumes, frequency, and composition of new tenders. Additionally, the promotion of technology exchange and alignment to the global supply chain can create export-oriented opportunities for the Indian manufacturing base.

1. INDIA WIND ENERGY SECTOR: BACKGROUND

India has over three decades of experience in harnessing power through a grid-connected wind energy system. Wind power continues to be a major constituent of India's renewable energy (RE) based grid-connected power generation mix and constitutes 4%[1] of the overall share of electricity generation in the country. Between 2010-2011 and 2019-2020, wind generation capacity grew at a CAGR of 11.39% while the overall installed electricity capacity witnessed a CAGR of 8.78%.[2] The National Institute of Wind Energy (NIWE), 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. This is almost 81% of the country's current installed electricity generation capacity.

With a massive growth in the power sector, particularly in the second half of the last decade, India has made great strides, for example, the country reports over 99% household electrification and is already running the world's largest RE expansion initiative. From 2017 onwards, new RE capacity addition has continued to exceed coal-based thermal power. These developments indicate the commencement of a new dawn in the Indian power sector.

Yet, India has a long road to walk. With a per capita electricity consumption of 1,208 units in 2019-2020, which is less than half of the world average, and an estimated emerging power demand of 2087 TWh in 2030 from 1207 TWh in 2019, India needs to prepare for the future[3]. Taking note of enormous future surge in power demand and to promote a low carbon growth, India had committed to a 175 GW of installed RE capacity (100 GW solar, 60 GW wind, 10 GW from bio-power, and 5 GW from small hydro-power) by 2022 and has already installed more than four times its original aggregate 2022 target of 20 GW. As of March 2021, wind power constitutes 42%[4] (39.2 GW) of cumulative installed grid-interactive RE power.

1 For April 2020 to March 2021; CEA executive summary report March 2021; Wind generation for month of Mar 2021 not available

2 Based on CEA's Growth of Electricity Sector in India from 1947-2020

3 As per the India Vision Case in the International Energy Agency's India Energy Outlook 2021

4 As on March 2021 as per CEA monthly installed capacity report

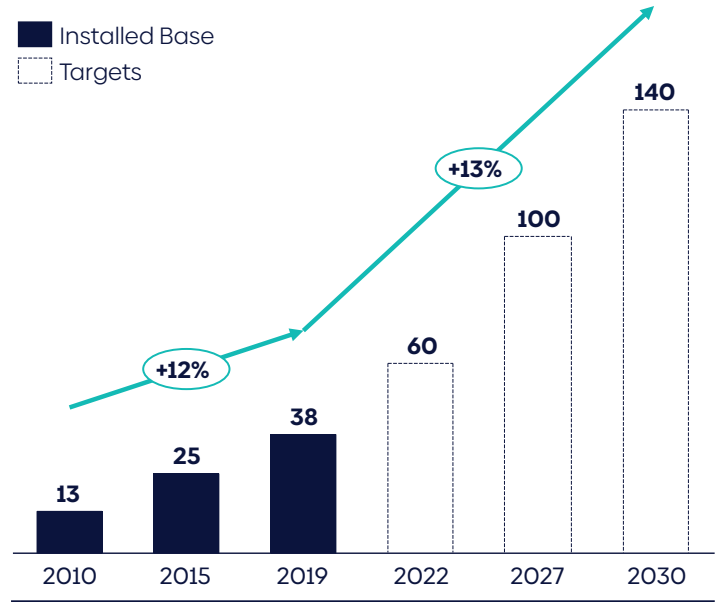
Robust long-term demand drivers continue to boost wind energy growth

Despite the short-term drop in India's energy demand brought by the COVID-19 crisis, the long-term drivers of energy demand and growth remain intact. Year-on-year electricity demand declined by 8%[5] between 2019 and 2020 in India, due to the impact of the global pandemic and subsequent economic slowdown. However, long-term projections towards 2025 foresee a recovery of energy demand,[6] expected to increase by 3% in the conservative case and as much as 18% in the ambitious case in the next five years[7].

RE remains the central axis of energy supply planning to meet the increasing demand in India. Although the progress towards targets and renewables installations stalled in 2020, India reinstated its commitment to clean energy in multiple national and international forums, including the UN Climate Action Summit 2020, World Solar Technology Summit (WSTS) of the International Solar Alliance, and 15th G20 Summit. The landscape for RE support continues to become favourable, in early 2021 the Reserve Bank of India has joined the Network for Greening the Financial System (NGFS) to define and promote best practices in green finance in India. India remains committed to a target of 40% electricity generation from renewable energy by 2030, delivered through 450 GW of installed capacity. This includes a cumulative target of 140 GW of onshore and offshore wind by 2030 (refer to figure 1).

FIGURE 1 | INSTALLATIONS VS TARGETS FOR WIND 2010 TO 2030

Installations vs targets for wind 2010 to 2030
GW



Source: CEA; Newspaper articles; MEC+ Analysis

In 2020, India installed nearly 1.1 GW of wind energy, majorly driven by central and state auction volumes, C&I wind installations saw a limited increase in the year. Around 0.8-1 GW of capacity which was expected to be installed in 2020 has been shifted to 2021, following the government's blanket 5-month extension granted to central projects on account of the COVID-19 crisis.

Last year saw the commissioning of a crucial substation at Bhuj in Gujarat, where 60% of the wind pipeline is concentrated. Under the newly proposed wind park/wind-solar hybrid park development scheme, the central government has raised the prospect of earmarking land for wind park development to address delays in allocations of land and grid. Additionally, the MNRE extended the inter-state charges waive-off from December 2022 to June 2023 and removed price caps for future auctions. India also launched an extending green electricity trading market, in form of GTAM in June 2020.

India is the world's fourth-largest onshore wind market, and new tenders and market mechanisms introduced in 2020 offer growth opportunities ahead.

5 Energy requirement (TWh) – Central Electricity Authority data for 2019 and 2020 monthly executive report on power supply position
6 TERI- July 2020: Bending the curve
7 Based on 1277 TWh electricity requirement in FY21; conservative case relates to L-shaped scenario in TERI study assuming a steeper contraction in 2020, and more damage to India's mid-term growth potential. GVA contracts by –7.4% in 2020, and rebounds by 6.6% in 2021. Thereafter, the sectors settle down into a more muted trend growth rate, i.e. about 5% year-on-year for industry and 6.5% to 7.0% year-on-year for services). The ambitious case is related to V-shaped scenario in TERI study assuming a contraction of –5.5% in 2020, and a recovery to 9% in 2021. Thereafter, sectoral GVA resumes at about 7% year-on-year for industry, and about 9% year-on-year for services

2. WIND RESOURCE ATTRACTIVENESS

Renewable energy continues to out-compete conventional capacity

Wind is an attractive cost-competitive utility-scale resource in India. On average, wind LCoE is roughly 35% lower than most coal plants present in the country providing much-needed renewable electricity.[8]

During 2020, both wind and solar benefitted from the favourable financing made available by the government for economic recovery, as well as loan tenures increasing from 15 to 18 years and a 75% debt ratio instead of 70%.

The cost differential between renewables and coal power plants is expected to increase towards 2025, as costs further decline for wind by 16% and for solar by 13%[9]. Wind costs are expected to have a steeper decline with the commercialization of 3 MW WTG towards 2023, decreasing per MW CAPEX and improving annual production making it more attractive (see figure 2 for current and 2025 LCoE projections on the wind, solar, and coal generation).

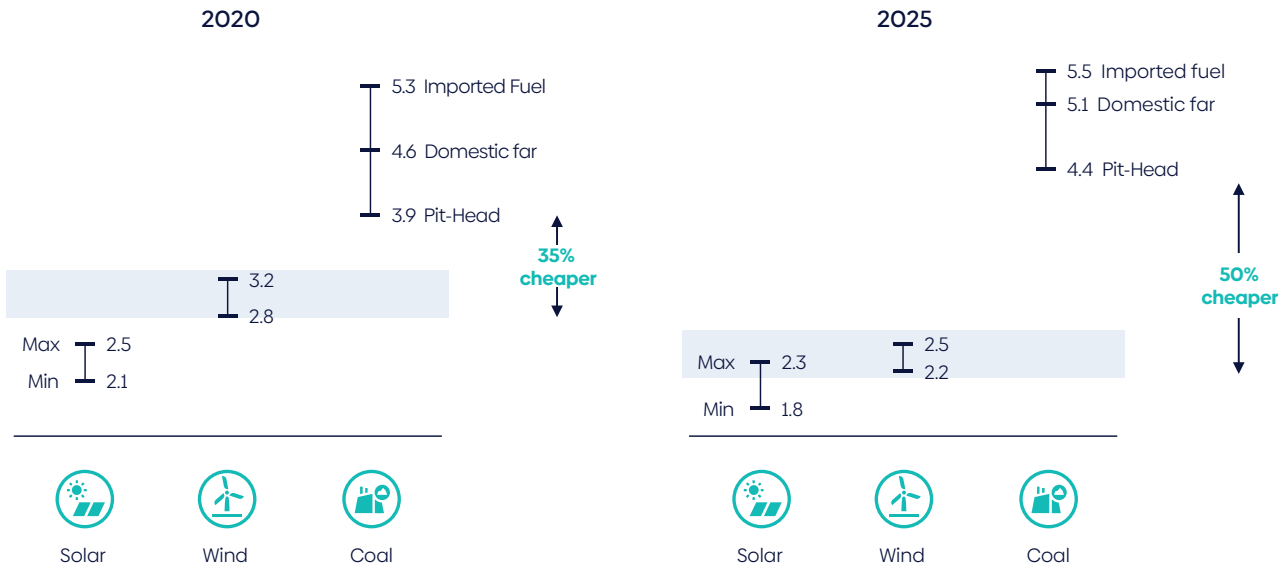
Moreover, owing to the following factors, wind's role in India is set to evolve into a value focussed role of providing power during the day in combination with solar and other technologies:

1. Wind and solar are complementary in generation profiles in terms of the time of the day and seasonality. Wind supplies power during peak consumption hours in a day. Seasonally, wind production is strong during the monsoon season when solar resource is lower, while the reverse is the case during the months of November and December.
2. Wind is driven by higher annual CUFs in the range of 35% to 40% as compared to solar operating at 16% to 20%. A wind plant combined with solar allows annual CUF to move even higher.
3. Wind offers a more consistent daily generation profile as compared to solar, which is available for 6-7 hours a day
4. Wind has relatively lower societal costs, including no costs of carbon, lower marginal costs for dispatch, minimal water requirement, matching load profile from the grid, and lower than solar balancing costs. Additionally, the wind industry has a higher job creation potential and requires skilled and semi-skilled labour throughout the project lifetime.

