

Global Onshore Wind Market Review



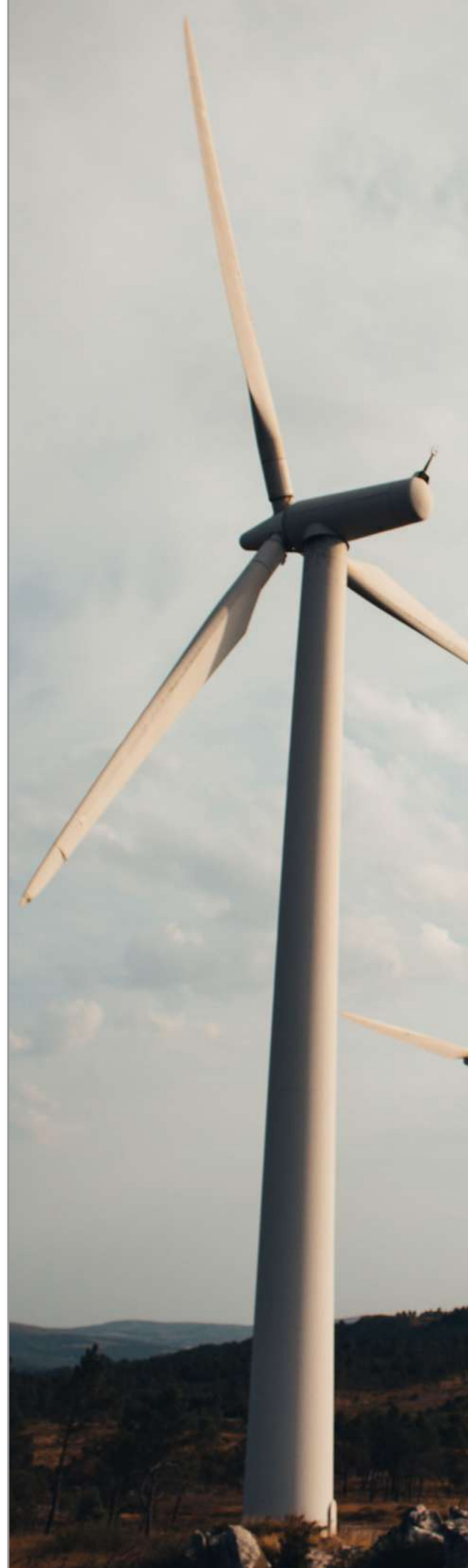
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About

This report offers valuable insights into the global onshore wind market. It is based on research conducted by Pan American Finance (PAF) and its research partner, Alchemy Research and Analytics. The report provides an overview of the industry, including recent trends, drivers, challenges, and outlook in major countries across Europe and the Americas. The report begins with a summary of the industry's dynamics, including regional variations, and analyses their implications. It then profiles major markets by country, offering a holistic view of the industry's state in these countries, highlighting growth opportunities, demand drivers, and current challenges. The report draws on macroeconomic data from multilateral institutions such as the International Monetary Fund (IMF), and industry-specific data from sources such as industry associations, government authorities / statistical departments, Bloomberg New Energy Finance (BNEF), and the International Energy Agency (IEA). This was supplemented by news reports, trade journals, and related sources.

This report is the result of a collaboration between PAF and Alchemy Research and Analytics, completed from June to October 2023. We would like to express our gratitude to the following executives for their contribution in preparing the report:

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Introduction

The ongoing worldwide energy crisis is a stark reminder of the long-pending need for resilient energy systems. This highlights the critical importance of transitioning towards renewable energy. According to the International Energy Agency, global energy investments could increase by 7% in 2023, reaching USD2.75 trillion. This will be primarily driven by investments in clean power generation resources. However, much more needs to be done to address the emerging complex trade-off between demand and sustainability in energy generation and consumption cycles.

The demand pressures are currently affecting the short-term through high fossil fuel prices and a competitive scramble for supplies. While this might urge countries to address their near-term issues, it is important to remember the longer-term priorities of sustainability and resilience. A deliberate and focused policy push is needed for this. Globally, oil and gas companies are witnessing almost 10% higher investments this year, with cumulative profitability projected to cross USD2 trillion.

The accelerated push for renewable energy projects in several markets is an encouraging sign. Utility-scale power projects, such as those based on wind and solar, are the most important, given the burden on power generation for its fossil fuel dependence and emissions. Mature renewable energy technology options, such as onshore wind, are instrumental in scaling up the share of clean energy at competitive costs. Furthermore, hybrid configurations involving wind-plus-storage or even wind-plus-solar-plus-storage, are increasingly making commercial sense for the flexibility and dispatch that were long regarded as the bane of renewable energy projects.

Realizing such potential will depend on how quickly the bottlenecks ease. Apparently, there are terrawatts of 'shovel-ready' onshore wind capacity that are locked-up for want of permissions or interconnection requests. Similarly, competitive choices between wind versus solar needs to be resolved as complementarity can be more efficient for grid connectivity. Investors' response to the select initiatives in this regard across the countries confirm how responsive the markets are to such steps.

The optimistic picture still carries its challenges and riders. High borrowing costs, a looming recessionary outlook, and the pricing adjustments across the supply chain – all contribute towards an uphill path. This is a phase that will have to be borne out until market forces balance. The capital flows in the overall energy market and onshore wind, in particular, are more likely to be aligned to fundamentals than transitory shocks. Therefore, we believe that the investment commitments are unlikely to change course drastically.

PAF's Annual Primer series aims to offer an overview of the demand drivers, opportunities, challenges, and outlook prevalent in various major markets for different renewable energy technologies, including solar PV and onshore wind. We hope you find our annual review of the Global Onshore Wind Market informative and enjoyable to read. We look forward to briefing you on other renewable energy technologies in the upcoming months.



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Executive Summary

The global onshore wind power market is expected to see a significant increase in capacity after a year of slow growth. Most of this growth is expected to come from projects that were delayed due to permitting issues and should be completed by mid-2024. The renewed momentum can be attributed to policy changes and attention to matters of energy transition, as the recent energy crisis has emphasized the need for renewable energy. Onshore wind energy plays a crucial role in this transition. The ambitious decarbonization targets set by various countries and regions further increase the urgency to add capacity. Countries globally are under pressure to reduce carbon emissions from the power sector, making this issue a critical concern.

Wind energy capacity growth rates vary across different countries and regions worldwide. As of 2022, China has the largest share, accounting for 40% of the world's total installed capacity, which stands at 836GW. Over the past five years leading up to 2022, China's wind energy sector has shown impressive progress, with a compound annual growth rate (CAGR) of 17%. However, North America and Europe have comparatively slower CAGRs of 10% and 7% respectively during the same period.

It's important to note that the countries with the highest onshore wind power capacity may not necessarily have the highest wind power penetration in their grid supply, which serves as a more valuable comparative benchmark. For instance, Denmark, despite having a smaller installed capacity than China, is a much smaller country, and thereby has the highest wind energy penetration rate at 55%.

While it takes time for wind power to become widely adopted, it remains cost-competitive with traditional energy sources. Even with cost pressures from materials and development challenges, newly built onshore wind farms are able to compete with coal and gas-fueled power plants in many developed and emerging market economies. Regulations in countries like China that require wind power to be priced based on grid parity show a shift towards a more balanced power mix. Other markets are also adopting technology-neutral auctions to ensure that mature technologies like onshore wind are given fair consideration alongside other options for power procurement.

The onshore wind industry is currently facing cost pressures due to a number of factors. Firstly, the macroeconomic environment, including high commodity prices such as steel and rising interest rates, is creating challenges. Additionally, the prices of wind turbines have increased across all major manufacturers, resulting in a higher capital cost for most projects. This has impacted the project pipeline and capacity commissioning schedule, particularly in the short-term. These cost challenges have led to under-subscribed auctions, higher risk premiums, and

even the cancellation of select ad-hoc policy plans that were later re-auctioned at better prices.

To counterbalance these issues, and to make planned projects viable with these increased costs would mean commensurate price adjustments in the power purchase contracts. Fortunately, a rising number of market-linked procurement of renewable energy is being led by the direct corporate power purchase contracts, which is a step in the right direction.

Policy measures aimed at regionalization and reshoring are reshaping the incentives for investors and developers in the US. The Inflation Reduction Act, implemented by the federal government, has created an unprecedented renewable energy subsidy support package to attract domestic manufacturing. The Act's primary objective is to promote local investments and moderate the concentration of the supply chain. This move is reviving the wind turbine industry and propelling the project pipeline. However, it may have triggered a competitive subsidy regime among countries. The full impact of these policies remains to be seen in the coming years.

According to the projections of the Global Wind Energy Council, there will be an average addition of 100GW of capacity annually until 2027, with China driving most of it. However, there might be a decrease in new-build capacity from 2024 onwards due to delayed projects. But, policy interventions can help to prevent such declines. Although the visible capacity pipeline is impressive, it is still not enough to achieve the net-zero objectives of 2030 or beyond. Just like the changes made in Europe's wind permitting rules and practices, clear policy directions can help the market to achieve the target.

Onshore wind power plays a crucial role in the global energy transition. The projected increase in capacity in 2024 will be vital in achieving the ambitious targets for renewable energy usage. Although onshore wind power remains cost-competitive against fossil fuels, it may face challenges due to the increase in commodity prices, financing costs, and the low profitability of manufacturers. Policies like the US IRA could be instrumental in driving investment momentum.

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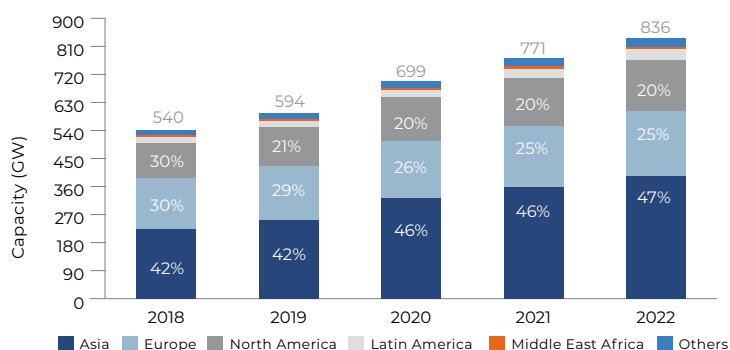
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Regional Overview

Globally, onshore wind energy is primarily concentrated in Asia, Europe, and North America (particularly the US). These regions collectively account for 92% of the world's onshore wind capacity (Figure 2-1), a share that has remained consistent over the past five years. Despite progress in Latin America and the Middle East, Asia, especially China, has shown the most significant growth over recent years.

Figure 2-1 - Regional Distribution of the Installed Onshore Wind Capacity

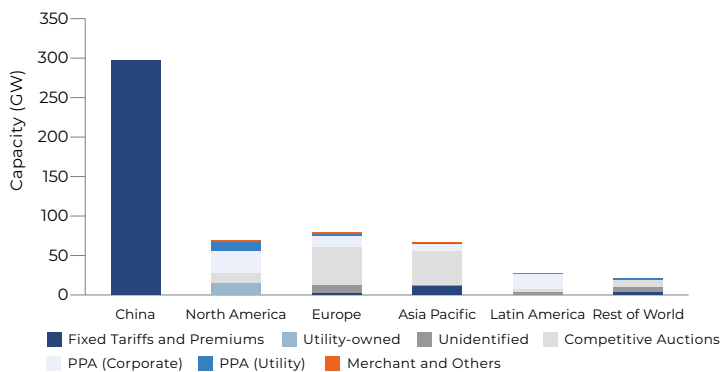


Source: IRENA, 2023

Policy-led offtake agreements, including administrative tariffs and competitive auctions, account for 60% of wind and solar PV energy projects. As shown in Figure 2-2, China is somewhat the outlier in offtake arrangements, relying entirely on provincial benchmark electricity prices, whereas auction-based models are prevalent in all other regions alongside power purchase agreements (PPAs), particularly in the Americas (IEA, 2023).

In Europe, onshore wind power plays a central role in decarbonization efforts with streamlined permitting processes which have accelerated since early 2023, reducing delays and potentially leading to a spike in European onshore wind power capacity by the end of 2023 or mid-2024.

Figure 2-2 – Primary Wind and Solar Offtake Type by Region



Source: IEA, 2023

In North America, especially the US, growth is driven by incentives under the Inflation Reduction Act, which provides tax credits for investments and production from clean energy assets. However, the industry's revival depends on factors such as supply chain efficiency, transmission connectivity, and regulatory support for renewable energy.

Latin America is emerging as a promising region for onshore wind energy, with a 74% increase in installed capacity between 2018-2022 (IRENA, 2023). Free markets, especially in countries like Argentina, Brazil, Chile, and Peru, are driving growth, favouring PPAs over fixed-price contracts. Wood Mackenzie's estimates predict around 40GW of new onshore wind power projects in Latin America over the next decade (Wood Mackenzie, 2023), with Brazil and Chile standing out due to their untapped power generation potential, although competition from solar PV remains a challenge.

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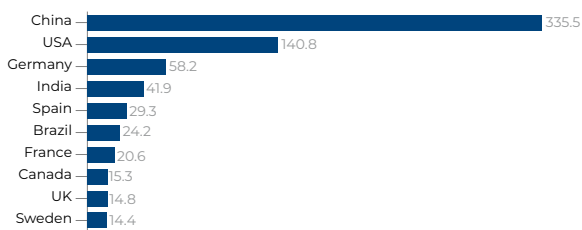
Top Countries

3.1 A Focus on Top Countries

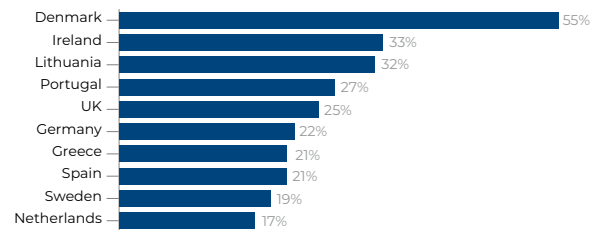
Onshore wind energy is geographically highly concentrated, with over 80% of the global capacity in just five key nations, a trend sustained over the last half-decade. China leads this pack by a significant margin, its 2022 installed capacity being more than double that of the closest contender, the United States. While China leads in generation capacity, the landscape shifts when considering wind energy penetration, the share of wind-based power in total grid-connected supply, highlighting the advancement of several European nations in transitioning to renewable energy sources. These countries, early adopters of wind power in their grid mix, dominate the top 10 list for wind energy penetration, reflecting their commitment to sustainable energy practices.

Figure 3-1 – Top 10 Countries in: Renewable Energy Generation Capacity, Renewable Energy Penetration

Renewable Energy Capacity (GW)



Renewable Energy Penetration



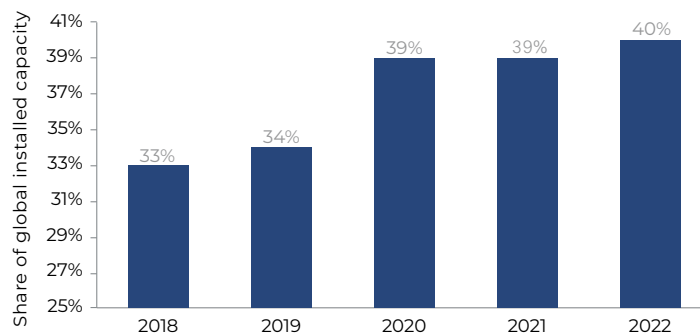
Source: IRENA, 2023; Energy Institute, 2023

3.2 China's Role and Growth in the Global Wind Market

China's position as the world's leading wind power market is bolstered by a shift towards market-driven growth. From 2022, the country embraced a grid-parity model, aligning with its ambitious goal to source at least 50% of the incremental power sector demand from renewables under the 14th five-year plan (Energy Foundation, 2022). Despite reaching only 13.8% of consumption from wind and solar combined (Balkan Green, 2023), China remains steadfast in its commitment, even in the face of steady coal-based capacity growth.

