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Global Onshore Wind Market Review

2022

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Contents

1. EXECUTIVE SUMMARY

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Executive Summary

Slowdown in Growth Due to Market Maturity and Institutional Delays

The onshore wind industry has gradually been approaching maturity across markets globally. It is an established technology with minimal scope for changes. The project cost is range-bound after providing for local factors, while most resource rich locations are exhausted. In such a backdrop, the industry's dynamics assume importance, especially as competitive options in solar and offshore wind are poised to tip the scales in the renewable energy mix. At 769GW, the installed onshore wind generation capacity held a quarter of the global renewable energy mix by the end of 2021. It has been significant progress since 2012, when the share was 18%. But considering recent years' growth, the relative share of onshore wind is somewhat stagnant – 23% between 2017 and 2019. The pace and volume of capacity addition lagged in recent years. In leading European markets, such as Germany, the challenges have been in permitting delays. In contrast, for others, competitive options in renewable energy (mainly solar) puts wind capacity under pressure

Technology Neutral Auctions & Subsidy Termination is the new Normal

For practically all countries, competitive auctions are the preferred route for capacity allocation. There are technology-neutral auctions where onshore wind developers are pitted against utility-scale solar and other renewable energy forms. Yet, based on the factors at play, the onshore wind projects appear to be holding on their own. The Spanish auctions in November 2021 had onshore wind developers winning the bid in a technology-neutral tender. The price discovery process through the auctions is seen mainly across the markets, with project bids aligned to general average capital costs adjusting for the local development factors. Both developers and equipment manufacturers chase narrow project margins to achieve cost and returns. Such a trend got reinforced as markets ditched the subsidies in favour of auctions

Evolving Market Dynamics

Wind turbine technology has also evolved – larger sizes, higher capacity ratings, taller structures, and increased rotor diameters, to cite a few. The developers, meanwhile, are adopting hybrid wind power generation, mostly involving attached battery-based storage. The US is one of the leading markets in this regard. In 2021, 41 hybrid plants (worth 2.4GW) were in operation in the US. Regulatory authorities are also taking note of hybridization, as observed in the Indian wind power auctions. While the demand side of the business is intact (due to policy objectives in renewable energy), the supply side faces challenges, albeit of short-term nature. The leading equipment manufacturers face profitability challenges due to years of narrow margins and aggressive pricing. This is being reversed. There are expectations that this could dampen some demand for the time being till the equilibrium reaches. It could also mean that, in some cases, the cost advantage of the wind power plants is eroded. In the long-term, though, it will help the equipment business align to market realities for growth

Investment & Policy Support is Vital Going Forward

The market outlook for onshore wind business points to a recovery in capacity addition rate by the end-2022. As per the BNEF estimates, new onshore installations could be 90GW – 97GW between 2023 and 2025. The European region's urgency to accelerate renewable energy projects (due to the energy crisis imposed by the Russian conflict) acts as a fillip for the onshore wind segment. Furthermore, repowering is emerging as a preferred option in certain pockets, as developers are keen to capitalise on the higher market prices in the aftermath of the energy crisis. The potential is much higher than most project pipeline trackers suggest – the critical bottlenecks arising from procedural delays, local community issues, or transmission interconnection constraints impact capacity realisation. The onshore wind industry's growth will, therefore, be through many factors, spanning energy transition policies, equipment supply chain and technologies, project development costs, and investment commitments