8 Referencing coal-based plants typically located 500 km from domestic coal mines but using domestic coal as fuel.
9 MEC+ wind, solar LCOE model

FIGURE 2 | LCoE COMPARISON OF SOURCES (NEW VS NEW), 2020 AND 2025

LCoE comparison of sources (new vs new), 2020 and 2025
INR/kWh



Note: Wind and solar LCoE calculations done at 12% internal rate of return while coal calculations done at 14% return on equity
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

3. CURRENT MARKET ACTIVITY

Market activity was challenged by the COVID-19 pandemic but recovered in H2 2020

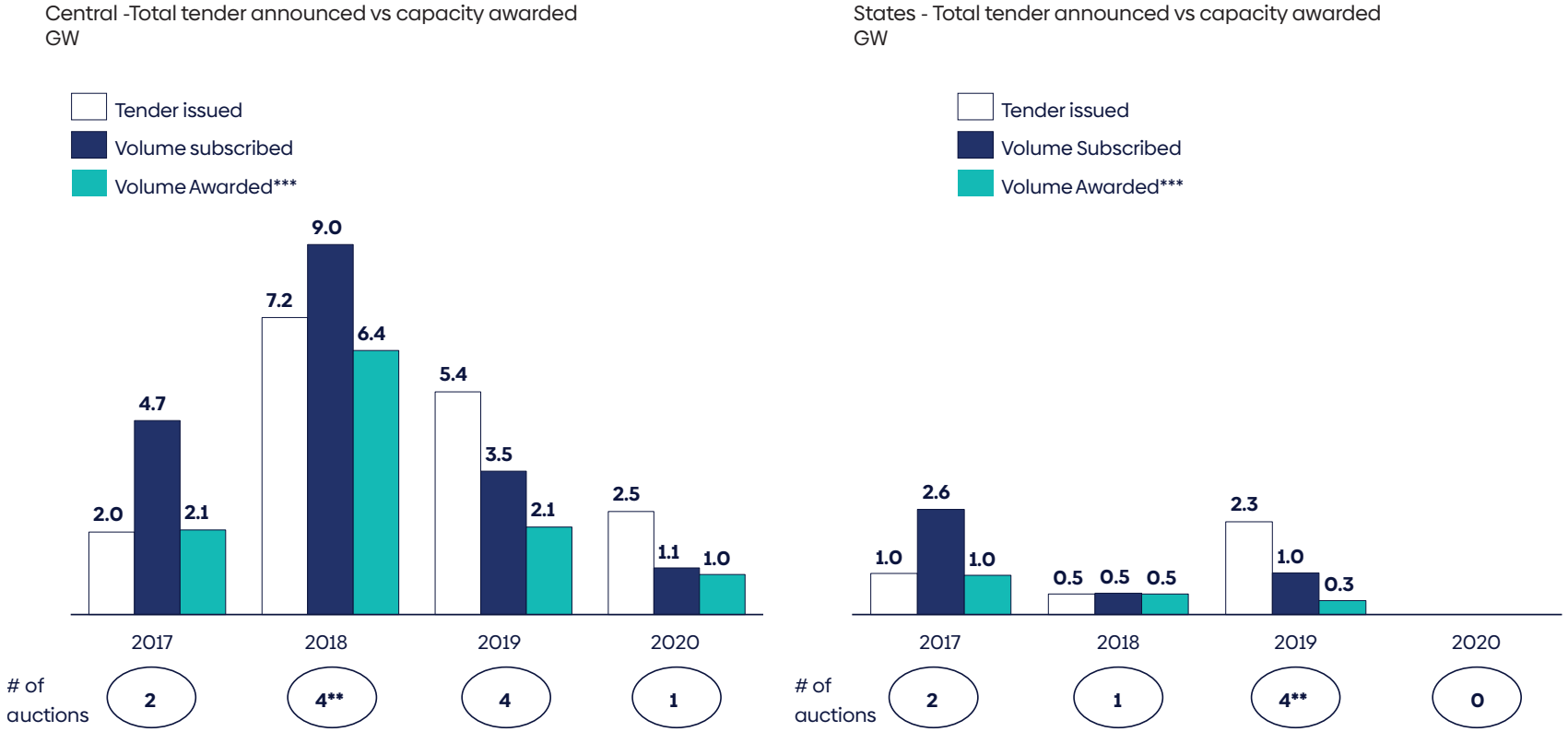
Shift of tenders to hybrid/blended format

India issued a 2.5 GW central wind tender (SECI-IX) and issued 3.7 GW of wind-solar hybrid tenders in the year 2020. While the SECI IX standalone wind tender did not get any bidders, hybrid tenders were oversubscribed. The SECI IX tender was revised to the blended wind (80%) and solar (20%) tender and concluded in mid-year with 0.97 GW awarded at INR 3/kWh (USD 40 / MWh). The hybrid tenders were fully awarded both for central and state tenders; 2.8 GW of central wind-solar hybrid, round-the-clock, and peak power tenders were awarded, and 0.9 GW of state wind-solar hybrid tenders were awarded by private utilities in the state of Maharashtra (refer to figure 3 for Y-o-Y activity in central and state wind tenders).

The difference in allocation under tenders indicates a subtle shift of power procurement towards technology neutrality and demand-linked supply in India. As of April 2021, there were 1.2 GW of pure-play wind tender awarded in March at a tariff of INR 2.77/kWh (USD 38/MWh) and an additional 4.3 GW[10] of hybrid/blended tender notifications. The role of wind in hybrid tenders remains crucial and wind will play a vital role in supporting the requirements of integrating renewables on the grid (see note box 1 for a detailed overview of hybrid auctions in India).

10 1.2 GW hybrid tranche IV & 2.5 GW RTC-II Thermal blended RE, 600 MW NTPC hybrid auction

FIGURE 3 | WIND AUCTION PARTICIPATION HAS DECLINED OVER YEARS IN INDIA



Note: Does not include Hybrid auctions

* Includes Maharashtra auctions which were issued for procurement from existing wind projects with expired PPAs

** Auctions retendered with changes in design have been considered as single auctions (Applicable on SECI V and Gujarat II)

*** Projects abandoned at a later stage after contract award are a part of volume awarded

Source: SECI; GUVNL; MSEDCL; TANGEDCO; NTPC; MNRE; MEC+ analysis

NOTE BOX 1: EMERGENCE OF WIND-SOLAR HYBRID AND BLENDED PROJECTS IN INDIA

MNRE announced a wind-solar hybrid policy in May 2018, with an objective of efficient utilization of transmission infrastructure and land, while reducing the variability in renewable power generation and achieving better grid stability.

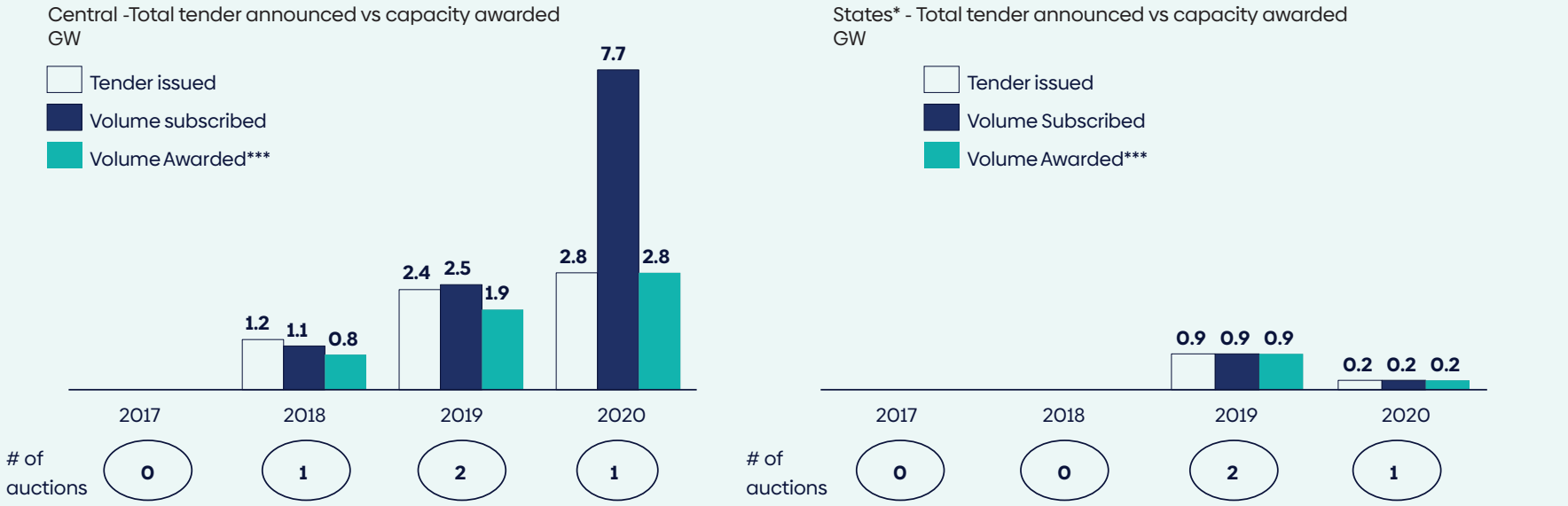
Since the introduction of the policy, India has concluded:

- Three wind-solar hybrid tenders of 1.2 GW each in years 2018, 2019, 2020 respectively, with a typical requirement in these tenders of 30-40% CUF requirement on an annual basis.
- A peak-power tender for 1.2 GW in 2020, with requirement of 35% annual CUF and 50% CUF in fixed peak hours (morning and evening). The tender mandated the use of storage to meet the performance requirement.
- A round-the-clock tender for 400 MW in 2020 with requirement of 80% annual and 70% monthly CUF to be met through use of wind and solar technologies.

Out of 5.2 GW tenders issued till date in central hybrid auctions, 4.36 GW has been awarded. The cost trajectory has also declined between the first and most recent hybrid tenders, from INR 2.62 to INR 2.41 per kWh (USD 33/MWh) in the central auctions (see figure 4).