The future landscape involves several 10GW wind and solar farms, spurred by active government support and bolstered by China's robust manufacturing base, which supplies 60% of the global onshore wind turbine nacelles (GWEC, 2023). Chinese Original Equipment Manufacturers (OEMs) are gaining prominence globally, a paradigm shift from conventional norms, fueled by increased competition within China.

Figure 3-2 - China's Share in Global Onshore Wind Capacity



Source: IRENA, 2023

Top Countries

3.3 US Inflation Reduction Act: A Catalyst for Growth

The US takes a significant leap in its commitment to renewable energy through the groundbreaking Inflation Reduction Act (IRA). This policy, unparalleled in its scale, not only revitalizes domestic manufacturing but also serves as a global catalyst for energy transition. By extending production and investment tax credits for wind power businesses, IRA provides stability and visibility, attracting investments and revitalizing critical manufacturing sectors like blade production.

This policy not only reinvigorates existing facilities but also prompts the establishment of new manufacturing capacities. With six new facilities announced for onshore wind power equipment, the US market is on the brink of a substantial surge. This emphasis on local supply aligns with the government's goals of a 50%-52% economy-wide emissions reduction and a net-zero emissions grid by 2035 (Reuters, 2023), underscoring the pivotal role onshore wind energy plays in the envisaged rise of renewable energy share.



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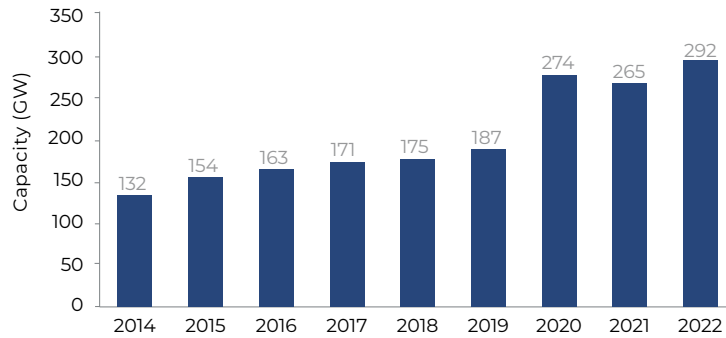
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Developing Trends

Onshore wind energy stands as one of the mature and proven renewable energy technologies, widely deployed on a commercial scale across the globe. Accounting for approximately a quarter of global renewable energy capacity, onshore wind plays a pivotal role in shaping energy transition policies worldwide. Its growth trajectory represents a significant consideration in the broader context of transitioning to sustainable energy sources. There has been a noticeable uptick in capacity additions (Figure 4-1), with an average of 277GW added in the three years leading up to 2022, a marked increase from the 177GW averaged during 2017-2019 (IRENA, 2023).

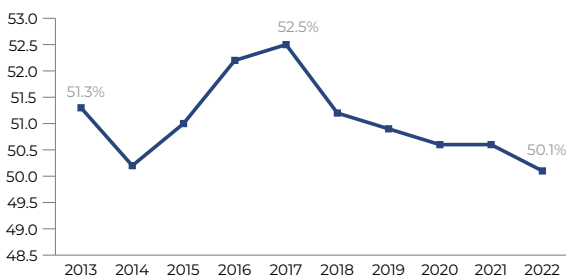
Figure 4-1: Annual Incremental Capacity in Onshore Wind



Source: IRENA, 2023

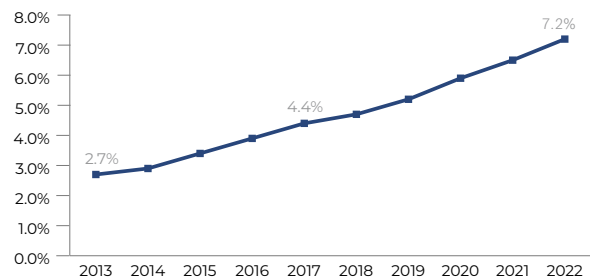
When assessing onshore wind energy's growth, it's essential to consider the broader energy mix. While the share of onshore wind in energy generation from renewable sources has seen a decline (Figure 4-2), this trend is influenced by the rapid expansion of competing options, particularly utility-scale solar PV, alongside other sources like hydro and biomass. Onshore wind generation currently represents roughly half of the total clean energy injected into the grid. However, when viewed in the context of the entire grid power generation, including hydrocarbon-based sources, onshore wind energy continues to exhibit consistent growth in penetration (Figure 4-3). This growth is buoyed by the swift displacement of conventional energy sources within the grid, supporting the upward trajectory of onshore wind energy share.

Figure 4-2: Onshore Wind Share in Renewable Energy



Source: Energy Institute Statistical Review of World Energy

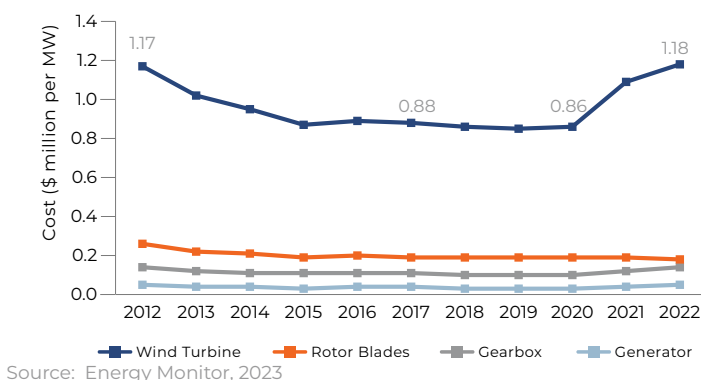
Figure 4-3: Onshore Wind Share in Total Power Generation



Developing Trends

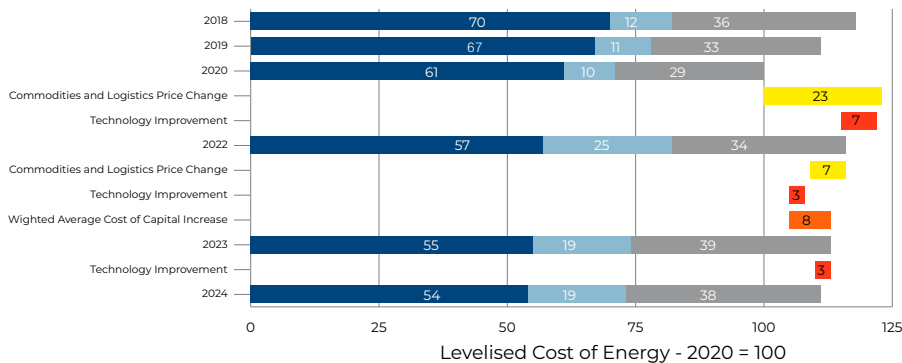
On a global scale, onshore wind power, accounting for over 90% of installed wind power capacity (IRENA, 2023), maintains a significant competitive advantage. In numerous developed and emerging economies, newly constructed onshore wind power plants prove to be cost-competitive with coal or gas-based counterparts. Even as fossil fuel costs reduced by 5% in 2023, data from BNEF (June 2023) indicates that onshore wind remains competitive against fossil fuels this year. For instance, in the United States, onshore wind's generation cost stands at 4.2 cents per kWh, contrasting favorably with gas at 8.6 cents and coal at 18 cents. Wind farms continue to assert their position in terms of generation costs, despite the narrowing gap with competing solar PV options.

Figure 4-4: Average Capital Cost of Wind Power Projects



However, the capital costs of onshore wind projects have experienced upward pressure recently (Figure 4-4). This rise in costs can be attributed to inflationary impacts on essential raw materials, development expenses, and financing costs. Although costs have reduced since the peak in 2022, following the Russia-Ukraine conflict and global supply constraints, they still remain higher compared to pre-pandemic levels. Notably, high upfront costs constitute a significant portion of the overall project economics, with operational and maintenance expenses being relatively minimal in comparison.

Figure 4-5: IEA's Estimate on Onshore Wind LCOE Index by Key Inputs



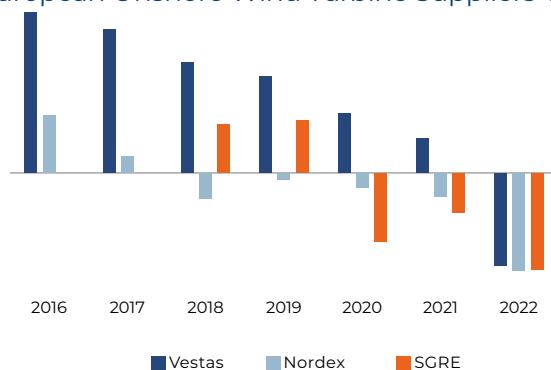
The landscape of global onshore wind power projects is undergoing significant challenges, impacting the cost dynamics. Recent estimates from the International Energy Agency (IEA, 2023) indicate a 10%-15% increase in the levelized cost of energy compared to 2020 levels over the next year. Several factors contribute to this rise, with one prominent factor being the escalating financing costs faced by developers. Many countries are witnessing a surge in lending rates, elevating the overall expenses for project initiators.

Moreover, sustained increases in material costs have created substantial hurdles for developers. From 2000 to 2022, steel prices surged by 160% in the US and 270% in Europe, while copper and aluminum prices rose by 60%-80%. Freight rates spiked dramatically, increasing sixfold during this period. Consequently, commodities and logistics jointly accounted for about 30%-35% of the capital expenditure for wind power projects in 2022. Although there has been a slight softening in commodity prices, they remain significantly higher than pre-pandemic levels, adding persistent pressure on project budgets.

Developing Trends

Additionally, the impact of these higher prices extends to project contracts. Several Original Equipment Manufacturers (OEMs) faced challenges in passing on the increased costs due to fixed terms in contractual obligations. Consequently, with the renewal or formation of fresh contracts, higher project costs are effectively transferred to the developers (Wood Mackenzie, 2023). Major OEMs, such as GE Renewable, Nordex, Siemens Gamesa, and Vestas, who collectively supply over 90% of the global market outside China, faced substantial losses in 2022. To address profitability concerns, these OEMs reported significant revisions in nameplate equipment prices. This contrasted sharply with wind power operators who experienced gains due to rising power prices in 2022, emphasizing the complex economic challenges faced by the industry (S&P Global, 2023).

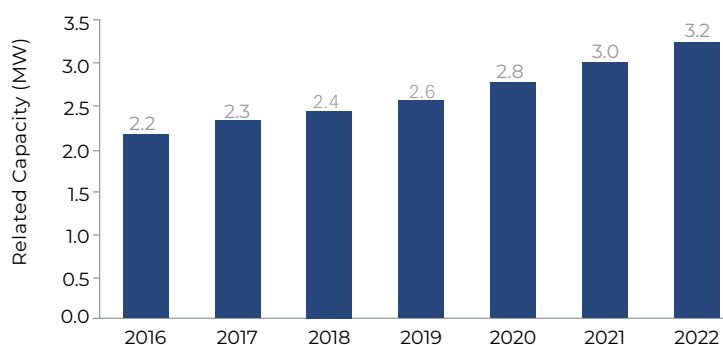
Figure 4-6: European Onshore Wind Turbine Suppliers' EBIT Margin



Source: Fitch Ratings, 2023

The onshore wind industry faces significant challenges due to squeezed profit margins and financial constraints (Figure 4-6), leaving limited room for technology-led innovations. Many OEMs are currently focusing on stabilizing their profit margins rather than investing heavily in research-led product innovations. However, technological advancements are expected to play a crucial role in reducing the Levelized Cost of Energy (LCOE) by improving efficiencies. The International Energy Agency predicts (IEA, 2023) that ongoing technological improvements will lead to a moderation in costs by 2024, assuming a stabilization of inflationary pressures.

Figure 4-7: Average Rated Capacity of Onshore Wind Turbines in the US



Source: US Department of Energy, 2023

Several OEMs are actively working on product developments to enhance their offerings. For example, Vestas is in the process of developing turbines with a remarkable 15MW rating, featuring a rotor diameter of 236m and blades measuring 115.5m. Similarly, Siemens Gamesa is working on turbines with a 222m rotor and 108m blades (CNBC, 2022). Currently, the largest onshore wind turbines in operation have nameplate capacities over 7MW, such as Vestas' 7.2MW V172 turbine and Enercon's 7.58MW E126 turbine (Our World of Energy, 2022).

The industry's focus has shifted towards higher rated turbines positioned at greater heights, especially in sub-optimal wind-rich sites. Chinese wind turbine OEMs are notably progressing with higher capacity ratings in their offerings, outpacing their Western counterparts. Reports from Wood Mackenzie (Wood Mackenzie, 2023) indicate that the average turbine size rating for Chinese OEM orders exceeds 5.4MW, compared to the 4.2MW rating for Western OEMs. This trend underscores the growing pressure to secure efficient turbine units, intensified by the dynamics of the wind power procurement market and the fierce competition for power purchase contracts. As the industry navigates these challenges, ongoing innovations in turbine technology remain critical for its future growth and sustainability.

Developing Trends

The strategy of auction-led capacity allocation is gaining prominence globally, reshaping the landscape of renewable energy projects. Notably, the European Union has accelerated its adoption of renewable energy through recent policy changes. In July 2023, Albania made significant strides in this direction, conducting its inaugural auction for onshore wind power capacity. With support from the European Bank for Reconstruction and Development, the Albanian regulator successfully allocated a total of 222.48MW across three entities (EBRD, 2023). Concurrently, France held auctions that allocated over 1.1GW of capacity, surpassing the targeted 925MW due to oversubscription (EQ, 2023). These auctions showcased an average price of €85.29/MWh across the 70 winning bids, reflecting the competitiveness of the market.

However, challenges persist in this approach, as demonstrated by Germany's experience. The country's onshore wind capacity auctions (Table 4-1) have been plagued by under-subscription due to project permitting delays, compounded by material costs and interest rate fluctuations. In the March 2023 tender, Germany received bids for only 1.5GW, less than half of the anticipated capacity. Efforts are underway to address procedural delays, but a significant turnaround in investor response may require time and further interventions.

These instances highlight the evolving nature of energy auctions, underscoring the need for streamlined procedures and policy frameworks to optimize the potential of renewable energy projects globally. As nations navigate these challenges, addressing bottlenecks and encouraging investor confidence will be essential for sustainable growth in the renewable energy sector.

The aftermath of the Russia-Ukraine armed conflict outbreak led to a significant spotlight on European wind power projects and other renewable energy units. The surge in wholesale market prices, primarily driven by natural gas prices, created substantial potential gains for renewable energy projects. To curb excessive profits, temporary windfall gains taxes were imposed, prompting generators to shift towards long-term power purchase contracts instead of volatile spot prices in the wholesale market.

Table 4-1: Trend in German Onshore Wind Capacity Auctions

	No. of tenders	Awarded capacity (MW)	Offered capacity MW)	Price (€/MWh)
2017	3	2,824	2,800	46.03
2018	4	2,342	2,710	56.88
2019	6	1,854	3,675	61.58
2020	7	2,865	3,778	60.98
2021	3	3,296	4,235	59.00
2022	4	3,220	4,588	58.64

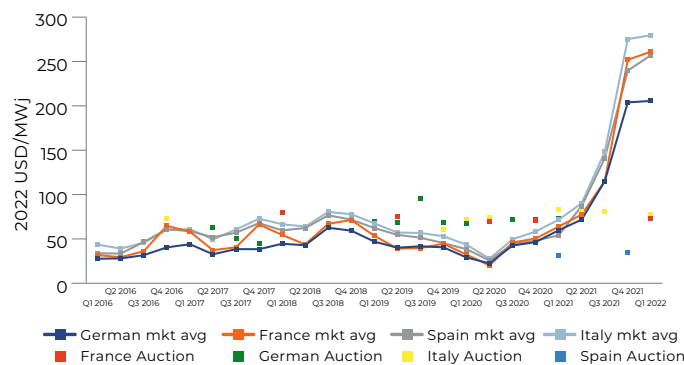
Source: S&P Commodity Insights, 2023

Several European countries, including Germany, the Netherlands, and Denmark, adopted a regulatory approach featuring sliding feed-in premiums (FIPs) with competitive bidding prices as the baseline. This allowed generators to sell in the spot market while subsidies provided additional revenue, leveraging the high wholesale market prices to their advantage.