2. REGIONAL ONSHORE WIND OVERVIEW

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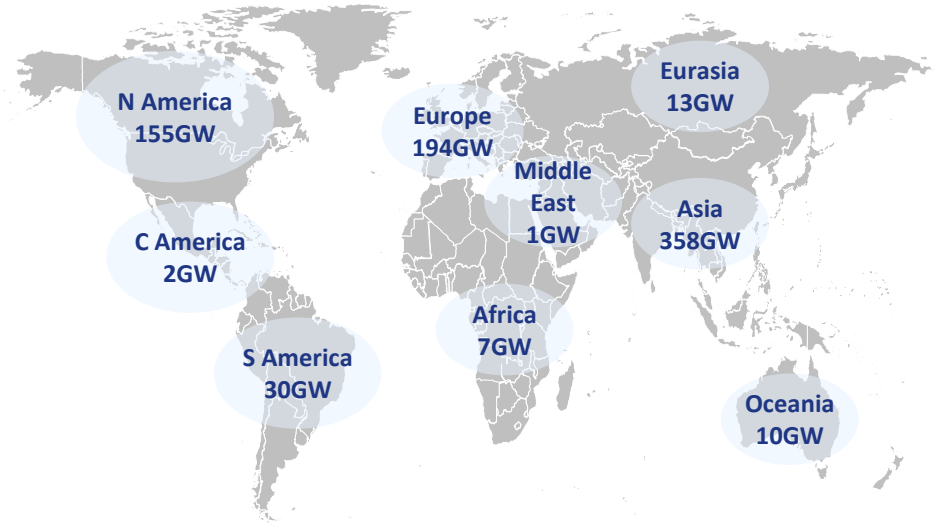
Onshore Wind Penetration by Region

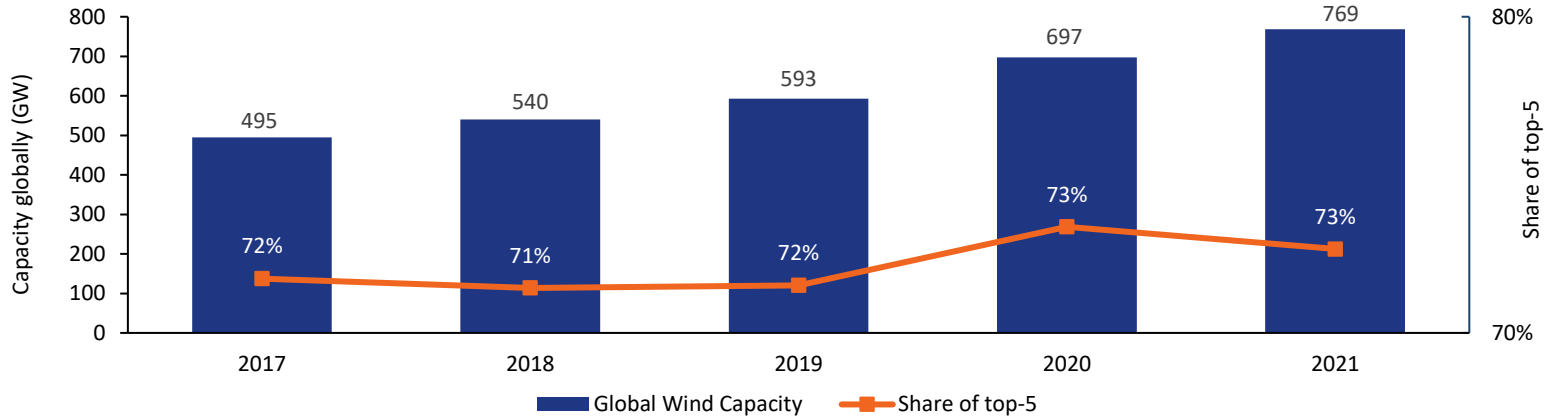
Installed Onshore Wind Capacity (GW) by Region in 2021



- **Europe**: By end-2021, European region's onshore wind capacity addition amounted to 11GW, contributing to a 6.2% annual growth in installed capacity base. Onshore wind is likely to play a vital role in the region's renewable energy capacity growth. In 2021, the total investment commitment towards new wind farms was EUR41.4 billion. As per Bloomberg estimates, an EU funding of EUR300 billion could enable Europe to remove gas entirely from the energy mix and replace by renewables
- **Americas**: Led by the US market, the North American region had the highest onshore wind penetration in 2021. Despite a slower capacity addition during 2021, the US has had a rising share of onshore wind in total power mix. In Latin America, Brazil offers the largest onshore wind market & the country's entire installed wind power capacity is onshore & is the second-largest power generation source. Other key markets include Chile & Argentina where clean energy targets drive the onshore wind growth
- **Asia**: The Asian region's growth is defined by the skewed contribution of China, that leads global onshore wind capacity. A steady demand together with the regulatory focus on auction-based capacity allocation is likely to ensure growth for China's onshore wind market. After China, India is the next important market. Policy & regulatory push like introduction of reverse-auction model, dedicated transmission corridors & established efficient power trading market are likely to drive the market ahead