Consequent tothe center's policy, three states, Gujarat (2018), Rajasthan (2019) and Andhra Pradesh (2019), have also notified hybrid policies and announced incentives (charge waivers) to promote the technology amalgamation in the

FIGURE 4 | HYBRID AUCTION PARTICIPATION HAS INCREASED OVER YEARS IN INDIA



Note: Does not include Hybrid auctions not awarded.
Source: SECI; GUVNL; MSEDCL; TANGEDCO; NTPC; MNRE; MEC+ analysis

state. The hybrid policy can be a step in the direction to re-open the demand in state auctions to meet the unmet solar/non-solar RPOs; however, none of the states have yet tendered any capacity.

The state hybrid tenders for power procurement have been limited to the private utilities — of Adani Electricity Mumbai Limited (AEML) and Tata Power in Maharashtra. The AEML concluded an auction in 2019 for the award of 700 MW of wind-solar at INR 3.24 per kWh (USD 44/MWh), with the tender requiring annual CUF of 50%. Tata Power concluded a power procurement auction in 2020 for award of 225 MW with requirement of 35% annual CUF; the prices are not known for this tender.

Multiple technology configurations of hybrid exist, depending on the requirement in tender around CUF and time of supply. The pricing in the special category hybrid tenders of peak-power and RTC have been specific to the requirements and design. The peak-power tender was awarded at tariff of INR 2.88 per kWh (USD 40/MWh) for off-peak hours and INR 6.12 to 6.85 per kWh (USD 84-94 per MWh) for peak hours discovered through competitive bidding. At the same time, the RTC tender was awarded at INR 2.90 per kWh (USD 40 per MWh) with provision of 3% annual escalation until the 15th year. The pricing dynamics have been quite interesting, and utilities are enthusiastic to sign PSAs for less-intermittent, cheap green power.

Hybrid wind-solar prices are expected to vary between INR 2.5 and 3.1 per kWh in 2020 (USD 34-43 per MWh) (75% solar and 25% wind blended) and decline by 15-20% by 2025. Towards 2025, storage is expected to become feasible in cost as well: Wind-solar hybrid integrated with storage (75% solar and 25% wind blended) is expected to generate power in range of INR 3.8 /kWh (USD 52/MWh) (in Gujarat, 4-hr. battery) to INR 5.2 per kWh (USD 71/MWh) (in Andhra Pradesh, 1-hr. battery) making this an interesting format for developers and procuring entities.

Growth slowdown due to delays and cancellation

In terms of capacity, nearly 1.9-2.1 GW of wind capacity was scheduled to be connected to the grid in 2020; however, nearly 0.8-1 GW of central and state-tendered projects were pushed into 2021, due to suspended construction activity during the peak months of COVID-19 in 2020. In addition todelayed projects, nearly 2.4 GW of projects have been cancelled and another 0.8 GW is designated as doubtful projects due to excessive delays or financial non-viability. The majority of the projects cancelled belong to SECI III and SECI IV which saw aggressive bidding at price levels of INR 2.4-2.5 per kWh (USD 33-34 per MWh), tariffs which are no longer feasible in the market due to escalation of costs owing to issues such as delays in land allocation and PPA signing/renegotiation. Additionally, cancelled and doubtful project belongs to the NTPC 1.2 GW tender that failed to secure a PSA or the state auctions in Tamil Nadu and Maharashtra.

India installed 1.1 GW of wind capacity in 2020 with 0.73 GW from central tenders of SECI II/III, 0.32 MW from state tenders of Gujarat-I, and 0.1 GW of C&I volumes. Three IPPs – Sembcorp Green Infra, Alfanar Energy, and Renew Power – accounted for 70% of the capacity online. Siemens Gamesa held its spot as the top WTG OEM for the year supplying 325 MW, followed by GE Wind replacing Suzlon as number two WTG OEM in the market by supplying 222 MW.

Central auction 2020 activity

During 2020, 0.7 GW of the central pipeline came online, mostly from SECI II and SECI III auctions in May 2017 and February 2018, and with several delays due to issues in grid, land, and PSA signings.

Additionally, 1.2 GW of central auction capacity was cancelled in 2020, which included 150 MW of contracts terminated by SECI on account of delay and 965 MW termination by developers due to non-viability of projects; 124 MW continues to be uncertain.

State auction 2020 activity

In 2020, no new PPAs were signed for wind power projects by state DISCOMs. However, private DISCOMs in Maharashtra conducted an independent auction in a hybrid format for 925 MW.

During 2020, 0.32 GW of the state auctioned projects were commissioned, all of it from the Gujarat-I (2017) tender after multiple delays. Nearly 175 MW missed installation in 2020 due to pandemic-related delays from Maharashtra-I 2018 500 MW tender.

Leveraging advanced digital technology and IT infrastructure

The global and Indian wind sector is continuously evolving. Through a fast-paced adoption of advanced digital technologies, wind players are outpacing challenges that would have made O&M expensive and challenging (refer to note box 2). Some of the applications of advanced digital technology include best practices for blade inspection and cleaning related data capture through drones, crane less technology, vibration analysis sensor, laser alignment gear, and generator, LiDAR technology for corrective yaw alignment. Apart from these, wind generation forecasting and analysis are supported by advanced analytical tools that leverage frontier technologies. Also, there is a growing trend towards the adoption of digital technologies that support wind project planning, design, procurement, engineering and commissioning, O&M, and management. Most importantly, the adoption of advanced technologies, including the LiDAR has helped NIWE in improvising earlier wind potential forecasts.

NOTE BOX 2: ISP-BASED O&M MODEL IS FUELLING DIGITAL TRANSFORMATION AND IMPROVED REVENUES

Evolving business dynamics have continued to redefine business models for the maintenance of wind farms in India. In the earliest projects, O&M was mostly outsourced to Original Equipment Manufacturers (OEMs). In this model, OEMs held the O&M contracts for the life of the wind farms supplied and commissioned by them, prominently in the case of retail or C&I customers. In this model, the contract value for O&M escalated by an average of 5% annually.

Gradually, customers became conscious of year-on-year increasing OpEx costs and declining performance of the assets. Hence, from the OEM-dominated long-term contract models, a shift to short-term contracts with OEMs and third-party long-term O&M contractors or self O&M gained pace. Recently, the transition to competitive bidding process for wind tariff from 2015 onward has also emphasized cost-effectiveness across the value chain. Therefore, IPPs are exploring a new business model, which has led to the roll-out of models based on Independent Service Providers (ISPs).

The latest trend in O&M through ISPs offers great benefits to project owners and investors. India's leading ISP, the GreenTech Megawatt (GTMW) is leveraging high-quality data to improve the reliability of the wind farm assets with advanced analytics. The GTMW has migrated to predictive maintenance strategy which has enabled smart planning of scheduled /periodic interventions for turbine operations thereby reducing unnecessary manual interruptions, while acknwoeledging design limits of components. During the lockdown in 2020, with seamless connectivity and data transfer from turbines in Tamil Nadu to local monitoring stations, all assets managed by GTMW were remotely operated. This limited the movement of technicians to turbines for only inevitable manual interventions validated through data analytical tools) and reduced their exposure to COVID-19 risks.

A range of solutions are emerging, such as drone technology for blade inspection, condition monitoring systems, advanced data analytics, and machine learning for predictive analytics. GTMW has been able to achieve a 20-30% reduction in downtime and a 15-20% drop in maintenance costs at the Theni windfarm. With the application of digital innovation, including frontier technologies, it has become feasible to gain control over project cost dynamics and design a customized solutions to support re-powering solutions for already commissioned units that are aging. Over the pandemic alone, the GTMW has witnessed a growth of over 40% in demand for remote and advanced IT services

In an ISP-based model, the availability of OEM's propriety items for retrofit solutions and re-engineering are made available. The offered services include spares for absolute turbine parts, retrofit, reconditioning of spares from end-of-life turbines. Also, there is greater clarity on ownership of shared infrastructures between the OEM/ISP with the asset owner. There is a growing need felt for high-quality data to improve reliability/performance of assets, asset health monitoring systems and to support advanced maintenance techniques. ISP led model whicle harnesses advanced digital technologies and IT infrastructure is now recognized as best practices in the wind sector globally.

4. FUTURE INSTALLATIONS (2021-2025)

India wind market reinvigorates in next five years on the back of a healthy pipeline and hybrid auctions

India is expected to install ~20.2 GW between 2021 and 2025, taking the cumulative installed base of wind power in India to 58.8 GW by 2025. The installations will be driven by Central Auctions, C&I, and state auctions.

Central auctions will contribute 18.2 GW driven by pipeline and new auctions and states will contribute 0.7 GW driven by existing pipeline in the wind and hybrid tenders, C&I will contribute 1.3 GW, driven by the need to shift towards RE and replacement of expensive DISCOM supply.

Meanwhile, supportive interventions have been introduced which enable the sale to clean power in an exclusive green power market (refer to note box 3). This is likely to emerge as an attractive avenue for resource rich and surplus states to earn revenues.

NOTE BOX 3: SPOTLIGHT ON GREEN TERM AHEAD MARKET IN INDIA (GTAM)

In the past years, there have been several instances of renewable resource-rich states being slow to prioritise renewables due to surplus of energy, while other states lacking renewable resource have been unable to fulfil their RPOs.

Although renewables penetration has increased over the years, the participation of renewables in market mechanisms like DAM and TAM has been very low (<1%), as there was no segregation between conventional and renewable power. To resolve these issues, the Power Ministry introduced an exclusive Green Term Ahead Market (GTAM) in India on 1 Sep 2020. Its key features include:

1. All contracts are bilateral in nature and will be considered as deemed RPO compliance for the buyer.
2. GTAM contracts are segregated into solar and non-solar in line with RPO targets.
3. Four different contracts are offered currently - Green Intraday, Day Ahead contingency, Daily and Weekly contracts.
4. Price discovery will take place on a continuous basis i.e., price time priority basis.

The introduction of GTAM is expected to provide an avenue to renewable resource-rich state DISCOMs and renewable developers (utility and C&I) to sell excess power in an exclusive green market. It is expected to provide price visibility as well as flexible and transparent procurement and remuneration.

Until December 2020, around 550 MUs have been traded at an average price of INR 3.5 /kWh (USD 48/MWh). While still in a nascent stage, going forward GTAM is expected to promote merchant capacity addition for renewables (~20GW) and promote states to procure clean energy surpassing their RPO obligations. The Power Ministry expects to add more products for further promoting renewables, including a Green Day Ahead Market (G-DAM).

i. Central auctions

India's wind sector underwent several positive developments in 2020 which will enable installations through 2025. A summary of the main drivers is provided in table-1.