Developing Trends

Moreover, the elevated wholesale market prices provided incentives for a relatively minor yet crucial sub-segment of wind power projects: repowering. With limited resources in onshore wind siting and stringent project approval conditions, the European onshore wind power market witnessed a rising trend in repowered capacity. This trend gained traction due to the aging onshore wind farm capacity in the European region (Figure 4-9). Germany, as of December 2022, had 17GW of capacity older than 15 years, with an additional 14GW operating for over two decades. Similarly, Denmark, Spain, and Portugal had wind turbine vintages averaging over 12 years, emphasizing the need for upgrading and repowering efforts in these regions (Wind Europe, 2023). The confluence of regulatory measures, high market prices, and the imperative to revamp aging infrastructure has spurred a new wave of innovation and investment in Europe’s wind power sector.

Figure 4-8: Onshore Wind Auction and Wholesale Prices in Select European Union Countries

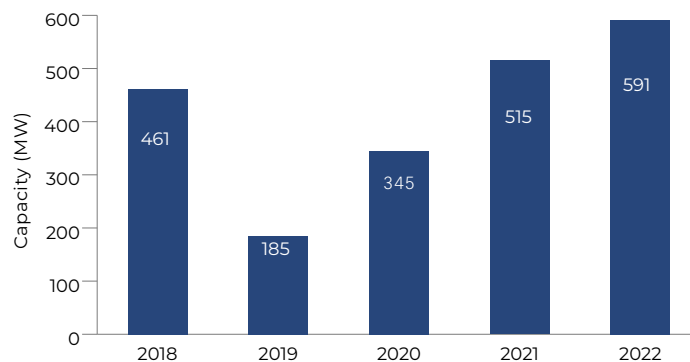


Source: IEA, 2022

The significance of wind power repowering transcends geographical boundaries and is not solely dictated by the age of assets. In the United States, for example, wind turbine refurbishment is not only driven by the age of the turbines but also by strategic considerations. As of the end of 2022, the median age of wind turbine refurbishment in the US stood at 11 years (US Department of Energy, 2023).

One of the pivotal factors motivating wind power repowering in the US market is the opportunity to access tax incentives, particularly the requalification for production tax credits. These incentives serve as catalysts for retrofitting and repowering existing wind turbines, creating a strong financial incentive for investors and developers.

Figure 4-9: Trend in Repowered Wind Power Generation Capacity in Europe



Source: Wind Europe, 2023

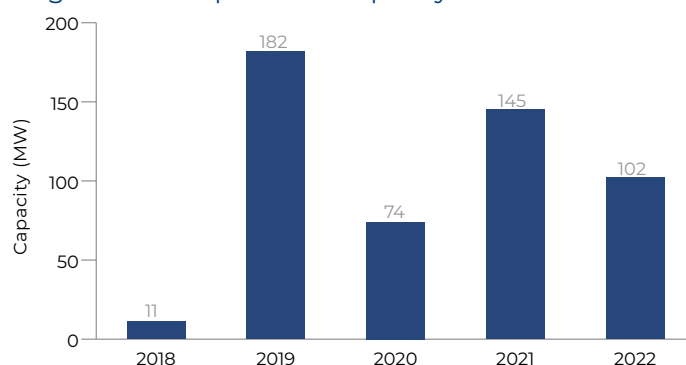
Efficiency plays a pivotal role in this process. Wind power projects are driven to upgrade their turbines, leading to orders that involve higher power ratings and larger rotor sizes. These upgrades enhance the overall efficiency and energy output of the turbines, aligning them with modern technological standards and maximizing their energy generation potential.

Developing Trends

The energy crisis of 2022 sent shockwaves through global energy markets, prompting significant reconsideration of conventional practices. In response, the European region geared up for transformative energy market reforms set to be implemented from 2023 onwards. These reforms herald a departure from traditional market practices, potentially elevating mechanisms such as Power Purchase Agreements (PPAs) and Contracts for Difference (CFD) to more prominent roles in wind power project economics.

Estimates from the International Energy Agency (IEA, 2023) indicate that approximately one-fifth of total power procurement in utility-scale wind and solar projects during 2023-2024 will be channeled through market-based routes. However, regional variations are crucial in this scenario. China, boasting a leading share in capacity and procurement, relies on fixed tariffs and premiums set by provincial authorities following the phasing out of feed-in tariffs. When excluding the Chinese market, a substantial 36% of power procurement will be market-based in 2023-2024, indicating a global trend towards market-driven renewable energy procurement.

Figure 4-10: Repowered Capacity Added in the US



Source: US Department of Energy, 2023

In the landscape of onshore wind power, specific policy measures aimed at accelerating project development have emerged as pivotal market drivers. One significant challenge faced globally has been the procedural delays in developing onshore wind power projects. Europe, in particular, has been grappling with this issue, as evidenced by research from Energy Monitor in June 2023 (Energy Monitor, 2023). The study revealed that Europe had a staggering 97GW of wind capacity held up in permitting, a figure five times greater than the capacity under construction, which stood at around 20GW.

Recognizing the urgency, the European Union took proactive steps by instituting a stipulated two-year timeframe for project approvals (Table 4-2). While this reform is a progressive move, its implementation across all member countries will take time. According to a study by Ember involving 18 countries, all nations exceeded the designated timeframe to varying degrees. Nevertheless, deliberate policy actions across European countries to ease permitting restrictions signify a significant shift. These measures are vital, given the enhanced renewable energy targets that mandate a rapid and sustained increase in capacity addition over the next 3-5 years.

Table 4-2: Illustration of Measures Initiated at Easing Permitting Bottlenecks

	Description
ESTONIA	Developers will have the opportunity to waive the second stage of planning in case of special planning of state and local government.
FINLAND	Certain projects to be given temporary priority till 2025 in regional administrative agencies' permit processing.
FRANCE	Local authorities empowered to create preferred 'go-to' and 'no-go' areas for projects.
GERMANY	Relaxation in the air radio navigation rules to accelerate the permitting process.
SPAIN	An accelerated temporary procedure to be followed till 2024 to grant approvals for wind projects of less than 75MW in capacity.

Source: IEA, 2023

Developing Trends

Recent policy deliberations across countries have emphasized a shift toward regionalization and reshoring of the supply chain in the onshore wind power sector. While the overarching goals include de-risking supply chain concentration and promoting localized sourcing, this transition is not without challenges. Despite these noble intentions, the lack of a coordinated approach could potentially jeopardize supply security for developers.

The Global Wind Energy Council's latest report (GWEC, 2023) has raised concerns about a possible shortage in onshore wind turbine nacelles and other critical components by mid-decade in the United States and Europe. This scarcity is attributed to national policies impacting the free flow of trade, disrupting the global supply chain. These policy measures extend beyond major components, encompassing upstream industries involved in the production of essential materials like steel and rare earth elements crucial for wind power equipment and projects.

From the perspective of developers and OEMs, there exists a delicate balance between localization and affordability. In the current globalized landscape of wind power equipment supply, China stands as the principal supplier for many components. Approximately 70% of wind power projects' powertrain equipment, including shafts, gearboxes, and generators, is globally sourced from Chinese facilities. In contrast, as of 2021, the United States lacked domestic wind power generation powertrain manufacturing capabilities.

The impact of policy incentives on trade flows creates a complex scenario. Artificially supplanting existing structures in favor of localization might not be financially justifiable. OEMs and developers are forced to weigh the advantages of localized production against the efficiency and cost-effectiveness of existing global supply chains.

This delicate balancing act underscores the necessity for thoughtful policy frameworks that promote both localized production and global cooperation. Achieving this balance is vital to ensuring a robust and secure supply chain capable of meeting the increasing demands of the onshore wind power industry. As nations grapple with these challenges, collaboration and strategic policy planning are key to ensuring a sustainable and resilient future for onshore wind power.

Table 4-3: Major Policy Measures towards Reshoring

Country/ Region	Measures
US	<ul style="list-style-type: none"> Enactment of the Inflation Reduction Act as of August 2022 Advanced Manufacturing Production Tax Credits for US-made renewable energy equipment including vessels, with sunsets beginning 2030 Onshore wind projects before 2025, to qualify for IRA's benefits, must source 40% equipment from the US. From 2026 onwards, the same is 55% 100% of steel and iron construction material must be manufactured in the US
European Union	<ul style="list-style-type: none"> The Net Zero Industry Act (NZIA) under Green Deal Industrial Plan of March 2023, aims to support investment in Europe-based manufacturing capacities for clean energy resources Within NZIA framework, EU should extract at least 10% of the critical raw materials from within Europe by 2030 15% of the annual raw material consumption would need to be recycled by 2050 European Commission imposed anti-dumping duties on Chinese imports of towers, raising the tariffs from 7.2% to 19.2%
Germany	<ul style="list-style-type: none"> With European Commission proposals to allow state aid, Germany plans to offer financial support to investments in domestic energy transition supply chains, together with the wind and solar power projects
Japan and South Korea	<ul style="list-style-type: none"> Both countries have strong requirements for local content in wind power projects that require localization of parts of the supply chain

Source: GWEC, 2023

05

Outlook

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Outlook

The global onshore wind market is entering a phase of recovery, marked by accelerated project approvals and strategic revisions in OEMs pricing strategies. While the energy crisis of 2022 underscored the imperative of energy transition, European countries have led the way by revitalizing permitting processes. Despite this positive momentum, the industry grapples with challenges related to development costs. The recovery trajectory is also influenced by the dynamics of long-term power purchase contracts and the imperative for new projects to offer higher prices, ensuring sustainable offtake and capacity expansion.

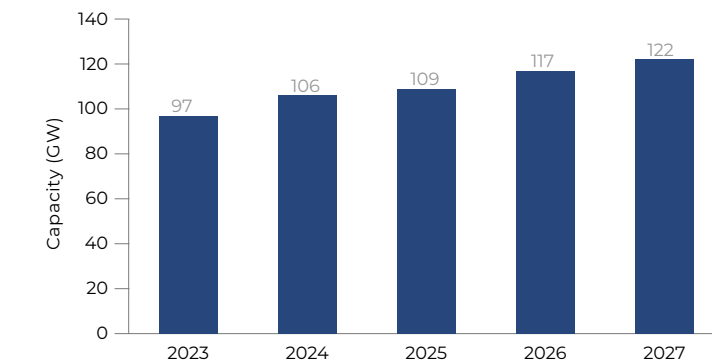
This section reviews some of the major factors shaping the onshore wind power's business outlook.

5.1 Capacity Addition

The surge in onshore wind power capacities is propelled by strategic policy initiatives aimed at ushering in a transition to renewable energy sources. The energy crisis of 2022 acted as a catalyst, intensifying efforts among policymakers and investors to accelerate this shift. With growing recognition of the severe impacts of climate change, renewable energy investments, particularly in wind and solar power, have gained paramount importance. Among these, onshore wind energy has emerged as a frontrunner due to its effectiveness and cost-efficiency, drawing substantial attention from policymakers worldwide.

One notable instance of policy-driven impetus is the UK government's step at expediting the approval process in cases of onshore wind farms involving public consent. This move was pivotal, aligning with the nation's ambitious goal of achieving a net-zero power sector by 2035. Simultaneously, European countries expedited procedural approvals, resulting in a remarkable 60% increase in German onshore wind capacity during the first half of 2023. Additionally, the United States witnessed significant growth dynamics shaped by the Inflation Reduction Act (IRA). This legislation incentivized the use of domestically sourced components in onshore wind projects, potentially lowering project costs and bolstering the sector's competitiveness.

Figure 5-1 - Outlook for Additional Onshore Wind Capacity



Source: Global Wind Energy Council, 2023

The Global Wind Energy Council's projections provide an optimistic outlook. The council anticipates an average annual capacity addition of 100GW globally, as highlighted in Figure 5-1. This estimation relies on substantial growth in key markets, with China slated to add 300GW between 2023 and 2027, followed closely by Europe with an estimated addition of about 100GW. The promising prospects extend to the entire wind energy sector, encompassing both onshore and offshore installations. Favorable policy frameworks and conducive business conditions could pave the way for the addition of approximately 1TW of new capacity by 2030.

China's wind energy market stands out as a dominant force, expected to contribute nearly 60% of the global onshore wind capacity addition by the end of 2023. This remarkable surge in Chinese wind power projects results from catching up with initiatives delayed by the disruptions caused by the COVID-19 pandemic. Despite these encouraging developments in 2023, concerns loom on the horizon. Challenges such as high capital costs, soaring material expenses, and procedural delays pose potential threats to future capacity buildouts. The International Energy Agency (IEA) has cautioned about a possible 5% decline in onshore wind capacity post-2023, underscoring the need for proactive policy interventions and sustained support to ensure the industry's vitality.

Outlook

In conclusion, while the onshore wind industry experiences robust growth driven by strategic policy reforms and expanding capacities, addressing the challenges ahead is crucial. To sustain this momentum, policymakers, investors, and industry stakeholders must collaboratively navigate these challenges, fostering an environment of innovation, efficiency, and resilience within the global onshore wind sector.

5.2 Costs Impacting Pipeline

The onshore wind industry faces a complex landscape shaped by rising costs, impacting the financial health of Original Equipment Manufacturers (OEMs) and, consequently, the viability of projects. Between 2020 and 2022, a sharp spike in costs, driven by various factors, significantly impacted OEMs' financial positions, leading to impaired returns for key players. While there is hope for relief in terms of commodity prices, the horizon reveals impending price revisions for wind turbines and related equipment.

A glaring example of this cost surge is evident in Vestas' onshore wind turbine pricing. In Q4 2022, the company's average contracted price soared to €1.15 million/MW, a stark contrast to the €710,000/MW charged in 2000 for comparable periods. This surge, echoing a general 40% increase in onshore wind turbine prices outside China since the pre-pandemic era, illustrates the sector's financial strain.

However, the challenges faced by OEMs extend beyond material inputs and capital concerns. Operational and Maintenance (O&M) issues related to new wind turbine configurations pose significant hurdles. Siemens, a leading OEM, projected a staggering \$1.75 billion cost for addressing wear and tear complaints in its flagship turbines. Additionally, the company anticipated a \$5 billion loss in 2023 due to repair and replacement costs. Vestas shared a similar outlook, with order backlog and contractual O&M servicing agreements affecting financial performance, despite improvements in supply chain and pricing strategies.

The stress on profitability and price revisions by OEMs casts a shadow on project viability. Typically, developers finalize fixed contracts for turbines at the project's initiation stage. However, the challenges faced by OEMs could jeopardize these contracts, leading to uncertainties in project pipelines. This concern was exemplified in Germany, where the government proposed allowing onshore wind developers (5GW worth) to abandon contracts due to cost-related unviability, enabling them to re-enter subsequent auctions offering higher prices. Although the plan faced industry criticism and was not implemented, it highlighted the dynamics at play in the onshore wind business.

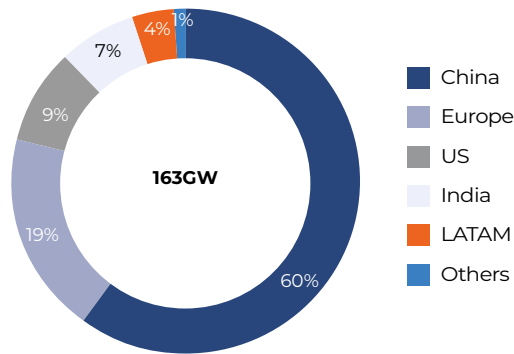
The critical nexus between costs and Power Purchase Agreement (PPA) prices further exacerbates challenges. Studies by S&P Global Commodity Insights project a rise in the break-in levels for a typical 10-year PPA in German onshore wind power projects starting in 2025. This rise, extending beyond wholesale power prices and capture rates, is expected to persist for at least the next two years, reflecting the rigid inflationary pressure on new projects under development.