Top Countries

Trend in the Share of Top Five Countries in Global Installed Capacity



Source: IRENA

- Historically, the top five countries between them have had 71% - 73% of the total globally installed capacity. The top five onshore wind markets remained unchanged during the last five years up to 2021
- China maintains an unchallenged global leadership in the installed capacity base, accounting for over half (54%) of the total capacity worldwide. The relative share has risen steadily in last five years, starting with 45% in 2017. This can be understood from the rise in incremental capacity addition each year – from about 18GW in 2018 to over 29GW each year
- After China, the second largest market by size is that of the US. Wind power has the largest share in the US renewable energy generation. With offshore accounting for a negligible share, the wind power generation so far has been based on onshore capacities. As per EIA, by 2021 wind power generation was 9.2% of the total power supply in the grid
- Within the European region, Germany is the third-largest onshore wind market by size. Onshore wind power generation has high expectations of filling in the gap created by phasing out of nuclear and coal-fired baseload power generation. In 2021, the German onshore wind association reported a 35% rise in installations (including repowering). Additionally, there are expectations that the country could boost the onshore wind capacity tendering volume to 10GW annually, against the current 2GW
- India is the fourth-ranking country in wind power market by size with ~60GW of new onshore wind capacity addition being targeted. However, constraints in critical supply inputs such as land availability & fundamental aspects such as the prices remain at play. The market is going through an auction specific regulatory transition in hopes of rejuvenating the country's energy mix

3. TRENDS AND DRIVERS

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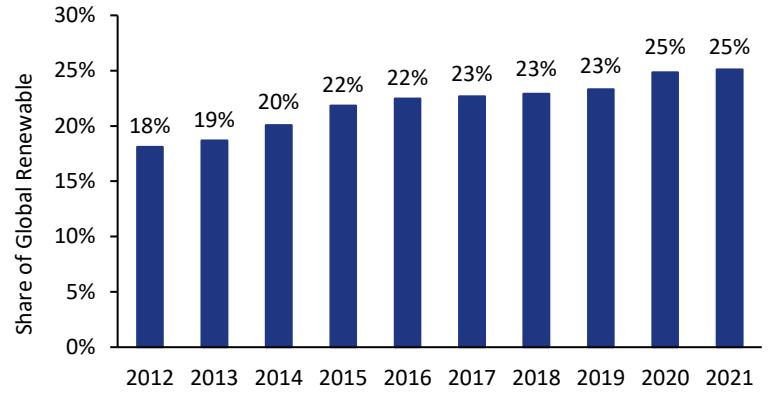
Trends & Drivers

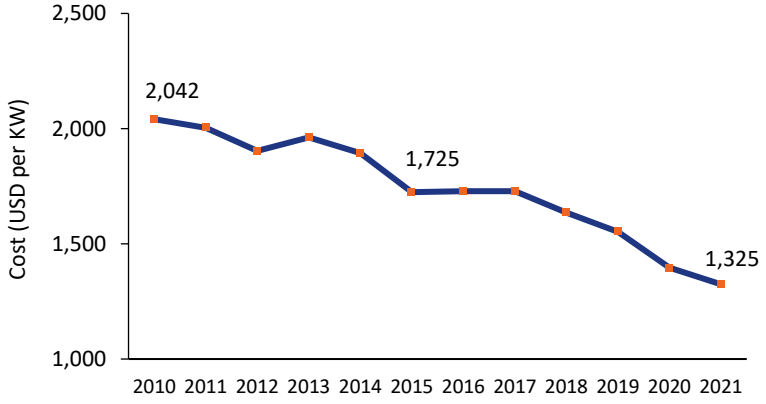
Trend in Share of Onshore Wind in Global Renewable Energy Capacity