TABLE 1 | TRAFFIC- LIGHT INDICATOR FOR CENTRAL WIND AUCTION SEGMENT

Characteristics	Comments
Policy and regulation	Framework for tender execution is transparent and well-oiled with hiccups due to the move to auctions ironed out. Hybrid wind-solar policy needs to be defined a bit further to sustain momentum
Infrastructure	Grid augmentation continued as per planning in 2020, further 1500 MW additional anticipated until March 2021
DEMAND	RPO from states and ministry are strong but need to be defined after 2022
Project execution	Ambitious land scheme has been announced, policy bottlenecks removed. ISTS charges have been waived off until June 2023
PIPELINE	Strong activity in 2020 to meet the PSA bottlenecks of central auctions. A pipeline of 9.4 GW exists already

Central auctions likely to drive volumes with the easing of infrastructural challenges

Central auctions are expected to be the largest contributor for volume in the next five years, with 13.2 – 20.1 GW total volume coming online from 2021 to 2025. New auctions are likely to award 9-10 GW of wind capacity in 2021 to 2023 (including wind and wind capacity in hybrid tenders).

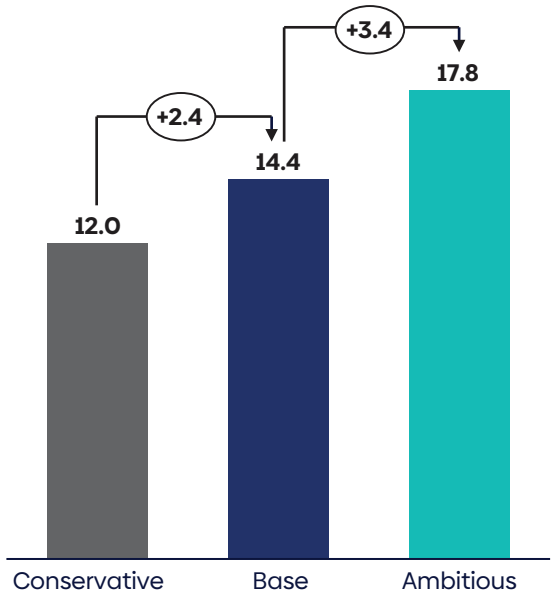
Demand and economics

The major driver for the central market is non-solar RPO from non-windy states, however, these are majorly defined until 2022 as per MoP and state orders.

The RPO trajectory is not defined beyond 2022 for most states in India, indicating that states may take multiple trajectories for RPO definition towards 2025. Three trajectories of non-solar RPO can emerge- conservative, base case, and ambitious, depending on post-2022 adoption by states.

In the conservative case scenario, the states may not increase their budget. In a base case, the RPO target is expected to vary between 6% to 12.3% in 2025, if states continue to increase RPO targets at respective historical rates, creating demand for 14.4 GW[11] of new wind procurement until 2025. In the ambitious case, go as high as 17.8 GW based on central RPO (refer to figure 5).

FIGURE 5 | NEW NON-SOLAR DEMAND IN CENTRAL AUCTIONS (2021-25)



Source: MEC+ Analysis

Pipeline

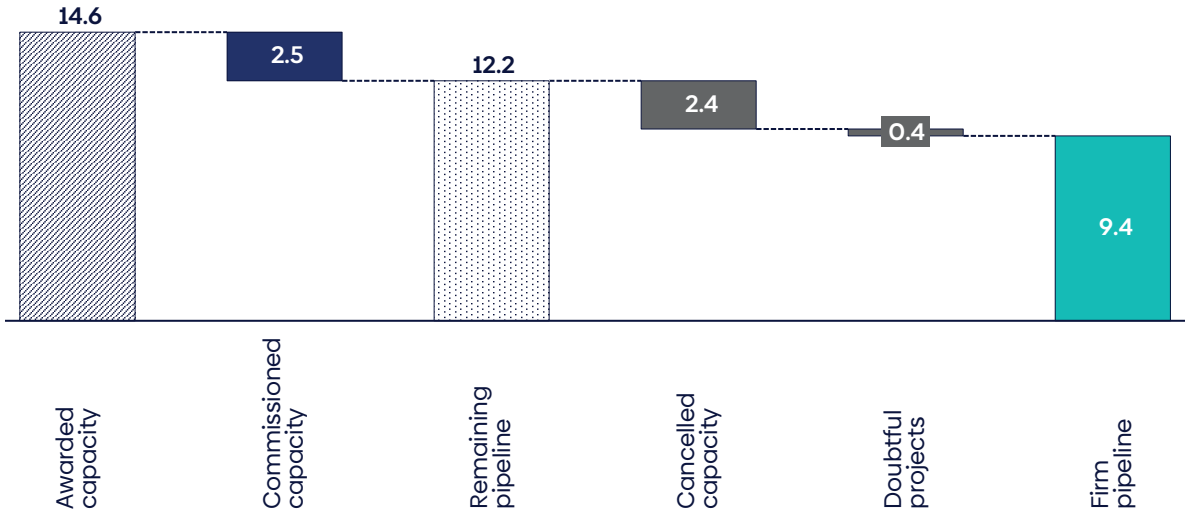
MNRE has concluded 18.3 GW standalone wind capacity in central auctions between February 2017 to March 2021, out of which 12.5 GW were awarded. Additionally, 5.2 GW of hybrid auctions were issued in the same period, of which 4.36 GW of hybrid projects were awarded (~2.1 GW of wind accounting in hybrid tenders[12]); creating a net awarded pipeline of 14.6 GW (12.5 GW+2.1 GW). The breakdown of the

11 Already procured power for 5.84 GW in auctions conducted (to be online)

12 MEC+ estimates based on hybrid tender requirement for CUF etc.

FIGURE 6 | STATUS OF PROJECTS AWARDED IN CENTRAL AUCTION (2021-25)

Status of projects awarded in central auction (Wind+ wind component of Hybrid auctions)
GW



Source: MEC+ Analysis

status of awarded wind volumes in central auctions is indicated in figure 6.

As of March 2021, central auctions have a pipeline of 9.4 GW (7.3 GW wind and 2.1 GW wind portion of 4.3 GW hybrid) which are scheduled to be commissioned within the next two years.

The pipeline excludes the 2.8 GW (2.4 GW cancelled and 0.4 GW doubtful projects) of projects which have been cancelled by SECI/NTPC, abandoned, or are at risk of cancellations by the developer.

A majority of the pipeline is expected to come online during 2021[13] and 2022, with the settlement of land allocation policy and easing of the grid and related infrastructure availability. WTG OEMs have also announced new products within the 3 MW platform for low wind sites in India including Vestas, Siemens-Gamesa, and Suzlon, which is expected to open larger sites for wind integration and ease up issues around profitability and land availability.

13 The volume installation in 2021 can be impacted by COVID-19 second wave in India (refer Note Box 5: Spotlight on CoVID-19 India second wave)

Grid availability

Grid delivery as per plan has eased delays in critical regions

Nearly 26 substations have been allocated to evacuate wind generation in India. However, the projects bid in central auctions has gravitated towards two substations – Bhuj in Gujarat and Tirunelvelli in Tamil Nadu. The former was preferred by developers due to the availability of cheap revenue land.[14] Sites in the Bhuj region allowed developers to engineer the lowest-cost bids utilising high resource sites and cheap revenue land, resulting in a concentration of nearly 60% of awarded capacity at the substation.

Due to lower project commissioning activity in 2020, grid-related constraints were eased with the commissioning of 500 MW of grid capacity in 2020 and an additional expected capacity of 6 GW by mid-2021.

Simultaneously, developers have started exploring projects outside Gujarat and Tamil Nadu; since the SECI V tender, projects[15] have diversified into Madhya Pradesh, Karnataka for wind projects, and Rajasthan for hybrid projects. More than 1 GW of wind project pipeline has been in these states.

14 Government land that can be allocated to developers for wind project development. Revenue land is typically 60-70% cheaper than privately held land in India.

15 Projects have diversified into Karnataka, Madhya Pradesh and Rajasthan for suitable sites, however, PPAs are signed with SECI for inter-state power procurement and not DISCOMs of these states

Land availability

For the past few years, the Indian wind industry has been struggling due to land availability, NOCs, and transmission-related issues. Unlike in the solar sector where projects are commissioned on contiguous land, wind projects require scattered land on a footprint basis which leads to higher transmission costs and land challenges. To overcome these challenges, MNRE proposed a new Wind/Wind- Hybrid park development scheme in November 2020 (see note box 4).

The policy for land availability in key states has been stable in 2020, except Gujarat notifying few additions to the 2019 wasteland allocation policy to prevent squatting on some of the best and cheapest wind sites in the country. The state agency has specified a timeline of three years to complete 50% of construction on the allotted land and 100% within five years.

Additionally, the state of Andhra Pradesh released its RE Export Policy in 2020, which can open the state for setting new wind projects. The policy prioritises land allocation to projects intended for RE export along with setting up manufacturing facilities in the state and demonstrates innovative ways of utilizing the land to the state's advantage.

NOTE BOX 4: SPOTLIGHT ON PROPOSED WIND/HYBRID PARK DEVELOPMENT SCHEME

The scheme proposes to create concentrated zones of development of wind/ wind-solar hybrid parks with proper infrastructure including evacuation facilities, to minimise the risks for wind developers. NIWE has identified around 10,800 km2 of land across 7 states to develop around 54 GW of wind/wind-solar hybrid parks. This includes 19 sites across these states with CUF greater than 30%, excluding non-usable areas. If the designated land is suitable for solar as well, the park developer can also build a hybrid park. The scheme proposes:

1. To build parks of greater than 500 MW capacity, however smaller parks can also be built depending upon land and resource availability.
2. State governments will help park developers (Government agencies and private institutions) to acquire identified sites. In case power is exported to other states will be entitled to 0.05 INR/kwh charge (USD 6.9/MWh)
3. MNRE would provide financial assistance to the park developer at the rate of INR 2.5 million per park (USD 34k per park) and INR 2 million/ MW (USD 27k per MW) or 30% of park development cost.
4. Park developer would be responsible for all statutory and non-statutory clearances. Additionally, building of one or more pooling substations and transmission lines to nearest substations would also be the responsibility of park developer.

According to MNRE, the Wind Park will provide a plug and play solution (availability of land, transmission, necessary infrastructure, and necessary approvals) to investors for installing wind/ wind-solar power projects. The policy is expected to resolve major problems faced by wind developers and increase investor confidence going forward. However, implementation of the scheme and timeline of project execution needs to be defined.

ii State market

State auctions have historically comprised auctions from the government DISCOMs in seven high wind resource states that have also been doing their individual tenders in the past. There was no activity in 2020 in the state auctions from the government DISCOMS. However, private DISCOMs conducted their auctions to procure power in 2020. Going forward, it is expected both public and private DISCOM will not offer substantial new tenders, in the base case. Some of them are likely to shift to central auctions due to higher competition in those auctions.