In navigating these challenges, stakeholders must engage in collaborative efforts to strike a balance between profitability, affordability, and sustainability. Proactive policy interventions, innovative solutions, and streamlined regulatory frameworks are essential to ensuring the resilience of the onshore wind industry amid evolving cost dynamics.

5.3 Equipment Manufacturing and Supply

The rapid expansion of onshore wind capacity has intensified the spotlight on the industry's supply chain, amidst evolving policies and shifting market dynamics. Despite challenges, the onshore wind turbine market remains optimistic due to proactive efforts by government bodies to bolster project pipelines. However, the industry's resilience hinges on ensuring the timely, sufficient, and cost-effective availability of equipment, a critical concern for developers, regulators, and investors.

Figure 5-2 - Reginal Breakup of Wind Turbine Manufacturing



Source: Global Wind Energy Council, 2023

Note: (1) Others refers to Asia Pacific excluding China and India (2) China's share includes the capacity of western turbine OEMs (3) Manufacturing capacity refers to turbine nacelle assembly capability and does not represent actual production

China continues to play a central role, serving as the global hub for wind turbine manufacturing and supplying crucial components. In the post-pandemic landscape, developers have sought diversification, exploring alternative sourcing options in countries like India in the Asia-Pacific region and MENA countries. This diversification strategy aims to enhance supply chain resilience and mitigate dependence on a single region.

However, challenges arise when considering major policy initiatives such as the Inflation Reduction Act and Made in Europe policies. Both initiatives, while aiming to bolster domestic industries, create dependencies on imports due to the lack of immediate domestic capacities. Disruptions in free trade flow triggered by these localization policy incentives can lead to supply bottlenecks, complicating the industry's growth trajectory.

Trade barriers, especially between China and the US/Europe, exacerbate challenges, directly influencing costs. Competitive subsidies from European and US policies further complicate the situation, conflicting with the principles of free trade. While the overarching goal is to achieve supply security through indigenous investments, the current framework risks sub-optimization due to these conflicting policies.

Navigating these challenges requires a delicate balance between regional policy objectives and global supply chain dynamics. Collaboration between nations, open dialogue, and a focus on fair trade practices are essential. Sustainable solutions must prioritize both supply chain security and adherence to free trade fundamentals. Only through strategic coordination and shared objectives can the onshore wind industry establish a robust, resilient supply chain, ensuring sustainable growth in the face of evolving global policies and market demands.

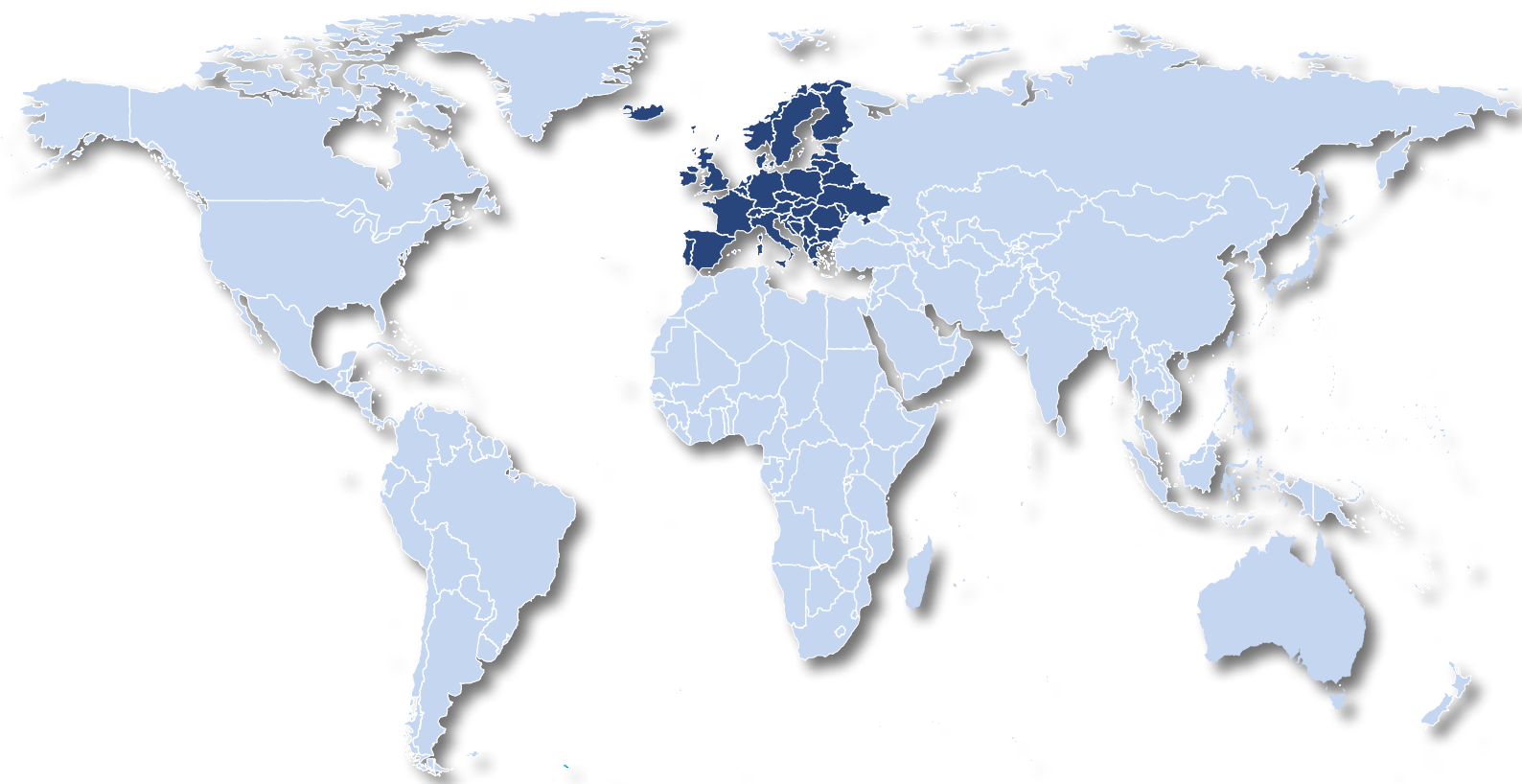


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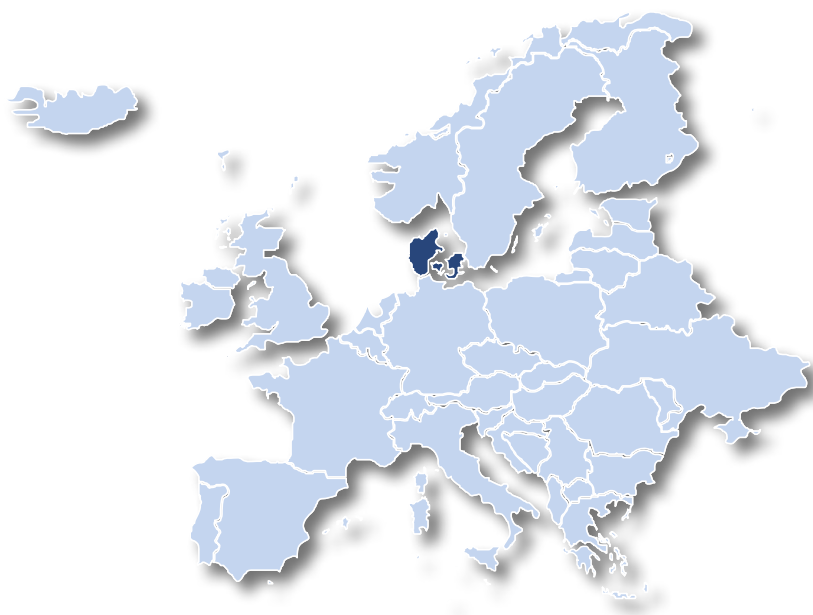
Key Regional Markets

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Key Regional Markets - Europe



Denmark



Denmark has been a trailblazer in generating a significant portion of its electricity from renewable sources, particularly wind energy, both onshore and offshore. Wind power now constitutes more than 60% of Denmark's clean energy mix (IRENA, 2023). The country has committed to achieving a 100% renewable energy supply by 2050 (CCACoalition, 2020).

Wind power, with its strong presence in the nation and the availability of abundant wind resources, plays a pivotal role in achieving these ambitious targets. The Danish onshore wind industry has experienced consistent growth, propelled by supportive government policies, favourable wind conditions, and continuous technological advancements. Denmark's journey in the onshore wind sector serves as a model for other nations, showcasing how combining expertise, policy support, and natural resources can drive the transition towards a renewable energy future.

GDP (Current Prices) USD (2022)	390.68bn
GDP Growth Forecast (constant prices) (2023-2027)	1.08%
Currency	Danish Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	12.4GW
Onshore Wind Share in Renewables (2022)	41%
Renewable Energy Target	2030 aim for renewable energy contribution to reach 100% in electricity generation and 55% in total consumption, in tandem with reduction of GHG emissions by 70% from 1990 level

GDP Source: IMF WEO, S&P and IRENA

4.8GW Onshore Wind Capacity

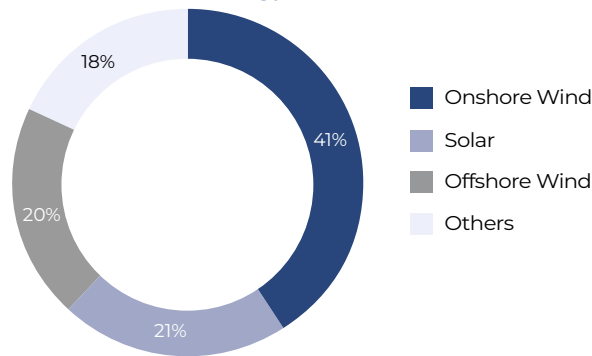
✓	Promotion of renewable electricity through a combination of market mechanisms and political regulation
✓	Stringent steps taken to speed up the permitting process, especially for subsidy-free renewable project development
✓	Robust funding initiatives amalgamated with upcoming CfD mechanism expected to boost corporate and merchant power projects
✗	Policy shift towards offshore wind and solar PV with a stagnated policy framework for onshore wind is expected to hit its deployment
✗	Strained public opposition and limited land availability constrained onshore wind growth

Denmark

Renewable Energy Mix

In 2022, Denmark achieved a significant milestone with approximately 11.7GW of total renewable energy installed capacity. Onshore wind led the energy mix among these renewable sources, contributing 41% of the total capacity (IRENA, 2023). However, there has been a decline in the share of onshore wind, dropping by 5% from the previous year as officials shifted their focus towards offshore wind and solar PV technologies. While there are regulatory shifts towards other renewable sources, onshore wind remains a crucial player in Denmark's renewable energy landscape, even as the country explores a diversified portfolio of clean energy solutions.

Current Renewable Energy Mix 2022

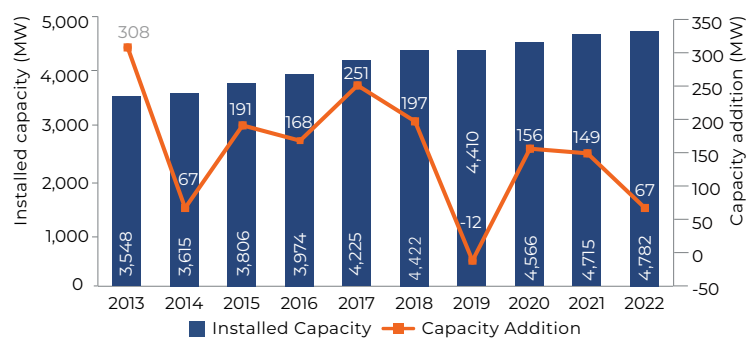


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Denmark's onshore wind installed capacity has experienced slow growth recently, with a compound annual growth rate (CAGR) of only 3% between 2017 and 2022 (IRENA, 2023). As a result, the onshore wind capacity remained below 5GW until 2022. Several factors have contributed to this stagnation, such as policymakers reallocating resources for offshore wind development, geographical constraints, permit delays, policy shifts, and public opposition. These challenges have limited the expansion of onshore wind projects, leading to minimal capacity additions, often below 100MW, in 2022 (IRENA, 2023). Despite these constraints, there were still some modest additions, contrasting with the absence of capacity additions in offshore wind projects during the same period.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Denmark

Demand Drivers

The importance of renewable energy has increased due to rising energy prices caused by geopolitical developments and ambitious national clean energy targets. In Q1 2022, Denmark announced a new reform proposal called "Denmark Can do More II". This proposal outlines measures to accelerate the transition to a more sustainable energy system and decrease reliance on Russian gas. The measures include speeding up the permitting process, especially for subsidy-free renewable project development, with the goal of quadrupling the total volume of electricity generated by solar energy and onshore wind by 2030 (European Commission, 2023).

In Denmark, authorities are progressively implementing robust funding plans to encourage renewable usage.

In June 2022, the government and Danish Parliament reached agreements covering a green investment fund, an enhanced unified carbon tax, and a renewable energy package, providing the necessary momentum to achieve the 2030 capacity targets. The fund covers EUR7.2 billion in investments between 2024 and 2040, prioritising larger and longer-term investments in climate, clean energy, and the environment (Ministry of Foreign Affairs Denmark). Additionally, in May 2021, the European Commission approved a support package of EUR400 million proposed by Danish authorities to support sustainable energy production from onshore and offshore wind, tidal power, hydroelectric power, and solar PV (European Commission, 2021).

Market Opportunity

In Denmark, the repowering of old wind projects presents a significant market potential, given the country's status as the home of the world's oldest fleet of wind turbines. Between 1978 and 2020, Denmark experienced a total loss of approximately 7.85TWh of wind energy production due to faults, failures, and age-related asset performance degradation (Renewables Now, 2022). Repowering these ageing assets has emerged as a cost-effective alternative to life extension and holds substantial promise for expanding the installed capacity base.

In 2022, noteworthy repowering initiatives included a 10-year power purchase agreement (PPA) between dairy cooperative Arla and renewables developer Eurowind Energy for a 39.6MW unsubsidised wind farm (Renewables Now, 2022). This repowered wind farm is expected to generate 137GWh annually. Repowering old projects has become crucial for Denmark to achieve its clean energy capacity targets, especially in the face of challenges such as limited land availability and local opposition to new onshore wind projects.

Despite these challenges, Denmark has seen a rise in subsidy-free renewable projects facilitated through the PPA route, driven by technological advancements and the increasing cost competitiveness of wind projects. Notably, the country witnessed its first utility-scale subsidy-free wind park, the 17MW Hirtshals Havnefond project, securing a 3-year PPA with Energi Danmark (AA Energy, 2019).

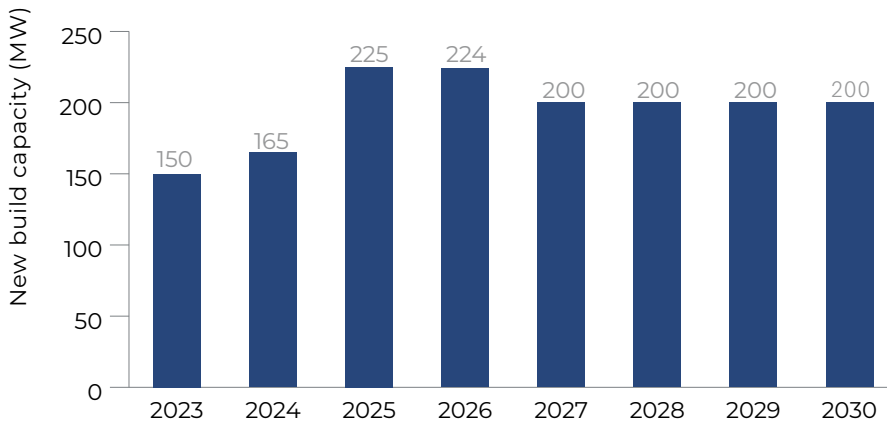
Hybrid projects integrating solar and wind energy have gained momentum in Denmark, primarily due to their efficient land use. Danish renewable company GreenGo has announced plans to partner with Ringkøbing-Skjern Municipality to develop a green Energy Park comprising 4GW of hybrid solar and wind energy, with an estimated investment of around DKK60 billion (€8 billion), projected to be operational before 2030 (Power Technology, 2023). Additionally, Eurowind Energy revealed plans to construct wind-solar hybrid capacity at five onshore energy centres in Denmark, totalling 2.5GW, with battery storage to provide grid services (WindFair, 2022).