Source: IRENA

- Globally, onshore wind accounts for about a quarter of the total installed renewable energy capacity
- In a long-term perspective, the role of onshore wind has been an instrumental one, being one of the early commercially viable renewable energy technology
- Its relative share however has been relatively stagnant in recent past, when compared against other competing options
- Yet, onshore wind, with a 93% share in total global wind energy capacity (IRENA, as of 2021) continues to play an important role

Trend in Weighted Average Installation Cost of Onshore Wind Power

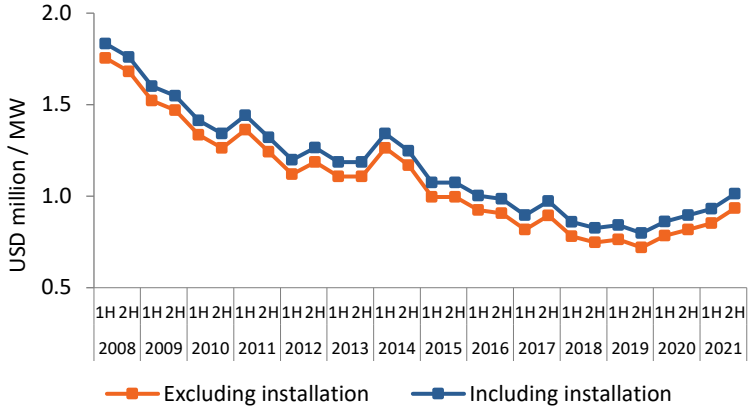


Source: IRENA

- Average installation cost of onshore wind power projects declined by over 35% in the 2010-2021 period
- The trend so far has been supported by a mix of factors such as the demand pull from policy support (subsidies and incentives), a strong manufacturing base and value chain enabling economies of scale, and improvements in technology and product innovations that ensured efficiency
- The availability of untapped wind-rich locations added impetus as well. However, while the cost advantages continue, the same factors are not exactly valid as the industry approaches maturity

Trends & Drivers

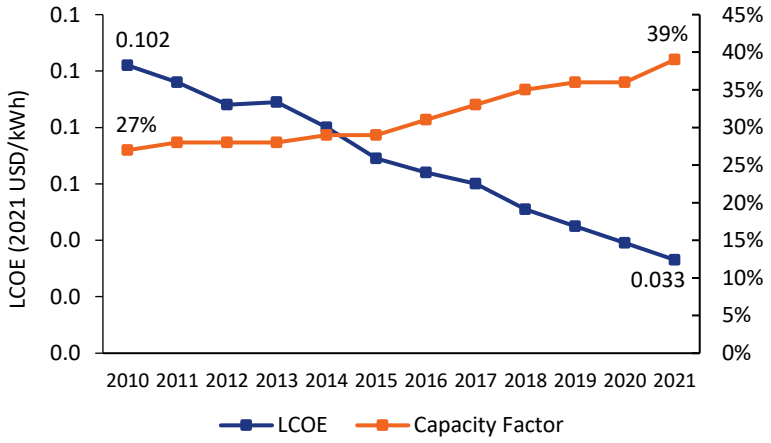
Trend in Onshore Wind Turbine Pricing Tracked by Signing Date



Source: Source: BNEF 1H 2022 Global Wind Market Outlook

- Demand strength, economies of scale & an aggressive competitive scenario helped to reduce the prices of wind turbines over the years
- By end-2021, the average onshore wind turbine prices, as per BNEF estimates, indicate a reversion to the level in 2016. While aggressive competitive bidding & rationalization in subsidy support set the stage, it was the pandemic of 2020 that aggravated supply chain bottlenecks & caused rapid rise in raw material & basic commodity prices
- There is an unanimity that the challenges are likely to persist through 2022 & early 2023 which could also result in leading suppliers chasing lesser projects to rationalise the cost structure & streamline the product offerings