The table-2 summarises the key drivers of the market and their outlook followed by detailed commentary

TABLE 2 | TRAFFIC-LIGHT INDICATOR FOR STATE WIND AUCTION MARKET

Characteristics	Comments
Policy and regulation	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
Demand	RPO enforcement required by SERC and RPO trajectory post FY22 needs to be defined
Project execution	Project execution is smooth with aligned land policy and grid connectivity agreements in place
Pipeline	Existing pipeline is limited at 0.9 GW, within which 0.7 GW is likely to be executed towards 2025

State markets continue to be dormant for wind procurement

The 7 states[16] with high wind resources have been traditionally driving wind procurement in India through feed-in-tariffs, hence most of the wind installations are under direct DISCOM PPAs to date in India. However, state-led wind procurement has declined in the last two years, 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 the states have a pent-up RPO demand; however, the timeline of activation of the demand remains uncertain.

The overall contribution of state markets to wind energy forecasts in the next five years is expected to be limited to 700 MW in the base case and no new state tender is expected.

Only Gujarat is expected to continue with state auctions in the ambitious case, while three states- Tamil Nadu, Maharashtra, and Madhya Pradesh are expected to procure wind from central auctions to meet non-solar RPOs. Karnataka[17], Rajasthan, and Andhra Pradesh are expected to be in a state of flux and will likely focus on solar procurement.

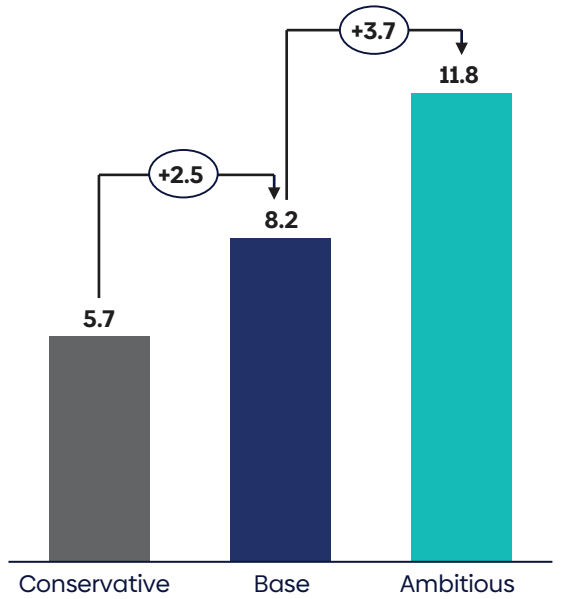
Demand and Economics

The 7 states which have high wind resource contributed nearly 52% of India's electricity demand in 2019.

In the recent past, states have been aggressive in the adoption of non-solar RPO trajectories, and some states even exceeded the MoP targets. However, it is only the state of Maharashtra where the RPO trajectory until 2025 has been defined. In other states, uncertainty continues around the non-solar RPO targets beyond 2022, which leads to variation in demand for wind in states towards 2025.

In the base case, the aforementioned 7 windy states continue to push on aggressive RPO targets, reaching 9% to 15% in 2025 and creating demand for 8.2 GW of wind procurement. However, given the uncertainty on RPOs post-2022, states can choose to cap RPOs at the 2022 level or continue pushing to meet MoP targets, creating new demand in the range of 5.7 GW to 11.84 GW for wind energy (see figure 7). The new demand until 2025 has been impacted by the downgrade in electricity demand to accommodate impacts of COVID-19 in state budgets.

FIGURE 7 | NEW NON-SOLAR DEMAND IN STATE AUCTIONS (2021-25)



Source: MEC+ Analysis

16 7 states comprise Gujarat, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Rajasthan

17 With reference to earlier reference to Central auction pipeline diversifying in Karnataka, the wind projects awarded in central auction are choosing Karnataka due to availability of suitable sites, however, PPA is signed with SECI for interstate procurement and not with Karnataka DISCOM. Karnataka DISCOMs are not expected to sign new wind PPAs in the forecast period

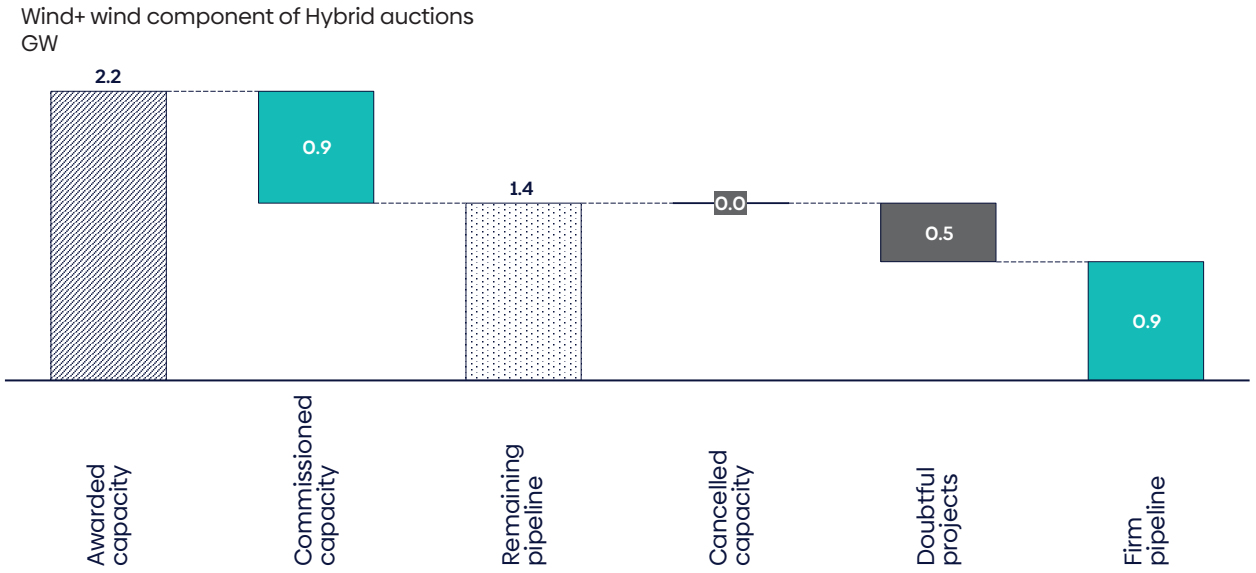
New auctions, if any in the ambitious scenario is pegged to the state of Gujarat, which may hold 2-3 wind/hybrid auctions to meet the demand towards 2025, given it is the only state to successfully conclude two wind auctions, with non-solar solar of 1.3 GW towards 2025. Within other states, Maharashtra, Tamil Nadu, and Madhya Pradesh are expected to meet their demand of 3.74 GW central auctions (included as part of central auction volume). The states of Karnataka and Andhra Pradesh are expected to continue to focus on solar procurement and contribute to no new volume creation[18].

The state of Rajasthan is a wildcard, with huge pent-up demand (~2 GW 2021-25) and a new wind-solar hybrid policy[19], which can increase the demand in state tenders; to make these successful, greater clarity and direction will be needed from DISCOMs.

Pipeline

Between Jan 2017 to March 2021, the states of Gujarat, Maharashtra, and Tamil Nadu have conducted four major auctions and awarded a cumulative 1.72 GW capacity. Additionally, the private utilities of AEML and Tata Power in Maharashtra have conducted two hybrid auctions of 0.7 GW and 0.225 GW respectively (estimated to be X0.54 GW of wind in hybrid tenders). Hence, the state auction pipeline in India aggregates to 2.2 GW (1.72 GW + 0.54 GW). The status of awarded wind capacity in state auctions is indicated in figure 8.

FIGURE 8 | STATUS OF PROJECTS AWARDED IN STATE AUCTIONS (2021-25)



Source: MEC+ Analysis

India has a pipeline of 0.9 GW (0.4 MW standalone wind and 0.5 GW of wind component in 0.9 GW hybrid state tenders) of state tenders which are scheduled to be commissioned within the next two years. Within the 0.9 GW pipeline, the status remains unclear on 175 MW of Maharashtra II tender about extension grant. This pipeline excludes 450 MW of uncertain projects.

Most of the pipeline from Gujarat II auction and private utility hybrid tenders is expected to come online during 2021 and 2022.

Payment delays

Heightened payment risks continue to dampen state markets

DISCOM financials – already in poor health – have further deteriorated in 2020, due to the decline in energy demand and widening gap in the cost of supply and per-unit revenue[20]. Owing to these conditions, overall dues have ballooned. The outstanding payments to renewable generators increased by 43% during 2020 to reach INR 112 billion (USD

18 Low probability of states willing to procure wind beyond RPO trajectory, which is currently met. However, low cost of wind as compared to conventional power may propel states to consider additional procurement

19 https://energy.rajasthan.gov.in/content/dam/raj/energy/rrecl/pdf/Home%20Page/RajasthanWindandHybridEnergyPolicy2019_2.pdf

20 India Ratings assessments- https://www.indiaratings.co.in/PressRelease?pressReleaseID=53270&title=Relief-Measures-to-Address-Short-term-Liquidity-Needs-of-Discoms%3B-Long-term-Financial-Stress-Unabated

1.5 billion) in December 2020, as compared to INR 79 billion (USD 1 billion) in December 2019[21]. Long payment cycles of 9-18 months continue to impact investor sentiment in the wind market, making developers wary of participation in state tenders without sovereign payment guarantees.

Going forward, the poor financial position of DISCOMs continues to restrict the ability of the states to conduct new auctions and secure interest from developers.

21 PRAAPTI Portal of India- Payment Ratification And Analysis in Power procurement forbringing Transparency in Invoicing of generators https://praapti.in/

NOTE BOX 5: SPOTLIGHT ON "MAKE IN INDIA" AND INDIA AS A WIND EXPORT HUB

Driven by pandemic-related bottlenecks in the supply chain and U.S.-China trade tensions, large manufacturers and OEMs in the wind sector have begun looking at India as an export hub for the future. This aligns well with the national "Make in India" policy and principle of self-reliance (Atmanirbhar Bharat) encouraged by the Modi administration.

India, with its well-established wind supply chain, has become an attractive option for manufacturers to set up new manufacturing hubs. The ease of doing business has improved significantly in the past five years driven by relatively cheap labour costs, affordable resources and ease in logistics highways from multiple ports.