Considering the rapid growth of hybrid projects, the seasonal variability in renewable energy production, and the grid's limited capacity to handle excessive wind power, energy storage solutions, particularly battery-based systems, hold significant potential in the Danish market. Developers are increasingly integrating battery storage into new power plants to address these challenges. Moreover, innovative and eco-friendly storage technologies like Molten Salt Storage (MOSS), as explored by companies like Hyme Energy, can potentially revolutionize energy storage, offering sustainable and cost-effective solutions for the wind energy industry (State of Green, 2022). These developments reflect Denmark's proactive approach to tackling challenges and leveraging emerging technologies to advance its renewable energy sector.

Denmark

Outlook

Denmark's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Denmark has a strong local manufacturing industry for turbines and employs skilled workers who support the wind industry for the long term. This helps the government set ambitious targets for onshore wind capacity deployment, which is crucial as the country is transitioning towards a greener future, and power demand is expected to double by 2030.

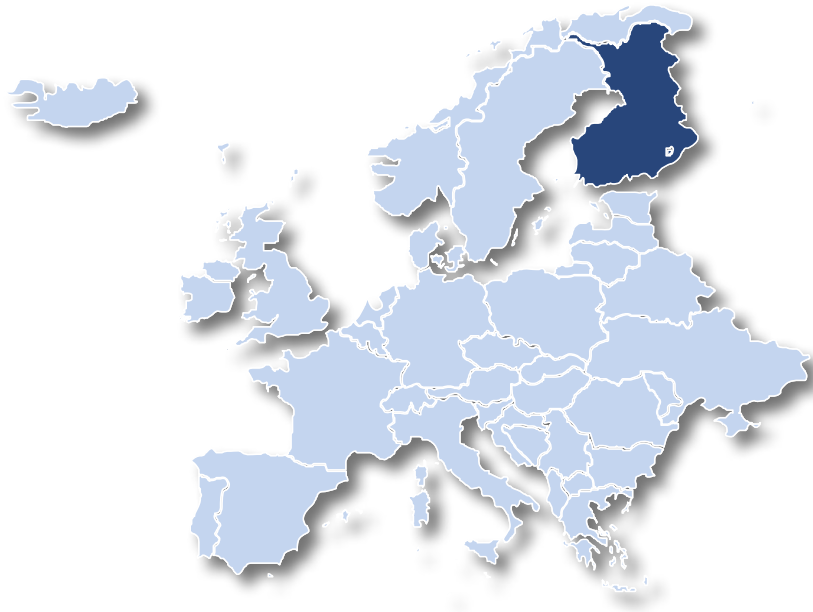
According to estimates by BloombergNEF (BNEF), Denmark's wind energy industry is expected to experience a slight increase in capacity until 2026 before levelling off at an average of 200MW per year from 2027. However, barriers to growth exist due to Denmark's ineffective and inefficient permitting and licensing rules, causing delays in wind projects. Additionally, public opposition to onshore wind due to noise pollution and its associated health impacts presents a major regulatory roadblock. One solution could be to involve municipalities with revenues in the approval process.

Another factor contributing to the industry's moderate growth is the limited availability of land, which can be addressed by implementing hybrid projects that combine solar and wind energy. This approach requires less land and generates more energy capacity.

Denmark's rapid decommissioning of ageing turbines creates an urgent need for repowering. However, replacing older machines with new and efficient models is not feasible without adequate funding. The good news is that onshore wind turbine prices have decreased in recent years, making project development viable even without state subsidies. Additionally, better grid management technology and more robust maintenance regimes can help avoid significant losses.

Finally, Denmark's onshore wind sector can continue to grow with the presence of a flexible power grid and an effective network of turbine OEMs.

Finland



Finland is leading the way in European energy transition policy, with 59.4% of its power mix coming from renewable sources in 2022 (IRENA, 2023). Onshore wind power is the most prevalent source due to its abundant availability. In fact, 2022 has been a remarkable year for Finland as it recorded Europe's second-largest onshore wind annual capacity addition. This remarkable progress is thanks to Finland's strict and direct energy transition goals, which include achieving carbon neutrality by 2035. Moreover, Finland has recently updated its energy consumption targets to ensure that at least 51% of the country's final energy consumption comes from renewable sources (Tamarindo Global, 2023). The government has also introduced various initiatives to boost the use of renewable energy and to phase out fossil fuels in industries such as transportation and electricity generation.

GDP (Current Prices) USD (2022)	281.05bn
GDP Growth Forecast (constant prices) (2023-2027)	1.04%
Currency	Euro
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2022)	12.1GW
Onshore Wind Share in Renewables (2022)	46%
Renewable Energy Target	Reducing GHG emissions by 60% by 2030 and reaching carbon neutrality by 2035

GDP Source: IMF WEO, S&P and IRENA

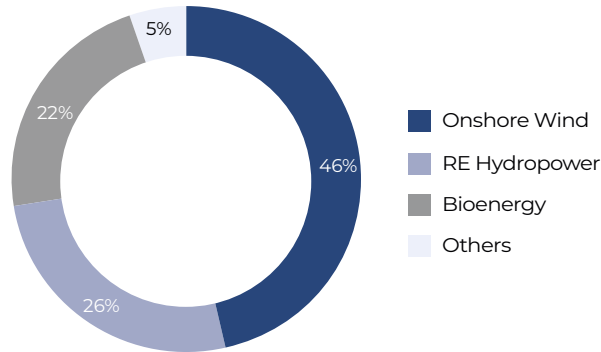
5.5GW Onshore Wind Capacity

✓	Commitment to stabilising regulation for onshore wind and funding initiatives are expected to boost onshore wind deployment
✓	Significant traction was observed for subsidy-free onshore wind projects leading to robust pipeline of projects
✗	Military restrictions due to wind farm impact on radar movement stagnated project developments
✗	A shift in regulatory focus towards offshore wind and solar PV deployment is expected to hit onshore wind

Renewable Energy Mix

Renewable energy in Finland is dominated by onshore wind, comprising 46% of the total mix, followed by renewable hydropower at 26%. Onshore wind has grown steadily over the years, increasing its share in the energy mix from 4% to 46% between 2012 and 2022, representing an impressive 11.5x growth (IRENA, 2023). This growth is attributed to the Finnish government's policy support and strict energy targets, technological advancements in wind turbines, and the timely use of the abundant wind energy potential, particularly in the coastal and northern regions. Finland is currently ranked second in onshore wind cumulative installed capacity in the Nordic region.

Current Renewable Energy Mix 2022

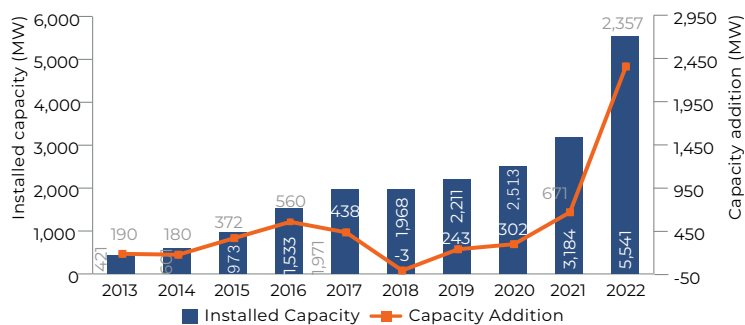


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Finland has experienced a steady increase in its onshore wind installed capacity over the past nine years, growing at 33% CAGR. However, the annual capacity additions have been volatile, with the highest capacity additions of around 2.4GW in 2022, resulting in a cumulative installed capacity of more than 5.5GW (IRENA, 2023). This increase can be attributed to a faster permitting process, advanced wind turbine technology, and decreasing prices of turbines that have increased cost-effectiveness. Moreover, the majority of projects that were awarded in the last auction held in 2018 (Climatescope) are anticipated to be completed in 2022, thus explaining the surge in installations. Despite the implementation of subsidies and FITs, Finland attracted private investments, reflecting its strong PPA and Merchant markets, which further boosted capacity addition (Wind Europe, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Finland

Demand Drivers

Finland's wind energy industry is thriving due to substantial fiscal support and strategic initiatives. The government's proactive approach, such as allocating additional funds for wind power surveys, studies, and permitting processes, demonstrates a commitment to accelerating wind energy deployment. The subsidy allocation of EUR1.5 million in 2022, in addition to previous subsidies, has significantly bolstered wind energy projects (IEA, 2023).

Local engagement is a key aspect, with property tax and radar compensation fees acting as mobilization tools. Wind projects contribute to the local economy by paying property taxes to municipalities and compensating for radar upgrades in specific regions (Finish Wind Power Association). These financial mechanisms, along with the gradual reduction in tax values, incentivize wind energy development and support local communities.

The upgrade plans for the electrical grid, outlined in Fingrid's Main Grid Development Plan 2022-2031, are pivotal. By investing around EUR200 million annually over

a decade, Finland aims to enhance the grid infrastructure, enabling the integration of renewable energy sources (FINGRID, 2021). This forward-looking strategy ensures that the grid system aligns with the evolving renewable energy landscape.

Additionally, the shift towards subsidy-free onshore wind projects, facilitated by corporate PPAs, has accelerated industry growth. Wind developers are partnering with major corporations like Google, Amazon, and Equinix, signing long-term PPAs that ensure profitability and stability in the market (ICIS, 2021). These agreements not only provide financial assurance but also drive the construction of new wind farms, meeting the rising demand for clean energy in Finland.

The synergy between government support, corporate investments, and local engagement creates a favourable environment for Finland's wind energy industry, making significant strides toward a sustainable energy future.

Market Opportunity

Finland has a huge potential for wind power, with a pipeline of 121GW of new wind power projects. However, most of these projects are still in the early stages of development. The Finnish Wind Power Agency estimates that Finland has 3.1GW of wind power projects under construction, which are expected to go online between 2023-2025 (Finnish Wind Power Association, 2023). With its massive wind power condition, Finland added 251% more capacity in 2022 than in 2021.

Among the cumulative additions in 2022, about 2.2GW of wind power projects were subsidy-free. More such subsidy-free and merchant wind projects are under construction and are expected to go online by 2028, demonstrating Finland's significant transition to subsidy-free wind power development following the withdrawal of subsidies in 2021. Therefore, it is projected that Finland's onshore wind capacity will increase from just over 5GW in 2022 to 20GW by 2030, resulting in an annual capacity addition of 2.1GW (Renewables Now, 2022).

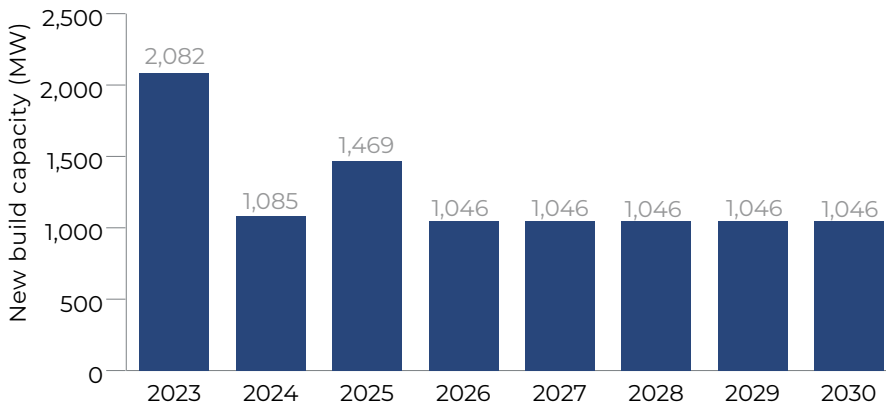
Wind power has significant potential in Finland, but there are seasonality constraints that need to be addressed. Advanced energy storage solutions could be the key to overcoming these limitations. Following the success of Neoen's largest battery energy storage system, Taaleri

Energia has announced a plan to invest around EUR20 million in 30MW/36MWh battery storage systems in Lempäälä, Finland (TAALERI Energia, 2023). This investment has the potential to double in the future, which will help to support the grid and increase the overall capacity of Finland's wind farms. In another recent development, Ilmatar and Glennmont are partnering to pair a 211MW Finnish onshore wind farm called Piiparinmaki with a 30MW BESS (Renewables Now, 2023).

Finland's stable and transparent political environment makes it a secure investment destination for investors. This is evident from the funds received from several European nations in recent times. In June 2023, Sweden's OX2 AB partnered with Finnish renewable developer Tuulialfa to construct 1.2GW of onshore wind parks in Finland's Northern Ostrobothnia and Lapland regions (Renewables Now, 2023). In May 2023, Copenhagen Infrastructure Partners (CIP), a Danish investment firm, announced a partnership with Finnish wind energy company Myrsky Energia. CIP will invest €2.3 billion to generate approximately 1.8GW of onshore wind power in Finland over the next decade (YLE Finland, 2023). In 2022, another Danish firm, AIP Infrastructure II, invested EUR135 million in a 148.5MW onshore wind project in Finland to finance fully merchant long-term projects (S&P Global, 2022).

Outlook

Finland's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

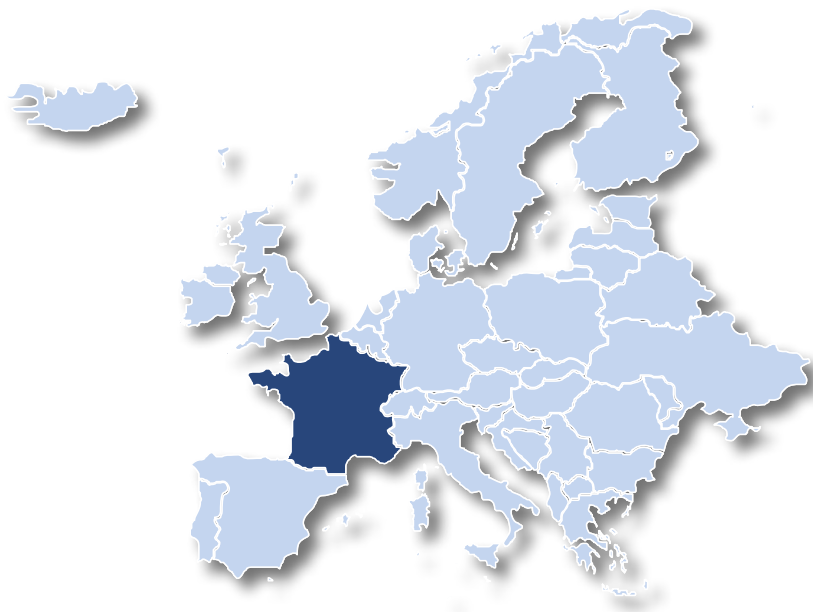
Finland's onshore wind market is poised for significant growth, with substantial investments and ambitious capacity addition projections. The supportive market conditions, including price competitiveness, increased demand, and policy backing, have positioned Finland's onshore wind sector as an attractive investment opportunity. The Finnish Wind Power Association's estimates of substantial investments in wind power and the favourable environment indicate a positive trajectory for the industry (Finnish Wind Power Association, 2023).

However, challenges such as the shift in policymakers' focus to offshore wind and solar, limited land availability, public opposition, and military restrictions due to radar issues pose hurdles (FINGRID, 2023). Overcoming these challenges will be crucial for sustaining the industry's growth momentum.