Trend in Levelized Cost of Energy and Capacity Factor in Onshore Wind Projects

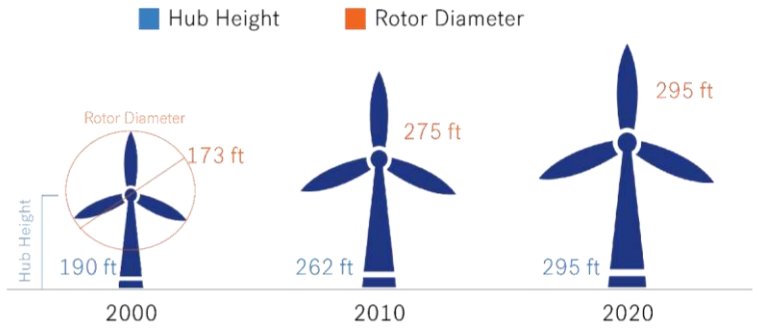


Source: IRENA

- The trend in onshore wind's levelized cost of energy has consistently declined over the years. Competition & improvisation in the wind turbine equipment technology/grade are some of the major catalysts
- OEMs have been launching progressively larger & efficient onshore turbines that are cheaper for the wind farm developers to install & maintain
- As per IRENA's estimates, onshore wind power projects are increasingly achieving LCOE less than 0.040/kWh. The most competitive ones have been observed across India, China, Sweden, Egypt, US Brazil and several other countries

Trends & Drivers

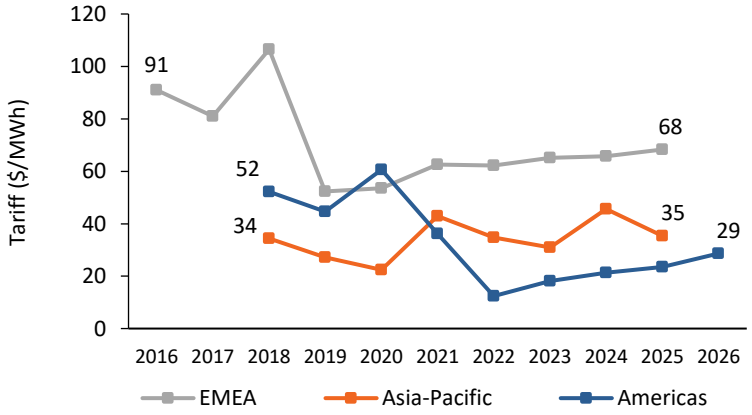
Long-term Trend in the Wind Projects' Configuration



Source: US Department of Energy
Note: The data may include both onshore and offshore wind power projects

- As per a survey of US Department of Energy, wind power experts and researchers project global annual average wind speed for new onshore projects to decline from 7.9 m/s in 2019 to 7.5 m/s by 2035
- The trend thus has been to enhance efficiencies in the equipment through a mix of measures including rise in hub heights, larger rotor diameter, or other improvements
- Corresponding to the rising heights and rotor diameters, the average equipment ratings are on a rise. As of end-2021, the average rating of ordered onshore wind equipment in Europe was 4.9MW. In 2018, the same average rating stood at 2.7MW. Further enhancements are likely to be undertaken to meet higher efficiency standards

Levelized Tariffs in Onshore Wind Auctions by Commissioning Schedule

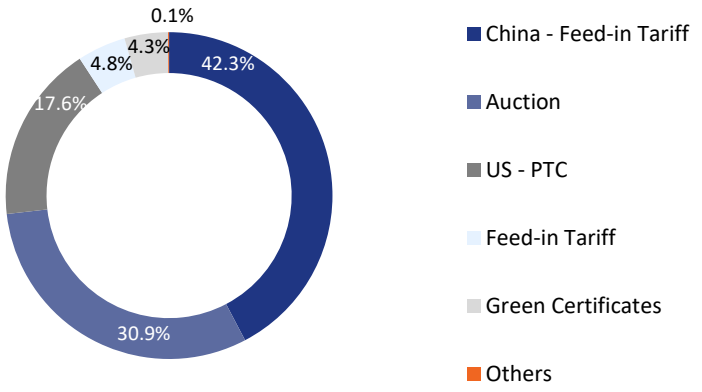


Source: BNEF 1H 2022 Global Wind Market Outlook
Note: Data Points for each year is the average of Levelized Tariffs in Onshore Wind Auctions