Tamil Nadu has become a favoured location for manufacturing companies, due to an established wind supply chain and accessibility to developed ports. An investment of around USD 8 billion has been mobilized by 10 companies, including Vivid Solaire Energy Private Limited, Baettr, Eickhoff Wind Asia Pvt Ltd, TPI Composites and others, that have signed MOUs in 2019 to establish a manufacturing plant. These companies will manufacture a wide range of products including wind blades, modular electric switchboard, composites components, turbine components, and others.

Many WTG OEMs has also started expanding or entering the Indian market as an export hub for higher capacity turbines. Among these, Vestas is establishing a new export-oriented nacelle and hub factory, as well as new converter factory in Chennai, expanding its current blade factory in Ahmedabad. Nordex signed a multi-year agreement with TPI Compositesfor two manufacturing lines in Chennai in 2020 and will expand its supply chain capacity in India to 4 GW for export to EU; it is also expecting to move current European partners to India.

Enercon also signed a contract with a blade supplier located in India, to supply its EP3 and EP5 turbines for international projects. Siemens Gamesa closed the Aoiz and Aalborg onshore blade production plants located in Spain and Denmark and plans to continue outsourcing blade production from low-cost countries, including India. Siemens Gamesa's SG3.4-145 and Vestas' V155-3.3 MW models have been introduced to India and will be commercially ready from 2021-2022. This is expected to provide a similar boost to the Indian wind manufacturing industry, reminiscent of the pre-2017 era, only this time the target markets are not limited to domestic installations.

The expansion of India's manufacturing capacity will require the development of a large domestic workforce serving a variety of requirements, from low-skilled to high-skilled occupations. This offers opportunities for high-value knowledge transfer to local companies and workers and should be undertaken with diversity and inclusivity as steering principles for talent recruitment and workforce development.

iii. C&I market

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

Background

The C&I or corporate procurement sector in India comprises primarily industrial and commercial consumers and to some extent public/ government institutions. The demand for electricity in this segment has grown from 100 TWh in 2011-12 to 654 TWh in 2019-20 and is expected to grow at 6% towards the next decade. The growth in demand is expected to arise from increasing industrialization in India, increased per capita energy consumption, rapid urbanisation as well as electrification of industrial processes.

The C&I sector in the country continues to rely primarily on local distribution companies for power supply, however, nearly 39%[22] of the power needs in the sector are met through self-generation or self-procurement, i.e., corporate procurement.

The corporate procurement of power in the country can be broadly divided into 4 categories (see illustration in figure 9):

22 According to MEC+ and estimates compiling data from CEA and other state and industry authorities.

- **Captive or Group Captive**[23]**:** Captive or Group Captive model wherein the power plant is set up with 26% or higher equity contribution (i.e., ~8% of the project costs) by the C&I consumer and consuming a minimum of 51% of the annual generation from the power plant. The plant can be installed onsite, i.e. within consumer's premises, or offsite i.e. where point of generation and consumption is connected via transmission and distribution grid. The projects are executed via a PPA wherein the project developer contributes remaining equity and operate the plant; unless 100% equity is contributed by the consumer.
- **Third-party PPA:** Third-party PPA or OPEX model is where a power plant is set up by a third-party developer and a PPA is signed to supply power to the C&I consumer. Like captive/ group captive projects, the projects can be onsite or offsite located.
- **Exchange power purchase:** Exchange power purchase is generally applicable to the short-term power procurement needs of corporate consumers. Exchange power purchase entails buying power from the wholesale electricity markets via the Indian Energy Exchange (IEX) or Power Exchange of India, Limited (PXIL). The contracts are generally week-ahead or day-ahead or real-time market power purchase.

23 By Electricity rules 2005, a captive/ group captive project in India is defined as projects with minimum 26% of the equity investment (i.e. 26% of the 30% of project cost) from consumers and minimum 51% of the annual generation consumption by consumers; except in state of GJ which recognizes captive only as 100% equity

FIGURE 9 | OPEN ACCESS POWER PROCUREMENT MODELS

Captive/Group Captive	Third party PPA	Buy from Exchange	Bilateral agreements
■ The corporate buyer makes an initial capital investment and consumes the bulk of the power generated from the project ■ This may be done by a group, i.e. Group Captive, in which one party owns at least 26% of the project and consumes at least 51% of the power	■ IPP sets up a project and sells directly to corporate buyer through PPAs of varying terms ■ The charges to use T&D network is paid by end consumer	■ IPP sets up a project to sell power through the power exchange (IEX) ■ IPP pays the central transmission charges while consumer pays the state T&D charges	■ IPP sets up a project and sells power to consumer with a trader as intermediary ■ Difference between bilateral and 3rd party PPA is that margin of trader is considered in landed cost

- **Bilateral or trader facilitated transactions:** Bilateral power purchases are much like the power exchange purchase except the trader or intermediary is a known trader and not a power trading platform. Like exchange power purchases, these are short-term contracts.

Activity so far

Within self-generation and self-procurement, nearly 90% of the needs have been met through conventional fuel-based captive units, set up in the 2000-2010 era to fight the problem of power cuts and poor quality of supply from distribution companies. Renewable energy installations within C&I kick-started with the growing prominence of wind technology in India. Nearly 5-6 GW of wind was installed between 2002 to 2010 under the Accelerated Depreciation regime to benefit from attractive tax incentives. The Solar C&I market picked up significantly recently with the rooftop solar segment becoming cost-competitive. As of date, 9 GW of wind and 8.1 GW of solar (including rooftop installations) are installed in the C&I procurement category in India.

Demand for wind within corporate procurement

Demand for wind within corporate procurement is driven by its relevance to the C&I customer's desired shift towards renewables, associated cost savings as compared to DISCOM's power supply, and their growing commitment to sustainability.

More than 70 companies with headquarters and/ or operations in the country having voluntarily pledged to RE100 – a global initiative connecting businesses committed to 100% renewable electricity. In doing so, these businesses are looking to procure renewable power at scale and seek enabling policies and regulations to not only meet their RE100 targets but also support the Indian government in achieving its climate goals. The initiative has already submitted its suggestion to the policy environment to enable easier adoption of RE technologies in the country.

In addition to the business case to adopt RE and the climate agenda of corporates, Environmental, Social and Governance (ESG) factors, which are becoming the central agenda of corporate policies in India. As Indian developers, move towards foreign institutions to raise finance, ESG factors continue to gain importance. ESG factors, when integrated into investment analysis and portfolio construction, offer investors potential long-term performance advantages; creating preference to fund ESG compliant companies and platforms.

Currently, electricity prices in India for commercial and industrial consumers are high, in the range of INR 6 per kWh to INR 11 per kWh (USD 82-150 per MWh). Hence, tariffs payable to the grid is 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 per kWh (USD 48 per MWh) for captive/ group captive and INR 2 per unit (USD 27 per MWh) for third-party PPA in states with incentives. However, given the cost competitiveness of solar as compared to wind, a larger C&I demand has gravitated towards solar.

Wind is expected to play a role as the initial load requirements of C&I 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 the additional demand, especially as hybrid wind-solar projects. The year 2020 saw the commissioning of the first set of hybrid corporate Open Access (OA) projects in India. Hybrid projects can offer benefits of lower intermittency, higher grid power substitution, and cost savings in shared infrastructure.

As standalone wind, as well as wind in hybrid format, is expected to be critical in meeting the overall electricity needs of the C&I sector in India.

Policy and Regulations

Corporate procurement in the country is enabled by the OA provision of the Electricity Act 2003. OA is a provision under which high power consumers (contractual load of 1 MW+) can procure their power from an entity other than the local DISCOM.

OA transactions are subject to approvals from multiple state-level agencies in India including the State Transmission Utility, state DISCOMs, State Load Dispatch Center, and State Electricity Regulatory Commission. In addition to multiple levels of clearance, each DISCOM has a different definition of long-term, medium-term, and short-term OA, designated consumers, and banking arrangements. The involvement of complex networks of stakeholders and approval mechanisms enables authorities to deny permission on arbitrary grounds. Although the situation varies from state to state, the pushback to OA is generally seen across states.

Economics

With renewables in a firm position as the cheapest source of grid power, C&I consumers have a strong financial incentive to switch to clean energy. C&I consumers typically pay 30-40% more per unit as compared to the other categories, and their tariff ranges from INR 6-11/kWh (USD 82-150 per MWh). As the costs of wind generation drop significantly, a head-to-head comparison of C&I tariffs and the cost of generation from renewable energy indicates a substantial differential. However, open access transactions are subject to additional charges which are levied to compensate for the use of infrastructure and DISCOM services on the OA consumer. These charges include:

- **Transmission and Wheeling charges and losses:** Charges payable due to use of state transmission utility and DISCOM grid network to route power to the C&I consumer. Central Transmission Utility (PGCIL) charges are also levied in case of inter-state open access
- **Scheduling charges:** Charges payable to SLDC or RLDC for scheduling and dispatching power
- **Cross subsidy surcharge**: Charges applicable so that the DISCOM can cross-subsidize its agricultural and domestic customers
- **Additional Surcharge:** Charges applicable for DISCOM to meet its fixed cost obligation arising out of its tied existent power purchase agreement. This is due to PPA capacities rendered idle due to open access consumer opting out
- **Trader margins:** Trader margin charges are payable in case a trader is involved in the power transaction in form of an exchange or trading company

The business case for C&I procurement is calculated after the implementation of charges on corporate procurement illustrated in figure 10.

FIGURE 10 | BUSINESS CASE EQUATION FOR C&I RENEWABLE PROCUREMENT IN INDIA

Business case for Consumer	=	Local DISCOM Tariff	-	LCoE/ PPA price	-	Grid usage charges	-	Open access charges	+	RECs	+	Concession on charges	>	0.5 INR/kWh
		Tariff paid by consumer to the DISCOM		LCoE of solar in that state considering target IRR of developer		Charges applicable for use of transmission grid, distribution grid		Charges applicable for cross subsidy and additional surcharges		Additional revenue available to RE plants (includes REC issuance charge) – only for REC plants		Waive offs on open access charges applicable on various project categories		Minimum difference required by customer b/w Tariff and OA landed prices based on Industry discussions
Nature of parameter		Local				Local		Local				Local		
Impact on market potential		High		High		High		High		Low		High		

Note: Excluding the chargers for trader and IEX margins as we are not considering the case and no added advantage are available in the same
Source: MEC+ analysis

Captive/ Group Captive is rendered the most popular model within open access transactions due to exemption from cross-subsidy surcharge and additional surcharge, as per the Electricity Act 2003 on the projects. Third-party PPAs, Exchange, and Bilateral transactions are liable to pay all the OA charges (see figure 11 for selective applicability of charges by different open access models)

Availability of incentives in the form of waivers on open access charges is a major driver for corporate procurement of renewables. Since the waive-offs are specific to state policy and available for a fixed duration, C&I RE procurement is a niche market in India, wherein certain states drive installation for specific periods.