Learning from Nordic peers and investing in research and technology to address radar issues and secure military approval could be essential strategies. Additionally, exploring innovative land-use solutions and engaging with local communities can mitigate opposition and enhance social acceptance.

Overall, the optimism surrounding Finland's onshore wind energy, coupled with strategic solutions to existing challenges, positions the country for substantial growth. The projected quadrupling of wind energy's share in electricity by 2030 underscores the industry's potential and its pivotal role in Finland's renewable energy landscape.

France



France has made significant efforts to achieve its goal of an emission-free energy mix by 2050 (FINEER GREEN, 2022). Over the past decade, the country has increased the share of renewables in its power mix by 16%, indicating a significant shift from its reliance on nuclear to renewable energy. Onshore wind power is one of the key renewable energy technologies that France has been using to go carbon neutral, thanks to its favourable wind conditions. Additionally, the government has actively supported onshore wind by providing funding and implementing appropriate policies. As a result, France has surpassed 20GW of cumulative onshore wind capacity in 2022 (IRENA, 2023).

GDP (Current Prices) USD (2021)	2,957.42bn
GDP Growth Forecast (constant prices) (2022-2026)	1.64%
Currency	Euro
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2022)	65.4GW
Onshore Wind Share in Renewables (2022)	32%
Renewable Energy Target	Producing 33% of its energy needs from renewable sources by 2030 Achieving 100GW of renewable capacity by 2050

GDP Source: IMF WEO, S&P and IRENA

20.6GW Onshore Wind Capacity

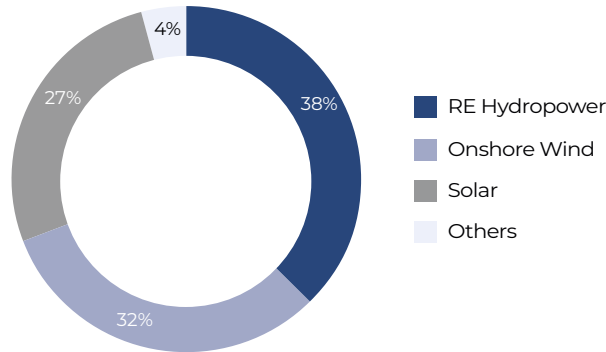
✓	Policy support through a new Renewable Energy Acceleration Bill and revised multi-year energy plan (PPE2)
✓	Overwhelming support of public created by the new strategy for communal inclusion in wind projects
✓	Robust funding initiatives unveiled under the 2030 National Investment Plan
✗	Limited focus on the onshore wind policy development and sturdy initiatives for offshore wind
✗	Delayed permitting procedures and project approvals compared to other major European markets

France

Renewable Energy Mix

France heavily relies on renewable hydropower as its primary source of renewable energy due to its favourable topography and rain patterns. However, the popularity of wind and solar PV is gradually challenging hydropower as the leading source of renewable energy. This is evident from the 2% YoY decline in hydropower's contribution to the renewable mix in 2022 (IRENA, 2023). The French government has played a crucial role in shaping the onshore wind energy industry. It has set a target of doubling the cumulative installed capacity of onshore wind to 36GW by 2050, to achieve the overarching Net Zero 2050 ambition (EN Former, 2023).

Current Renewable Energy Mix 2022



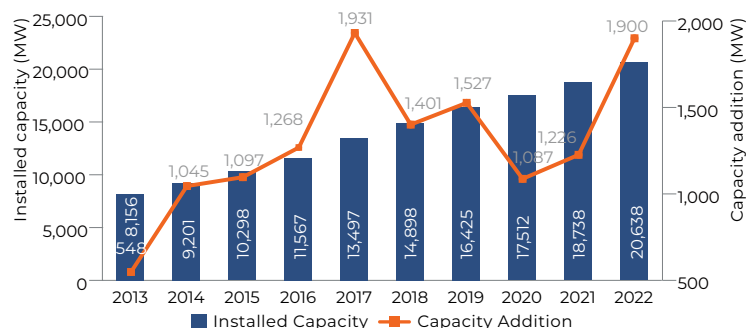
Source: IRENA Renewable Capacity Statistics July 2023

Over the last decade, onshore wind has exhibited a steady growth of 12% in its share in the energy mix, thanks to the government's strategic policy formulation. The national law on Climate and Energy introduced in 2019 is an excellent example of this. It directly aims to phase out coal by closing the last four plants in 2022 and replacing them with new renewable capacity, including onshore wind (REUTERS, 2019).

Installed Capacity: Status and Trend

Over the past 7 years, there has been significant growth in the capacity of onshore wind installations, with capacity more than doubling from 10.3GW in 2015 to 20.6GW in 2022. In particular, the capacity added annually increased by 55% in 2022 (IRENA, 2023). This strong performance can be attributed to the supportive regulatory environment and funding from the public and corporations in France, as the cost of wind power generation has decreased. Despite this positive trend, France is still approximately 4GW away from its target of reaching 24GW by 2023.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

While offshore wind energy is gaining more government support, with the first commercial-scale offshore wind farm Saint Nazaire already in operation and more floating offshore farms planned, onshore wind is still expected to play a crucial role in achieving France's 2050 net zero objective. Favorable new schemes such as the Renewable Acceleration Bill, the 2030 Investment Plan, and the upgrade of the PPE program are expected to further support the growth of wind energy in France (EN Former, 2023).

Demand Drivers

Following the outbreak of the Russia-Ukraine war, the REPowerEU, mandated by the European Commission (EC) in May 2022, is prioritizing the simplification and speeding up of the permitting process for renewable projects in order to address the energy crisis. Member states will receive an additional €20 billion in funds under this mandate (European Commission, 2023). France intends to use its share of the funding to clear its permitting backlog, which will help to accelerate onshore wind activity. Currently, there are about 11GW of onshore wind projects that are waiting to secure permits, and 4.8GW are in the final stage of the permit procedure (Wind Europe, 2023). By resolving permitting delays, developers will be able to start their projects and achieve the assigned targets for installed capacity later on.

The onshore wind market's sustained development is heavily reliant on policy support. The multi-year energy plan (PPE), now revised to PPE2 in 2021, is of utmost importance. It aims to achieve over 34GW of installed capacity for onshore wind by 2028 through a series of auctions (Wind Europe, 2023). The latest onshore wind auction held in July 2023 resulted in the award of more than 1.1GW of onshore wind tenders. This is a significant oversubscription from the scheduled capacity of 925MW (Renewables Now, 2023). Moreover,

in February 2023, the French government introduced the Renewable Acceleration Bill. This bill empowers local authorities to provide consents for renewable projects, and the permitting process is faster. The bill also includes auctions of 6.5GW of onshore wind capacity with an additional 2GW for technology-neutral, scheduled until 2028 to accelerate onshore project builds (Wind Europe, 2023).

Although strategic policies are the main drivers for the development of the French onshore wind sector, there are other opportunities that can lead to growth in the industry. The merchant market and PPAs, for example, can also create new avenues for growth, especially with the decreasing prices of wind technology. Since 2019, PPAs have been gaining momentum in France, and the French government is taking steps to attract companies by creating schemes such as PPA guarantee funds for renewables. The objective is to cover the default risks of renewable power projects with up to 500MW of cumulative installed capacity (PV Magazine, 2022). By mitigating the risk from high market prices, companies would be more likely to sign long-term PPA contracts in France. Already, companies such as Boralex, Octopus Energy, RWE, and ENGIE are showing interest in the French onshore wind market.

Market Opportunity

France is working towards its 2023 target through legislative reformulations and increased financial support for the expansion of renewable energy. In 2022, the French government announced the 2030 National Investment Plan, which includes an investment of EUR1 billion in renewable energy innovation projects to increase the installed capacity of renewable power to approximately 100GW by 2050 (IEA, 2022). With favourable wind conditions and supportive policies like the FITs, onshore wind power has the potential to double its capacity by 2030.

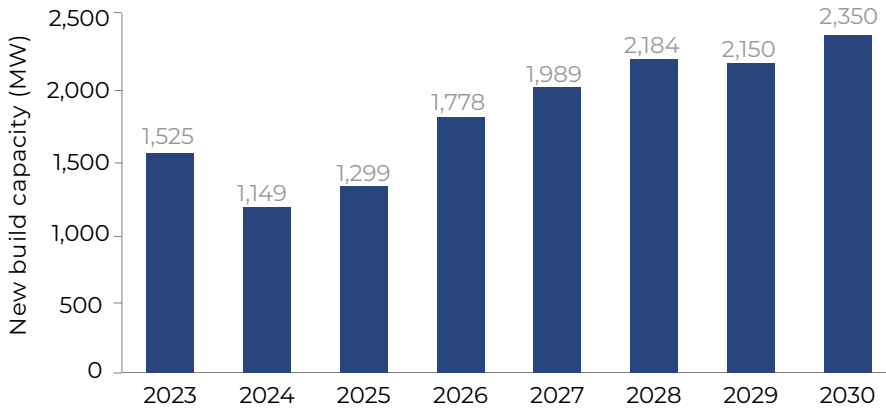
Many companies are investing in France's onshore wind due to favourable market conditions. Octopus Energy is one such example, having announced in 2023 that they will invest about EUR1 billion in three wind farms in France over the next two years (Octopus Energy, 2023). Additionally, RWE and TotalEnergies inaugurated the new Couprou onshore wind farm in April 2023 with a capacity of 12MW in the French department of Aisne, investing EUR20 million. This project has increased RWE's renewable portfolio in

France to 21GW, and they plan to invest more in the future (RWE, 2023).

Repowering has emerged as an important investment option for renowned developers in France, noting that 3,565 wind farms are estimated to reach the end of their operational life in 2025, entailing an investment of €18 billion to repower them (SIA PARTNERS, 2022). Notably, Q Energy is set to launch four projects in France for a total installed capacity of 56MW between 2023 and 2024 (Renewables Now, 2023). In association, the government provides suitable recycling options for decommissioned wind turbines. Thus, the repowering of legacy wind turbines is another profitable business opportunity. Alongside, hybrid wind-solar projects are noticing growing footfalls. In June 2023, France's first hybrid project came online with a 24MW wind farm and a 5MW solar farm in Savigné (PV Magazine, 2023). Such hybrid projects would bring attractive investment opportunities since they offer the most efficient usage of land for renewable energy generation.

Outlook

France's Projected Onshore Wind Builds



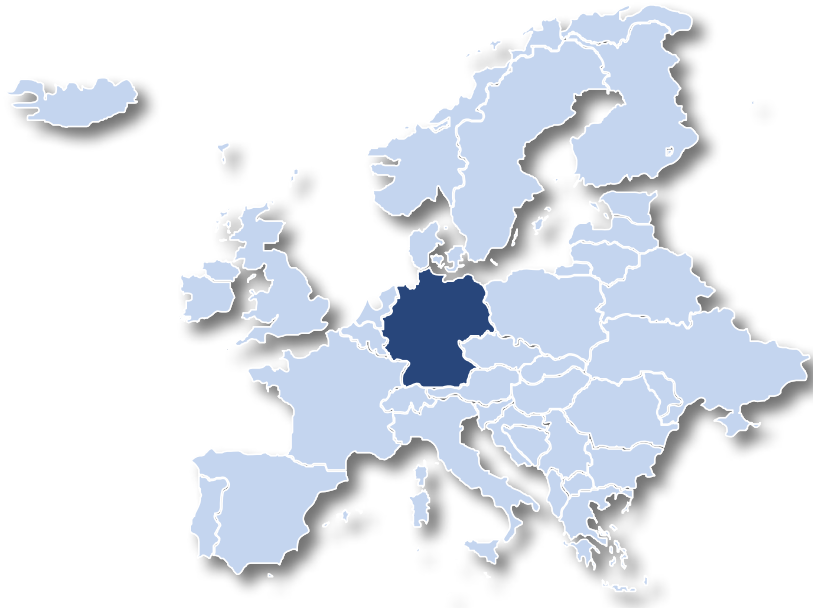
Source: BNEF Global Wind Market Outlook

Although France has made notable progress in its energy transition to achieve its ambitious decarbonization goals, it has fallen short of meeting the targets it has set. This is due to the postponement of several major policy initiatives over the last decade. The original goal of reducing nuclear energy production from 70% to 50% by 2025 has been pushed back to 2035, and there are concerns that it may be abandoned altogether in order to ensure energy security (REUTERS, 2019). Additionally, the onshore wind industry has experienced a slowdown in capacity installations since 2020, which means that in order to reach the 2028 target, approximately 2.8GW of new capacity must be added each year. According to BNEF, annual cumulative additions will be less than 2GW until 2027, with more than 2.1GW being added from 2028 onwards. This indicates that there is currently not enough being done to meet the targets.

France's onshore wind growth is being impeded by a number of challenges. Some of the main issues include administrative barriers, public opposition, and increased government focus on offshore wind projects. Since 2020, onshore wind projects have experienced delays in permit procedures, which has led to a halt in project developments (Windpower Monthly, 2022). Political support for public opposition has also contributed to a lack of project commencements. Furthermore, the government's shift in resource allocation for offshore wind projects is causing further delays in the approval of onshore wind projects.

However, the government is taking proactive steps to design and implement policies that will speed up the permitting process. They are also including local communities in project approval to facilitate a faster commissioning process. Despite these backlogs, onshore wind power is expected to play a pivotal role in achieving carbon neutrality by 2050 due to favorable wind conditions and potential investment opportunities. Nonetheless, as recommended by IEA, significant investment is needed for the technology to have a realistic chance of reaching its 2028 target (IEA, 2023).

Germany



Germany is leading the way in the global shift towards renewable energy, with a total renewable share accounting for 58.6% of the country's electricity mix (IRENA, 2023). The country's Energiewende initiative is committed to phasing out nuclear power, reducing fossil fuel use, and achieving continued economic growth through the use of clean energy resources. Onshore wind power plays a significant role in achieving these goals, thanks to favorable wind power conditions, legislative support, and policy initiatives. However, the COVID-19 pandemic caused a collapse in capacity additions and ground loss in the wind energy sector. Despite these setbacks, the sector has quickly recovered, thanks to key initiatives, financial assistance, and increased pressure from the European Commission (EC). The German government has also reformed licensing and permit procedures and adjusted carbon neutrality targets to speed up the transition to clean energy (BMWK DE, 2023).

GDP (Current Prices) USD (2022)	4,075.40bn
GDP Growth Forecast (constant prices) (2023-2027)	1.22%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	148.4GW
Onshore Wind Share in Renewables (2022)	39%
Renewable Energy Target	Germany targets 80% share of renewables in the power mix by 2030 as against 47% in 2022 to attain decarbonisation by 2045

GDP Source: IMF WEO, S&P and IRENA

58.2GW Onshore Wind Capacity

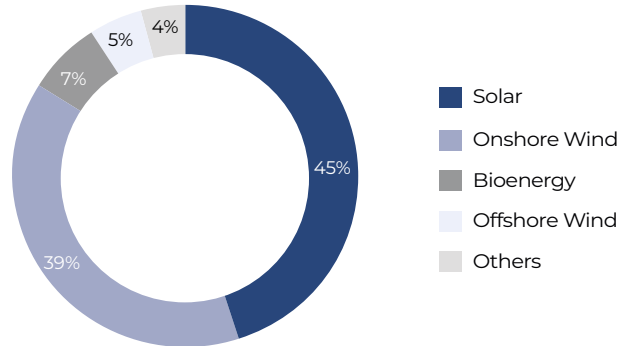
✓	Ambitious targets of 160GW of onshore wind by 2035 and carbon neutrality by 2045
✓	Strategic policy support through the enactment of EEG 2023 for renewables and WindLandG for onshore wind
✗	Sluggish permit procedures, inefficient grid management, and shortage of skilled workers
✗	High capital cost due to land constraints

Germany

Renewable Energy Mix

Germany's current renewable energy mix is primarily dominated by solar energy, with wind power (onshore and offshore combined) following closely behind. Together, they make up around 44% of the country's renewable energy sources. In 2022, Germany added approximately 2.5GW of wind power capacity, with onshore wind accounting for 88% of the total capacity added (IRENA, 2023). Despite the significant growth of wind power over the years, it faces stiff competition from solar power, which is in high demand in residential areas. Additionally, the increasing interest in offshore wind power installations may affect its growth in the future.