- An auction-led project allocation has been the biggest institutionalized driver for efficiency in the onshore wind business. The approach facilitated a price discovery & transitioned developers & OEMS to chasing narrow margins for securing winning bids rather than relying on subsidies
- In Spain, a total capacity worth 2,258MW was allocated as of November 2021. This was a technology-neutral auction in which bids based on onshore wind power won the capacity award at an average price of EUR30.18/MWh
- A similar bid price (EUR30.15/MWh) came up in the Polish wind power auction in December 2021. But in general, there is a wide variance in auctioned bid prices, suggesting specific local project development factors

Trends & Drivers

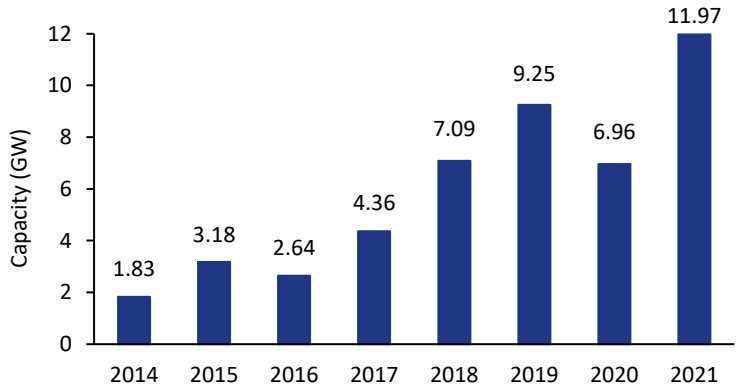
Distribution of the New Onshore Wind Capacity in 2021 by Market Mechanism



Source: Global Wind Energy Council

- As a market mechanism, competitive bidding is set to be the default option of capacity allocation in all the renewable energy markets. But the auction-based mechanism could be due for revision to ensure end objectives are met
- One important result of rising market commercialization is the traction in subsidy-free onshore wind power projects. It has already gained ground in the mature wind market of the European region
- Contrastingly, In Ireland the average bids for wind power capacity have been way higher when compared against the regional counterparts in France, Germany and the UK. All the same, the market forces continue to shape the growth trajectory

Trend in Global Corporate PPA based on Wind Power



Source: BNEF Corporate PPA Deal Tracker

- The merchant power sales often take the route of PPAs as it helps the power generators overcome cost of financing subsidy-free projects while managing the generation side on the grid. Between 2017 and 2021, corporate PPAs based on wind power tripled in terms of linked capacity
- Rising prices in the wholesale power market has opened the scope of profitability for projects which are not part of any subsidy support scheme. This is most clearly observed in case of Europe, where the wholesale power prices surged due to crunch in natural gas
- By end-2021, the value of PPAs rose manifold as cost of grid power spiked. This served as one of the main reasons why C&I entities are considering onshore wind PPAs as part of their options to rationalise total energy costs