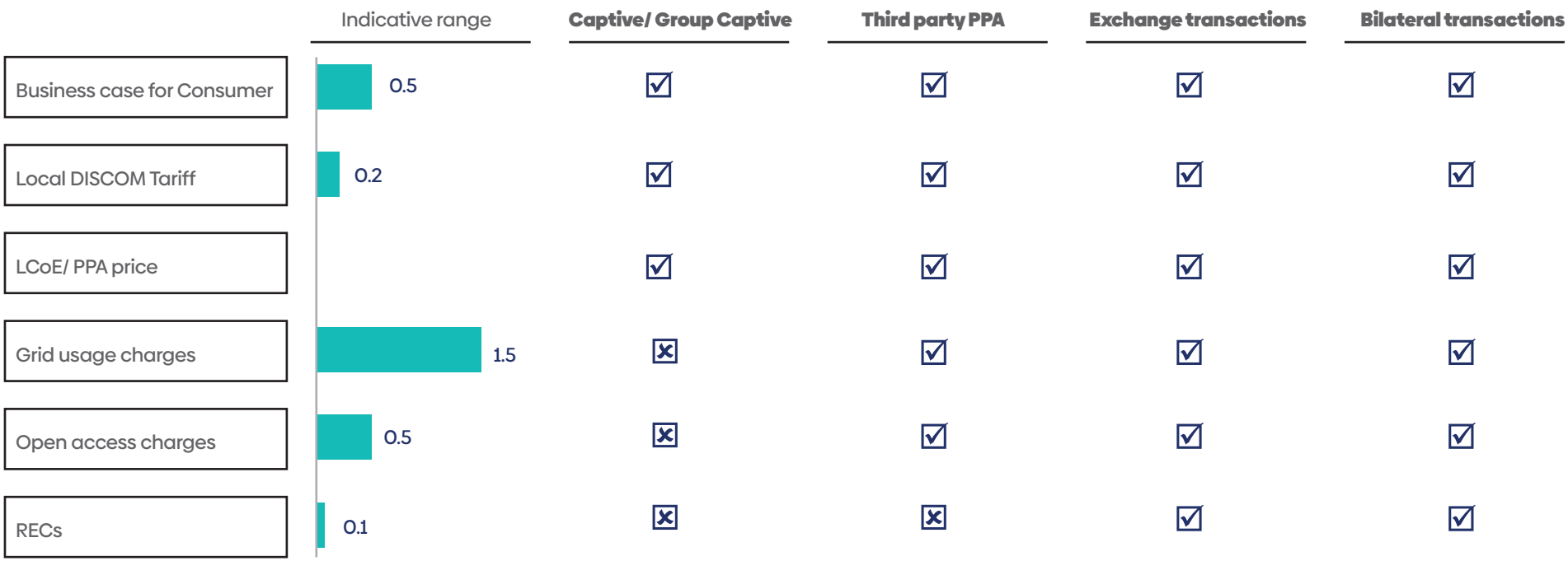
Currently, 6 major states provide attractive waive-offs for renewable energy-based open access projects. A higher degree of waive-offs within captive/ group captive set-up and low applicability of charges makes the model quite an attractive business case.

Attractiveness of hybrid solutions

In all seven states with high wind potential, solar resource availability is also high. Hence, hybrid wind and solar projects bring greater benefit to the consumer in terms of substituting 75-80% of grid power instead of 50-55% of standalone wind or solar[24], promising greater returns and lower payback periods on the investment.

24 As per analysis by CleanMax; leading C&I developer in India

FIGURE 11 | CHARGES APPLICABILITY FOR BUSINESS CASE DETERMINATION OF INTRA-STATE OPEN ACCESS



Source: MEC+ analysis

TABLE 3 | WAIVE-OFF FOR HYBRID OPEN ACCESS PROJECTS

Open Access charges	Gujarat	Rajasthan	Andhra Pradesh
Cross-subsidy surcharge	50% concession for third-party	-	50% concession for captive/third-party given in initial policy issued in 2018, waivers withdrawn in November 2019
Additional surcharge	50% concession for third-party		
Transmission charges	-	50% concession for captive/third-party	50% concession for captive/third-party given in initial policy issued in 2018, waivers withdrawn in November 2019
Wheeling charges	-	50% concession for captive/third-party	

Outside captive arrangements, waivers of OA charges announced recently in 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 (see table 3).

In the long term, both wind and solar will play a role in meeting the power needs of the large and growing industrial sector in India, due to shared benefits of cost competitiveness, moderated variability of generation, and higher displacement of grid power.

Forecast

RE corporate procurement will continue to see an inter-play for the regulatory barrier, business case attractiveness, and sporadic support from states with charges waive-off. Therefore, the market is expected to be small, lumpy, and driven by niche geographies.

In the next five years, wind installations in C&I are expected to vary between 0.85 GW to 1.7 GW of installations. The ambitious case for wind installations within C&I can be unlocked through the adoption of hybrid projects by C&I customers to achieve higher grid power substitution and reduce the intermittency of power supply in the grid.

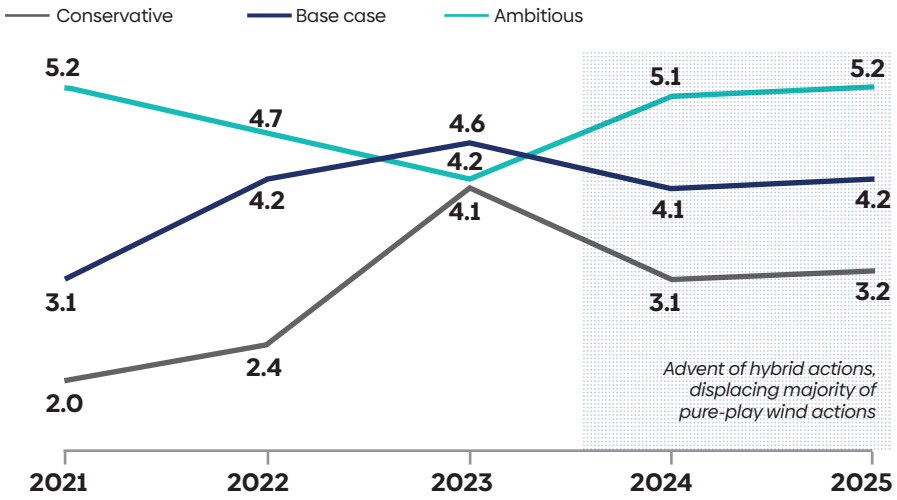
iv. India wind energy forecast: 2021-2025

India is expected to install more than 20 GW of wind in the next five years, with a peak in 2023

The interplay of the three markets —central, state, and C&I procurement, is expected to spur 15 GW to 24 GW new wind installations between 2021 and 2025, while base case installations are anticipated to be ~20 GW. This forecast is driven by a combination of pipeline and new tender awards. The pipeline contributes nearly 50% of the forecasts across scenarios and the new auction award capacity varies between 6 GW of new allocation in conservative case to 13 GW allocation in the ambitious case(see figure 12 for various scenarios of annual wind installations).

In the conservative case, 14.8 GW of wind is expected to be installed, with lower installations due to limited tendered capacity, demand evaporation

FIGURE 12 | Y-O-Y NEW WIND INSTALLATIONS IN INDIA 2020-25



Majority of active pipeline is commissioned until 2022; except in conservative case due to continued land, fin. issues

Peak in installations in 2023 with expiry of ISTS waive-offs in June 2023

Installations stabilize with annual hybrid auctions, where wind plays critical role; trajectory visible from 2023 in ambitious case

Installations 2021-25	Scenario Definitions
24.4 GW	Active pipeline is commissioned by 2022; new annual auctions of 9 GW for hybrid and 1 GW for pure-play wind; C&I installations scale with increased competitiveness towards 2025
20.2 GW	Active pipeline is commissioned until 2023; new auctions scale from 4 GW hybrid and 1 GW wind to 6 GW hybrid and 1 GW wind by 2025; C&I installations regain pre-2019 levels
14.8 GW	Active pipeline contracts with cancellations and is back-loaded towards 2023; new auctions are solely hybrid technology based (5 GW p.a.) and no wind stand-alone tender

Note: As per calendar years; forecasts are inclusive of hybrid projects
Source: State ARRs; RPO documents; PGCIL; NTC and RTC Meeting minutes; credit rating report; CEA; SECI; MEC+ analysis

from an economic slowdown, and limited uptake of standalone wind tenders (please see note box 6). The base case sees the cumulative installation of 20.2 GW between 2021 and 2025, with new auctions continuing at the current pace of 1 new wind auction and 2-3 mixed[25] hybrid auctions. The ambitious case sees the installation of 24.4 GW driven by increased uptake of hybrid auctions and selective re-opening of state auctions. The conservative case also sees a lack of new activity in the state market and volumes limited to currently awarded capacity in the market.

In addition to the wide range of volume between scenarios, the market is expected to be uneven across the next five years. This lumpiness is most pronounced in the ambitious case, wherein tendered central projects are front-loaded in 2021 and 2022 and lead to a more moderate 2023 after which auctioned capacity in 2021 comes online.

The highest variance is seen in 2021 between the three scenarios due to the uncertainty of activity picking up in the year. In the conservative case, the volume is limited to 2 GW of projects which are partially constructed or starting construction. It improves in the base case, around 3 GW is expected to come online which has progressed well in terms of financing and land. In the ambitious case, 5.2 GW projects come online as per scheduled/extended commissioning dates. The market accordingly scales up or down in 2022 depending on the remaining tendered capacity. It is expected that in the 2021-2025 period, the year 2023 will be a peak year due to the retirement of ISTS charge waivers in June 2023.

The volumes in 2024 and 2025 are a function of the expected new tenders in the market. In the base case, the market is driven by 6 GW of hybrid and 1 GW of pure-play wind auctions annually, increasing from 4 GW hybrid and 1 GW wind in 2021. The ambitious case assumes a higher number of hybrid auctions, while the conservative case sees no new wind auctions and limited hybrid tenders.