Current Renewable Energy Mix 2022

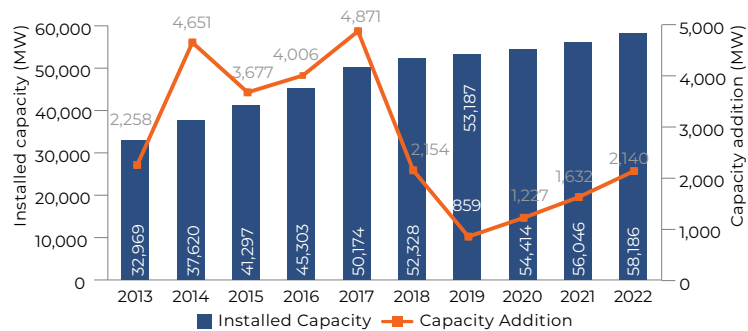


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Germany's onshore wind installed capacity has seen slight growth over the years and has now reached approximately 58GW of cumulative installed capacity in 2022. However, the trend in capacity additions shows wide fluctuations, with the highest increases in 2017, followed by a significant drop to below 1GW in 2019 due to bureaucratic hurdles, plant closures, and supply chain disruptions. Despite these setbacks, the industry has made some progress and has shown marginal but steady growth in annual capacity additions since 2020 (IRENA, 2023). This growth can be attributed to government funding and supportive policies, rising energy costs, and the cost competitiveness of onshore wind technology.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Germany

Demand Drivers

In the wake of the global energy crisis, Germany has decided to speed up its shift towards renewable energy by revising its current targets. In 2023, the European Union introduced Renewable Energy Directives (RED III) which increased the renewable energy expansion targets to 45% from the previous 32.5% by 2030. Germany has already adopted this “New Deal” and raised its renewable energy targets to 45%, with a target of 160GW of onshore wind energy by 2035 (BMWK DE, 2023). Furthermore, in December 2022, Germany announced a simplified permitting process policy for onshore wind projects, in line with the EU’s REPowerEU initiative (IEA, 2023). This policy aims to streamline the permitting process and remove backlogs, potentially speeding up onshore wind builds.

In Q3 2022, the German government announced a new onshore wind law known as “The WindLandG”. The law aims to expand onshore wind capacity by 12GW annually until 2025 and 10GW annually thereafter (Wind Europe, 2023). This policy forms part of the upgraded Easter Package in the EEG2023 scheme and includes a mandate to achieve an 80% share of renewables in Germany’s electricity mix by 2030, and a completely climate-neutral energy system by 2045 (Die Bundesregierung, 2022). The law also simplifies permitting procedures to enable faster project approvals.

The Onshore Wind Power Act is a complementary policy that aims to remove obstacles such as land availability and local opposition. It does so by mandating that 2% of German state sites be reserved for onshore wind generation and by involving local communities through financial participation and approvals. German states that are unwilling or unable

to comply with the law can exchange up to 50% of their designated sites with overachieving states by 2032 (Clean Energy Wire, 2023). This breakthrough has boosted Germany’s onshore wind sector, which has been constrained in recent years by issues such as land availability, project approvals, local opposition, and surging raw material prices.

The government is using a strategically curated auction route to allocate projects. In 2023 alone, the government aims to auction 12.8GW of onshore wind. However, the results of the first auction round held in February 2023 showed that out of 3.2GW of offered tenders, only 1.4GW were awarded, indicating an undersubscribed auction (Wind Europe, 2023). To make the auction more competitive and attract more bids, the German authorities have increased the price ceiling by 90% to EUR 113/MWh (IEA, 2023).

With the Feed-in-Tariffs (FiTs) fading away and auctions gaining popularity for project development, corporate buyers such as StatKraft, Fraport AG and Octopus Energy have shown significant interest in buying energy from the onshore wind energy sector. Some companies are taking the Power Purchase Agreement (PPA) route to enter the energy sector. For instance, in May 2023, Fraport AG announced signing a 5-year PPA with Centrica for a 20MW onshore wind farm in Germany (CENTRICA, 2023). To further facilitate the adoption of merchant wind and PPA, the European Union has urged Germany and its member states to simplify the signing procedure for PPA agreements, which could potentially drive investors’ interest in long-term commitments.

Market Opportunity

Germany’s heavy reliance on Russian gas imports has accelerated the country’s shift towards alternate energy sources, including renewables. In July 2022, the country approved a fund injection of EUR35.4 billion earmarked for 2023, with a total of EUR177.5 billion to expedite this shift (Bloomberg, 2022). In addition, the European Commission approved EUR28 billion in December 2022 under Germany’s renewable support scheme to rapidly expand the use of wind and solar energy (EURO NEWS, 2022). This investment is made under EEG 2023, which offers premiums to renewable energy developers in addition to their market price for selling power, while small developers can benefit from guaranteed electricity prices through FiTs.

Since 2015, Germany’s VRE curtailment has been stabilized, but a lack of interconnection capacity has resulted in production-consumption mismatch and curtailment (IEA, 2023). However, Germany is actively investing in grid connectivity and has already implemented smaller-grid expansions. In May 2023, transmission system operators 50Hertz, Amprion, Tennet, and Transnet unveiled a plan to invest €128.3 billion up to 2045 to integrate more renewables

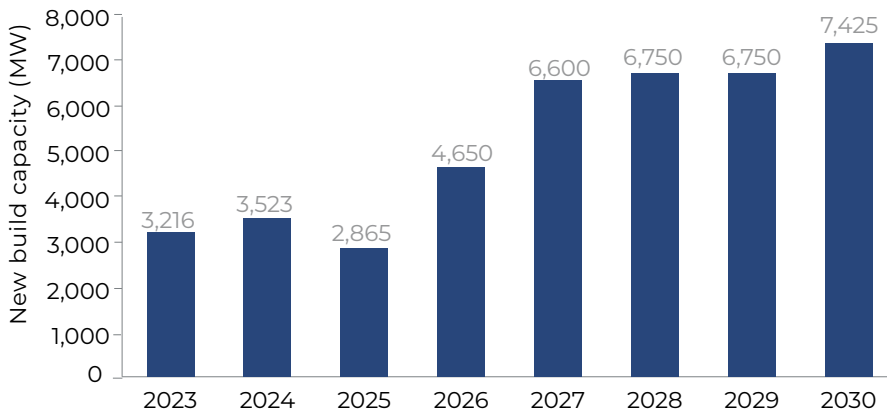
(OIL PRICE, 2023). Similarly, the large-scale energy storage market is expected to double due to rapid expansion targets and “Innovation Tenders” launched for storage plus projects (PV Magazine, 2023). Notably, Copenhagen Infrastructure Partners launched Baldur Power GmbH as its dedicated platform for the development and realization of renewable energy and storage projects in Germany (PV TECH, 2023).

Apart from this, Germany has a significant repowering market, as about 266MW of wind power was decommissioned in 2022 (Wind Europe, 2023). This presents a clear business opportunity for OEMs to meet the demand for new turbines. Companies such as Nordex Group (Repowering-61.8MW and 99MW in 2023) (WIND INSIDER, 2023) and Vestas (Repowering-66MW in 2022) (VESTAS, 2022) have already secured substantial orders to repower Germany’s wind farms. Further, companies like Qualistas Energy, VSB, and Enova have received approval to repower wind farms in 2023 with capacities of 21MW, 105MW, and 87MW, respectively, providing renewed focus to Germany’s repowering market (Qualistas Energy, 2023) (RENEWS, 2023).

Germany

Outlook

Germany's Projected Onshore Wind Builds



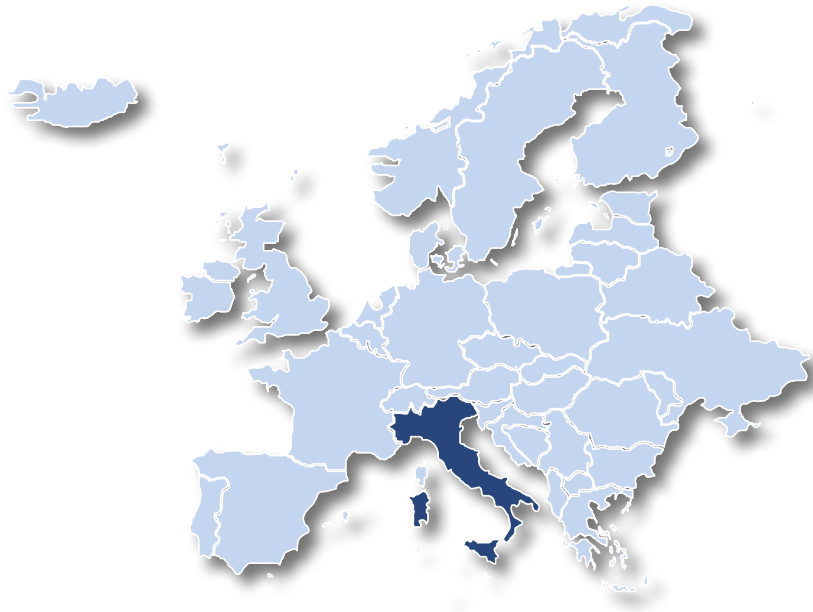
Source: BNEF Global Wind Market Outlook

Germany's onshore wind sector is poised for significant expansion, with a considerable project pipeline and ambitious targets. Efforts to streamline permit processes, simplify regulations, and address labour shortages through immigration reforms demonstrate the country's commitment to renewable energy development.

The challenges, including permit delays, land limitations, and variable energy generation, require comprehensive solutions. Advanced energy storage and grid management can mitigate power shortages caused by wind farm variability, ensuring energy security. Additionally, attracting skilled immigrants and easing distance guidelines for wind project siting are positive steps to address labour shortages and land usage issues.

While these initiatives are in the early stages, they have created a positive market outlook, attracting investor interest and potentially accelerating capacity additions. Germany's commitment to decarbonization, coupled with ongoing reforms and regulations, provides a foundation for the onshore wind sector's growth. Successful implementation of these initiatives can lead to the substantial expansion of Germany's onshore wind capacity, contributing significantly to its renewable energy goals.

Italy



Italy is a significant market for renewable energy in Europe, with a total installed capacity of around 60GW in 2022 (IRENA, 2023). The country mainly relies on renewable hydropower and solar energy, but onshore wind is also gaining traction due to auction-related schemes and revised energy generation and consumption targets. As of 2022, Italy is ranked fifth among European Union countries in terms of cumulative onshore wind installed capacity (Wind Europe, 2023). However, with the strong wind speed in the coastal regions and decreasing wind project costs, there is great potential for Italy to increase its onshore wind activity and climb higher in the rankings.

GDP (Current Prices) USD (2022)	2,012.01bn
GDP Growth Forecast (constant prices) (2023-2027)	0.96%
Currency	Euro
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2022)	59.9GW
Onshore Wind Share in Renewables (2022)	20%
Renewable Energy Target	Targets increasing renewable energy's share in the country's power mix to at least 40% by 2030 and 65% in electricity generation

GDP Source: IMF WEO, S&P and IRENA

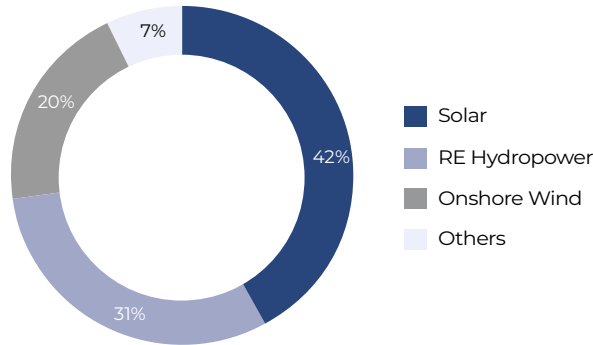
11.7GW Onshore Wind Capacity

✓	Regulatory initiatives for streamlining wind farm permit and approval procedures
✓	Extended auction program under FER1 and FER2 to boost renewable capacity growth between 2023-2026
✓	Funding initiatives for wind turbine manufacturers under the Just Transition Fund (JTF)
✗	Bureaucratic hurdles in the approval process causing lukewarm competition in Italy's renewables auction
✗	Insufficient grid infrastructure with regulatory uncertainty pushing onshore wind downwards

Renewable Energy Mix

Over the past decade, renewable energy has assumed an increasingly significant role in Italy's overall power mix. It currently accounts for 49.2% of the country's total power mix, 11.7% higher than ten years ago. Hydroelectric power and solar energy are the two primary sources of renewable energy in Italy, making up 31% and 42% of the mix, respectively. While onshore wind has been growing more slowly, its cumulative installed capacity has increased from 17.4% in 2012 to 19.6% in 2022 (IRENA, 2023). The renewable energy sector in Italy is poised to benefit from the EU's decarbonization drive and Italy's National Integrated Energy and Climate Plan (PNIEC), which aims to increase wind power capacity and the share of wind power in electricity generation by the end of the decade (Italian Climate Network, 2023).

Current Renewable Energy Mix 2022



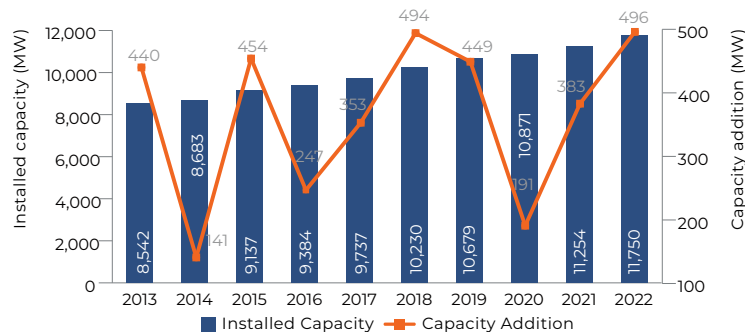
Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Italy's onshore wind installed capacity has been growing at an average rate of 4% annually since 2013, concentrated predominantly in the high-windy region of the south. However, annual capacity additions remained below the 500MW mark, averaging 365MW annually from 2013 to 2022 (IRENA, 2023). The reason for this backlog is the complex permit processes, which have led to repeated undersubscribed auctions (Wind Europe, 2022).

Despite these challenges, the increasing attention of corporate off-takers towards cost-effective onshore wind has resulted in a slight increase in capacity additions, from 383MW in 2021 to 496MW in 2022, the highest in the last nine years (IRENA, 2023). To further accelerate the sector's growth, steps are being taken to streamline the permitting process and reduce the permitting timeline within two years, in line with the REPowerEU plan (IEA, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

In the aftermath of the Russian invasion of Ukraine, the global energy sector was hit hard by soaring gas prices. Italy responded by accelerating its push to reduce heavy dependence on imported gas, with plans for renewables to account for 40% of gross energy consumption in all sectors by 2030. As part of the REPowerEU program, the Italian government announced in 2023 that it aimed to generate two-thirds of its electricity from renewable energy sources by the end of the decade and to revise the target for electricity generation from clean sources from 55% to 65% by 2030 (REUTERS, 2023). To achieve this, the government revised the cumulative installed capacity targets, aiming to attain 28GW of wind energy by 2030, up from the previous mark of 19.3GW, which means that 2.4GW of annual additions will be required by 2030. The government has already begun to phase out coal plants gradually by 2025 and has allocated EUR59.46 billion under the “Green Revolution and Ecological Transition scheme” to develop renewable energy and promote sustainable agriculture, which is expected to boost the expansion of this technology (Italia Domani).