4. OUTLOOK

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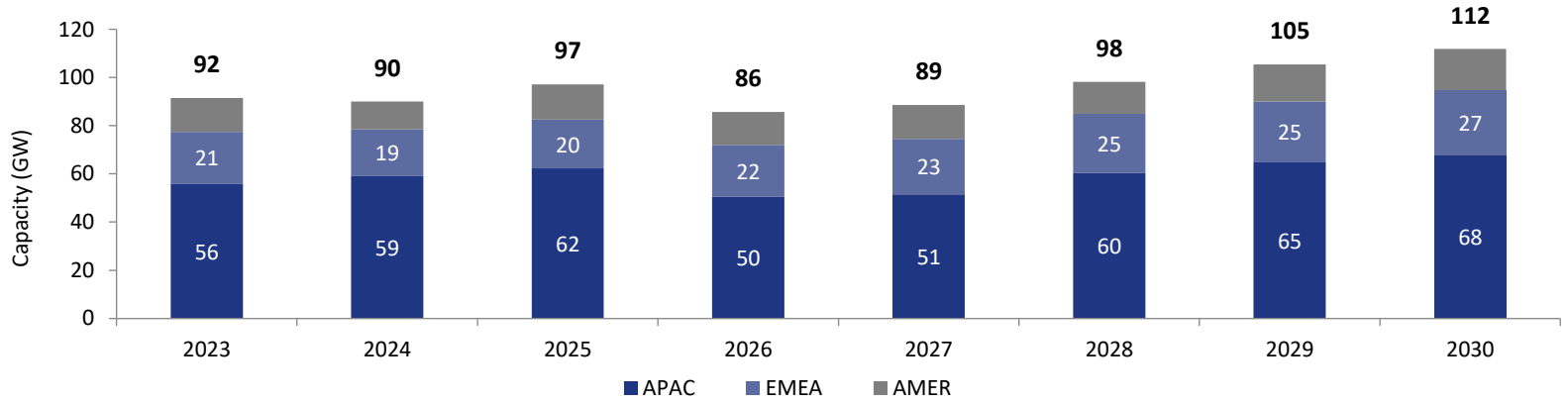
Outlook