Given the diversification of bidding substations, capacity is expected to move outside of Gujarat and Tamil Nadu into Karnataka and Madhya Pradesh for wind auctions[26] and Rajasthan for hybrid auctions. However, Gujarat and Tamil Nadu are likely to contribute to the largest share of volume commissioned.

Overall, wind volumes are expected to transition from standalone wind projects to wind-solar hybrid projects across the central, state, and C&I markets. In the years 2021, 2022, and to some extent 2023, wind standalone projects are expected to dominate; however, from 2024 the market is likely to see a higher share of wind capacity commissioned in a hybrid set-up.

NOTE BOX 6: SPOTLIGHT ON IMPACT OF COVID-19 INDIA SECOND WAVE ON FORECASTS

The forecasts in the report have been produced at the end of April, 2021, when India was entering into the second wave of the COVID-19 pandemic. As seen in the year 2020, a prolonged period of regional lockdowns in the country can impact the base-line forecasts for the year 2021.

The exact impact on the 2021 volumes eludes the industry due to uncertainty of extent and duration of the second or any consequent waves. However, given that the severity of the lockdowns is lower than the previous year wherein manufacturing and industrial logistics are unaffected, the year is expected to conclude with higher installations than last year.

The report anticipates activation of the conservative case of nearly 2 GW installation in 2021 in case the raging second wave extends beyond June. In worst case, 1/3rd of the predicted volumes can leak from 2021 into 2022, indicating an annual market of 1 GW.

25 Mix of peak-power (with storage), round-the-clock and solar-wind hybrids

26 Projects to be set-up for central auctions (SECI) for inter-state PPA

v. Looking towards 2030

Towards 2030, India is expected to continue pushing towards its climate goals for the Paris Agreement and work towards achieving its vision of 450 GW installed renewable energy capacity by that year. The carbon neutrality agenda is expected to receive a further push from the government towards 2030, as the country explores new pathways including floating solar, offshore wind, decentralised renewables, and bolder initiatives green energy storage, electric vehicles, and its National Hydrogen mission.

The government has set multiple long-term climate agendas; however, a lack of short-term milestones and market roadmap for emerging sectors like offshore wind makes it difficult to assess feasibility. More recently, in the run-up to COP26, there have been high-level discussions around global targets to achieve net-zero emissions by 2047/2050. To push its post-pandemic green recovery and support global net-zero discourse, India might choose to adopt a more aggressive trajectory to phase out fossil fuel-based generation.

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

- **Repowering:** India has the potential of nearly 2.9 GW of projects for repowering, with sub-MW WTGs and more than 15 years of operational lifetime. A repowering policy has been launched by the states of Gujarat and Tamil Nadu; clarity on incentives, land procurement, and owner aggregation will be needed for investors to capture the opportunities. Towards 2030, the repowering opportunity is likely to double with nearly 4.5 GW of potential for replacement of <1 MW turbines. Given the extant challenges around land allocation and cost for new renewables generation, a robust and effective framework for repowering older wind projects at high-resource sites can accelerate India's renewable energy progress. Also, any future interventions for augmentation of low capacity commissioned units, which are currently not eligible for repowering, may add great value.
- **Offshore wind:** India announced a 1 GW Expression of Interest in 2018 in Gujarat, although the tender could not be conducted due to a mismatch of pricing expectations. The government is now exploring multiple pathways to kickstart the offshore wind sector in India including nearshore development, demonstration projects, and decentralised development.
    - During 2019/2020, the government signed a 3-year Indo-Danish Strategic Sector Cooperation on offshore wind, which will include studies of the expected cost of generation of offshore wind through the "Financial modelling of offshore wind in India" initiative.
    - NIWE has identified sites for nearshore development in Gujarat and Tamil Nadu and is currently in the process to secure the necessary approvals. Also being explored is a technology demonstration site in Tamil Nadu's Dhanushkodi jutted land for exploring various turbine and foundation designs suitable for India.
    - Concurrently, NIWE plans to install two additional LiDARS in Gujarat and Tamil Nadu by September 2021; considerations are ongoing within MNRE to bring forward the latter development, given the superior wind quality in the state.
- **India as a wind export hub:** As discussed in the note box, 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 the world, with further expansion supporting job creation, GDP growth, and technical excellence, in line with the government's "Make in India" initiative.

The long-term drivers for wind continue to be strong in the Indian market as the country will move towards technology neutrality and low carbon growth. Reforms underway in the market, including the Draft Electricity (Amendment) Bill, Market Based Economic Dispatch (MBED), and emerging wholesale markets, indicate a shift towards a more efficient power market structure girded by cost-competitiveness and inclination towards the promotion of RE in the electricity mix. Although growth has stalled in recent years, the position of wind is expected to strengthen

as green, cost-competitive, and hybrid resources are called upon to meet the growing needs of India as an industrial powerhouse and engine of global development.

WAY FORWARD

India has a highly ambitious goal to install an additional 100 GW wind power by 2030, however, the regulations are majorly defined until 2022, which needs to be extended going forward, to rapidly deploy capacity.

The pace of installations is likely to double over the next 2-3 years, as compared to the average installations since 2017. Currently, the 10.3 GW pipeline is active in the market and new tenders of 9-10 GW in the next 2-3 years are required to achieve the forecast of 20 GW new installations by 2025.

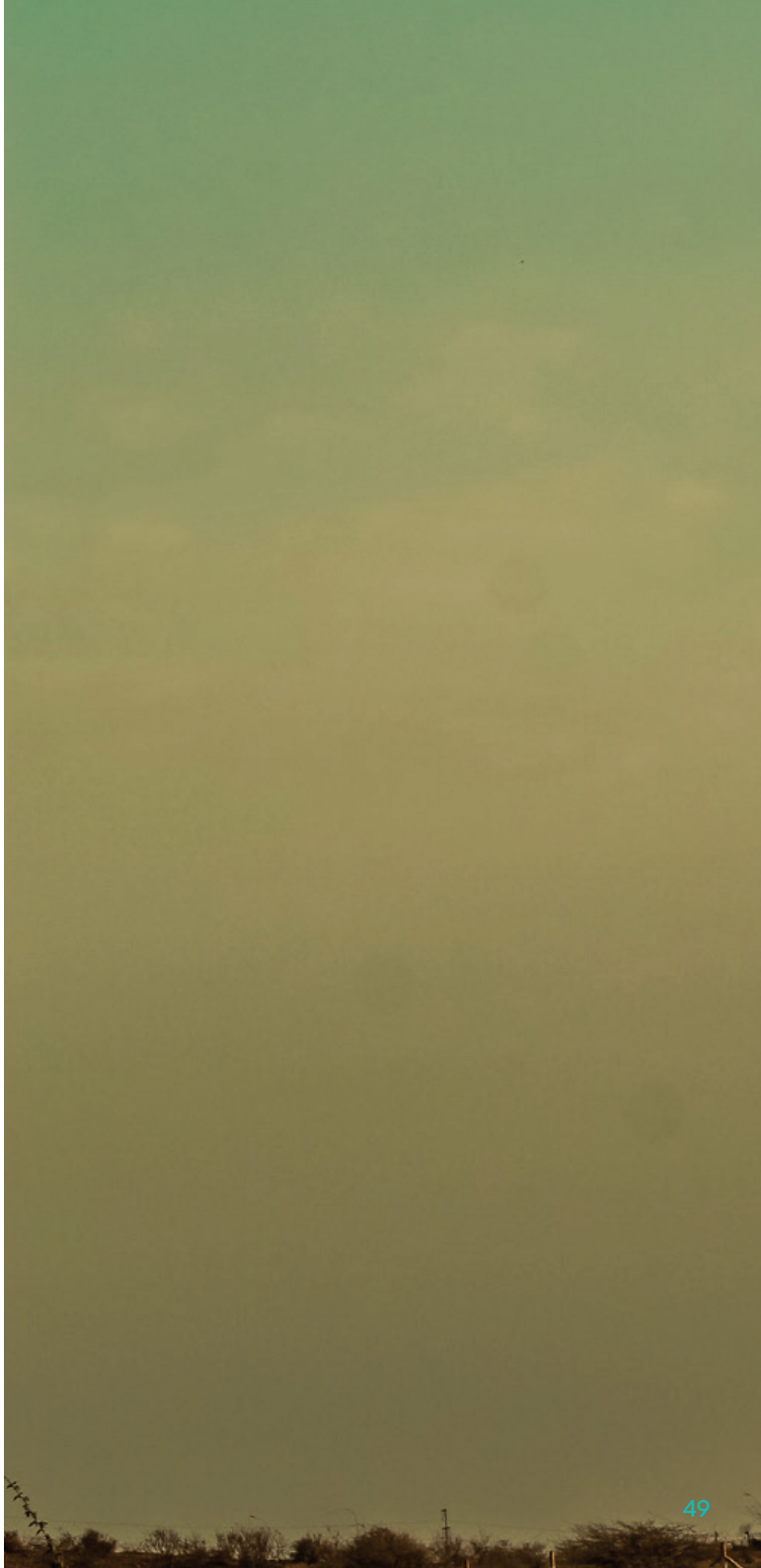
Last year, the central government intervened to resolve the bottlenecks within land and grid availability. Going forward, proactive development of infrastructure is needed to support power evacuation. On the demand side, C&I markets can emerge as a green-shoot, as hybrid projects provide higher value to this segment as compared to standalone wind and solar.

Wind as a resource, is a high-value resource, as it not only a cost-competitive utility resource but also complements, other generation sources in India. To exploit it consistently in the next 10 years, additional steps can be considered by various stakeholders:

Strengthened consensus and coordination: As states develop/strengthen their climate action plans there must be greater consensus and coordination between the centre and respective states. This will ensure that in the future both central and state auctions are in sync with macro-level wind targets, which will likely incite the interest of wind stakeholders. Better coordination between the centre and state will ensure necessary support for permits, clearances, and power evacuation during the execution and post-commissioning stages.

Market Roadmap: A roadmap defining volume, frequency, composition and pricing expectations will help the planning of supply chain, infrastructure, and finance. Volume can further improve if states come up with an individual roadmap and align to central government target, both in terms of volume and sustainable pricing.

Supply chain utilization: Current forecast will still lead to spare capacity within the supply chain in the next five years. Utilization can be improved by looking at the repowering, offshore wind, and export to south-East Asian countries. While repowering can utilize the existing supply chain, offshore wind and export will require significant ramping-up of the capabilities including set-up of R&D facilities, removing trade and non-trade barriers for integration within the global supply chain, facilitating technology transfer, as well as training of skilled manpower.



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