Projected Global Onshore Wind Installations

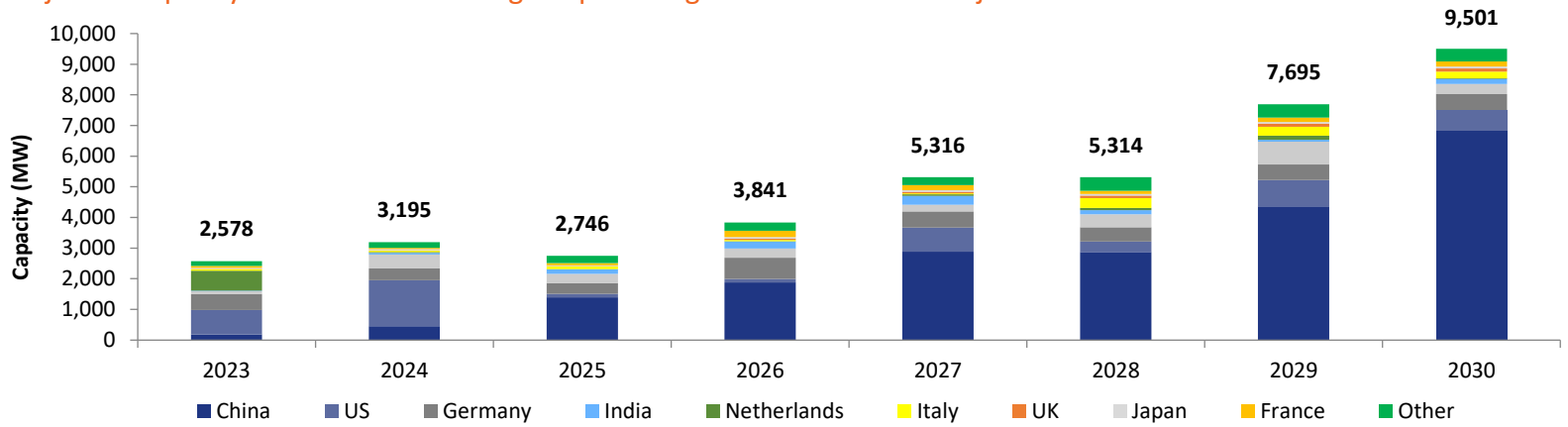


Source: BNEF 1H 2022 Global Wind Market Outlook

- While the importance of the onshore wind segment stays largely unchanged, the underlying market conditions shifted drastically. The Russia-Ukraine conflict, permitting delays, rising queues for transmission linkage and the supply chain uncertainties are some of the constraints which are likely to impact growth. Globally, the policy targets by the respective governments set the agenda for renewable energy capacity growth
- Various agencies point to a recovery in onshore wind capacity addition rate from 2022 onwards. BNEF's estimates indicate new onshore installations of capacity ranging 90GW – 97GW during the years of 2023 through 2025. Notably, these estimates were revised upwards to reflect the changed conditions after European energy scenario (due to Russia-Ukraine armed conflict)
- The European share is just second to the Asia-Pacific region's outsized contribution propelled by China. The latter accounts for over half of the onshore capacity addition projection till 2030, due to a combination of factors including competitive turbine costs, gigawatt-scale project clusters and the renewable energy targets
- Auction-based capacity allocation is expected to be the dominant force across markets. This is despite the developers' challenges in costs and profitability. The variations will include across auction models of wind-only, hybrid, overall renewables, and technology-neutral auctions

Outlook

Projected Capacity to be Realised through Repowering of Onshore Wind Projects

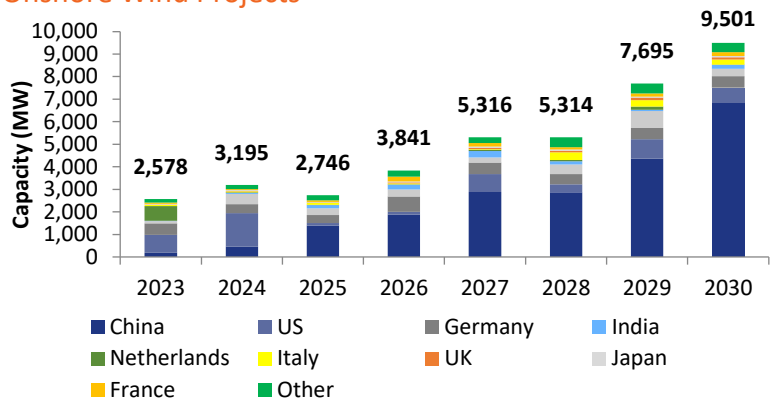


Source: BNEF 1H 2022 Global Wind Market Outlook

- The focus on capacity growth, together with the lack of adequate attractive wind resource-rich locations are driving a renewed push towards repowering of onshore wind projects
- After the phaseout of the feed-in tariff and subsidy-based regimes across major markets, a significant share of the existing capacity base is nearing the end of useful life. In the current circumstances the old onshore wind power plants are worth reconsidering for the potential returns. In fact, the spike in European wholesale power prices have made a strong case for developers to consider repowered wind projects
- The gradual stablisation and commercialization of grid-scale energy storage technologies has been a major development for the entire renewable energy sector. As per the IEA's estimates, the global installed storage capacity is projected to grow by 56% over the five years to 2026
- Hybrid onshore wind power projects have been a fallout of the favourable trend in battery-based storage. Such power generation projects are coupled with onsite battery storage. There have been hybrid auctions in India and Germany, for developers to capitalize with contracted prices in the range of USD40-60/MWh

Outlook

Projected Capacity to be Realised through Repowering of Onshore Wind Projects



Source: BNEF 1H 2022 Global Wind Market Outlook

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Demand and Adoption of Energy Storage

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- As per the IEA's estimates, the global installed storage capacity is projected to grow by 56% over the five years to 2026. China and US account for majority of the projected battery-based storage capacity growth
- Hybrid onshore wind power projects have been a fallout of the favourable trend in battery-based storage. Such power generation projects are coupled with onsite battery storage
- There have been hybrid auctions in India and Germany, for developers to capitalize with contracted prices in the range of USD40-60/MWh

Equipment Manufacturing and Supply

- While the demand outlook gets stronger, the supply side increasingly looks constrained
- With the supply chain bottlenecks and the cost pressures, most of the leading original equipment manufacturers (OEM) are unable to maintain the same profitability as before
- The impact on profitability has been a culmination of aggressive market competition in recent years owing to a mix of issues, ranging from higher commodity prices to product development and delivery challenges. Notably, The leading OEMs like Vestas, Siemens Gamesa, GE and Nordex saw their orders decline by 5.2% during 2021
- The ongoing financial constraints and worsening profitability could make way for another round of consolidation among onshore wind OEMs

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