Despite these ambitious plans, Italy has been hampered by a sluggish and complex permitting process. However, in March 2022, Italy began streamlining the permit procedures by bypassing local authorities to license some renewable energy projects (IEA, 2023). To demonstrate the

effectiveness of the streamlining process for large-scale projects, regulators authorized six wind projects in March 2022, with a cumulative capacity of 418MW, indicating progress towards carbon neutrality (Renewables Now, 2022). Currently, more than 2.2GW of onshore wind projects are under permitting pipeline, which, when approved, will lead to a 2x growth in capacity installation (Wind Europe, 2023). Regulators are taking steps to simplify and accelerate permit procedures.

Furthermore, the skyrocketing prices of conventional energy have affected Italy's wholesale electricity rates and material costs. Despite this, demand for large-scale onshore wind has increased among communities and corporations, given its relative cost competitiveness to other renewable technologies. To take advantage of this opportunity, authorities plan to schedule auctions through the FER program, which will auction off the remaining 1.3GW of the technology-neutral scheme in 2023. However, given Italy's surging wind power prices and repetitive undersubscribed auctions, injecting competitive auctions in two-way fixed contracts for difference (CfD) could help maintain wind power's cost-competitiveness. Additionally, Italy plans to introduce the FER 2 auction scheme to boost renewable capacity growth between 2023-2026 (Wind Europe, 2023).

Market Opportunity

The wind turbine manufacturing industry is set to receive a boost from the State aid scheme worth EUR450 million, which is available to EU member states (European Commission, 2023). The scheme aims to speed up investments in all renewable manufacturing equipment, including a significant amount allocated for the development of wind turbines. Additionally, the Just Transition Fund (JTF) has set aside up to EUR 1 billion in funds for climate transition, which also aims to support wind turbine manufacturing and promote the use of renewable energy among SMEs (European Commission, 2022). This presents a clear opportunity for OEMs to produce wind turbines locally.

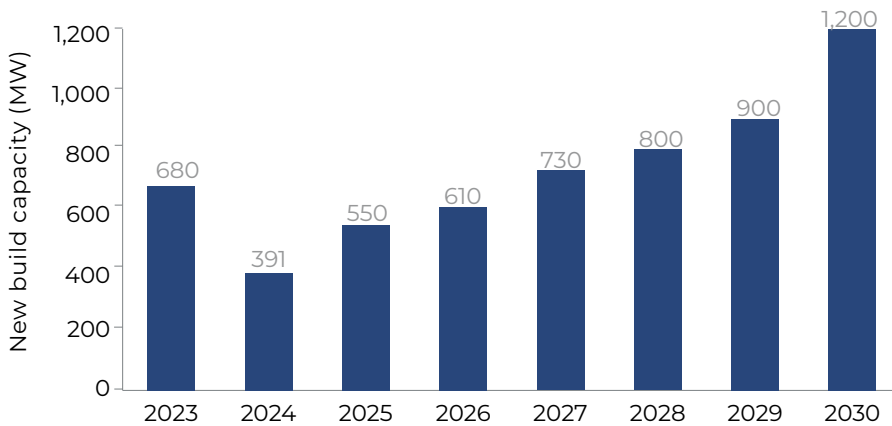
According to a study conducted by ANEV/Studio Elemens, Italy has an extensive market for repowering its legacy turbines, with a potential incremental capacity of 8.5GW by 2030 (ENEL Energia, 2023). Due to land availability constraints and restrictive planning guidelines, the trend is expected to pick up, as seen from recent market transactions. The Vizzini Wind Farm in Sicily, with a capacity of 58.8MW, is set to be repowered and is currently in the permitting stage, with an overall investment of about EUR 54 million (Power Technology, 2023).

Corporate power purchase agreements (PPAs) are gaining momentum in Italy's onshore wind industry. Following the removal of subsidies, unsubsidized projects in the form of PPAs and merchant plants are gaining popularity and are expected to grow further in Italy, as evidenced by the signing of new long-term projects in 2023 (IEA, 2023). One such project was signed in March 2023, where EssilorLuxottica signed a 12-year PPA with ERG for the supply of around 900GWh of wind power between 2023 and 2034. The wind farm is located in Palermo, Italy, and is currently being repowered and is expected to come online in 2023 (ERG EU, 2023). Another merchant-based PPA was signed in May 2023 between Glenmont and Trailstone Group for a wind capacity of 84MW in Italy (RENEWABLES NOW, 2023). However, solely merchant-based projects are still in the early stages and are using the PPA route for guaranteed revenues.

Additionally, foreign renewable energy developers are interested in generating clean energy using onshore wind technology. In July 2023, RWE announced an investment of EUR180 million to build two onshore wind farms with a total capacity of 108MW in the Apulia region of Italy (RWE, 2023). Furthermore, renewable fund manager Glenmont purchased 27MW of onshore wind from OX2 to expand its renewable portfolio in Italy, indicating the growing interest of corporate buyers (OX2, 2023).

Outlook

Italy's Projected Onshore Wind Builds



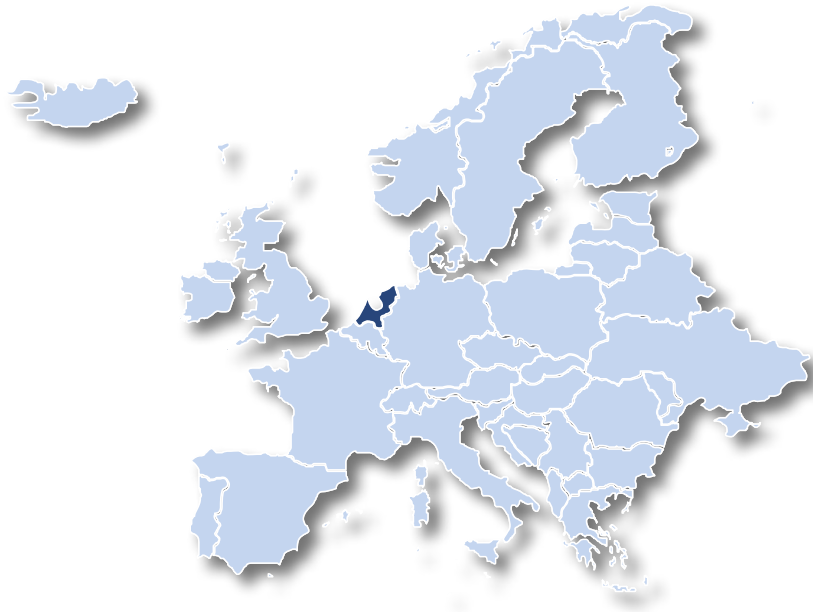
Source: BNEF Global Wind Market Outlook

Italy has the potential to grow its onshore wind industry, but it is currently falling behind in achieving the country's 2030 carbon-neutrality target. According to estimates by BNEF, onshore wind builds are expected to peak at 1.2GW in 2030, with acceleration from 2025 onwards.

The development of Italy's onshore wind energy industry faces several significant obstacles. The major challenge is the lengthy and complex project permitting process, which has affected the number of bids in auctions. In Italy, it takes five years to secure permits for wind projects, compared to the two years mentioned under the RED scheme of the EU. This creates planning risks for wind energy producers. Therefore, recent auctions launched under the FER scheme have produced a series of undersubscribed results, with onshore wind rewarded below 500MW capacity due to bureaucratic bottlenecks in the approval process (Wind Europe, 2023). Such bottlenecks have resulted in lukewarm competition in Italy's renewables auction. Furthermore, regulatory uncertainty and the lack of stringent policy commitments have contributed to the ineffective installation of wind power in the country.

To achieve its carbon-neutrality target by 2030, Italy needs to streamline project approvals and provide funding to support the growth of the onshore wind sector. Additionally, focusing on developing onshore wind in central and northern Italy could lead to the installation of around 2GW of new capacity, taking into account feasibility in those areas (Wind Europe, 2023).

The Netherlands



The Netherlands is committed to achieving carbon neutrality by 2050. To that end, it has set a target to generate 16% of its energy from sustainable sources by 2023 (IRENA, 2023). Meeting this goal will require significant contributions from onshore wind sources. Historically, onshore wind was the leading source of clean energy, with a favourable ecosystem for its development. However, changes in regulatory environments and policies have shifted the focus to solar energy. Despite this shift, the onshore wind industry in the Netherlands still has significant potential, given the existing project pipeline and opportunities for repowering legacy wind farms.

GDP (Current Prices) USD (2022)	993.68bn
GDP Growth Forecast (constant prices) (2023-2027)	1.37%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	32.8GW
Onshore Wind Share in Renewables (2022)	19%
Renewable Energy Target	Targets generating 70% of electricity from renewable sources, primarily solar and wind power by 2030

GDP Source: IMF WEO, S&P and IRENA

6.2GW Onshore Wind Capacity

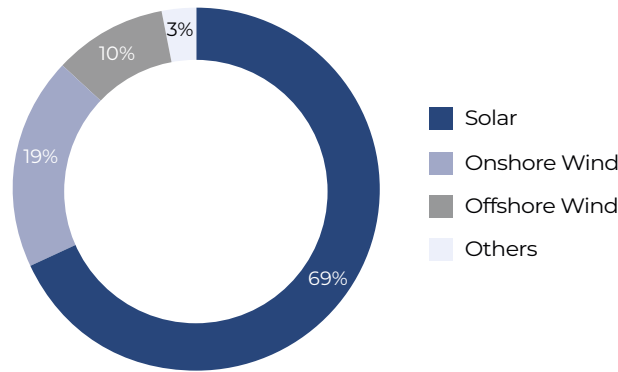
✓	Promotion of renewable development through SDE++ scheme
✓	Low cost of capital for wind farm projects compared to its peers driving investor morale
✗	A decline in annual capacity growth due to delayed-unresolved court proceedings surrounding the Nevele Judgement case
✗	Inefficient grid capacity at the middle and high voltage levels is expected to lead to long delays of the projects

The Netherlands

Renewable Energy Mix

Renewable energy has experienced significant growth in the Netherlands over the past decade. Its share in the country's energy mix has increased five times from 2012 to 2022, making up more than 50% of the total energy mix of 56.3GW, with 32.8GW of energy coming from renewable sources (IRENA, 2023). Despite the impressive growth, the Netherlands still heavily relies on fossil fuels and gas to meet its energy needs.

Current Renewable Energy Mix 2022

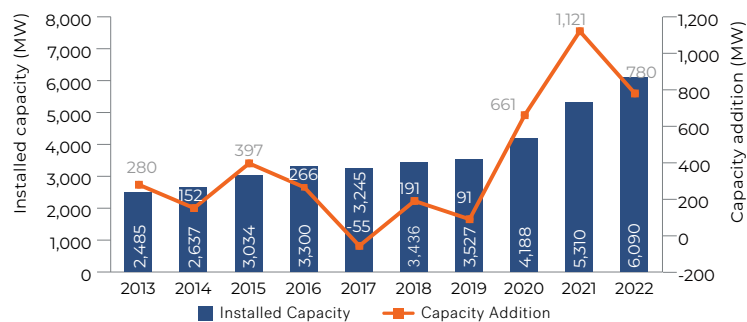


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

In terms of harnessing wind energy on land, the Netherlands has been at the forefront of this movement, as evidenced by the country's installation trends. However, the capacity addition has not been consistent. There were low installations at the beginning of the decade, followed by a sudden increase in 2019, which peaked at 1.1GW in 2021. This increase was due to the release of funds by the EU and the Dutch government to support onshore wind projects, the rise of subsidy-free corporate projects, and the renewables auction. Unfortunately, in 2022, the capacity dropped to 780MW, bringing the cumulative installed capacity to approximately 6.1GW. Nevertheless, this is still impressive compared to the yearly additions between 2013 and 2020 (IRENA, 2023). The setbacks were partly caused by the uncertainty created by the Nevele judgment case in 2021, which enforced a stricter environmental assessment process for wind farm approval (Windpower NL, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

The Netherlands

Demand Drivers

The Netherlands has set ambitious carbon neutrality targets, which were renewed after the election and formation of the new government in 2021. To achieve these targets, the country aims to reduce greenhouse gas emissions by at least 60% by 2030 and 80% by 2040 (Government of the Netherlands). As a result, renewable technologies need to be rapidly deployed to replace conventional sources, such as coal-based power by 2029 and nuclear power by 2033. To speed up the process, stringent efforts are required to accelerate approvals for onshore wind projects, which currently have a lead time of 1.5-2 years. As of 2022, 1.3GW of onshore wind projects are in the permitting stage (Wind Europe, 2023).

The Dutch government has allocated a budget for achieving its energy transition objectives. Among its plans is an

investment of EUR 28 billion towards renewable energy generation (Euro News, 2023). In 2022, the government announced its intention to involve local communities in project approvals and seek their assistance in onshore wind project developments to reduce public opposition. In addition, the government has included new distance rules for onshore wind turbines in its coalition agreement to address noise pollution and health concerns (Norton Rose Fullbright, 2021). To achieve its goal of decarbonizing the energy sector by 2035, the government plans to convert gas power stations to hydrogen, connect wind farms to battery storage, and create offshore solar fields with a total capacity of 3GW. These policies aim to streamline the approval process for onshore wind projects and support energy storage development.

Market Opportunity

The Netherlands has taken significant steps towards climate neutrality policies as gas and coal prices have skyrocketed in Europe. To achieve its targets, the government has changed the SDE+ to SDE++ for Sustainable Energy Production and Climate Transition Stimulation, which grants subsidies to organizations generating renewable energy. The government has allocated a budget of EUR8 billion under the SDE++ scheme in 2023 for renewable energy growth, particularly for solar and wind energy. Onshore wind has significant potential to achieve climate targets and is estimated to add around 835MW of new capacity in 2023 (Shftlimburg Netherlands, 2023).

The government's contributions towards the industry have increased the viability of investments from corporates and energy developers. In addition, the Netherlands and Germany have the lowest cost of capital for utility-scale onshore wind projects, according to IRENA. Corporate buyers have shown interest in investing in the country through the PPA route. For instance, Google has signed a 10-year PPA deal with Eneco to obtain 153MW from two new wind farms, Windpark Fryslân (nearshore-73.5MW) and Windpark Kroningswind (onshore-79.8MW) (DCD, 2023). This indicates that the onshore wind industry in the Netherlands has substantial prospects for unsubsidized projects from corporate buyers.

There is significant potential for progress in the repowering sector, which has already adopted onshore wind energy

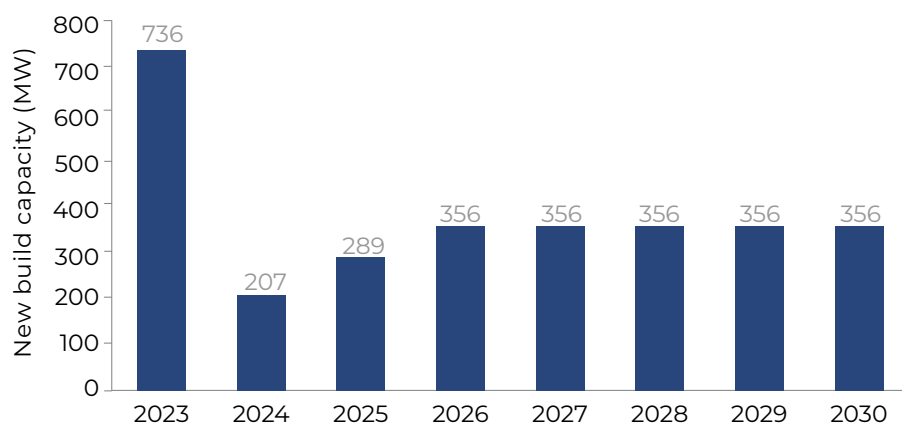
and now has many decommissioned turbines. In the Netherlands alone, around 80MW of wind power has been decommissioned as of 2022, making it the second highest in Europe after Germany (Wind Europe, 2023). This presents a sizable business opportunity for Original Equipment Manufacturers (OEMs) to tap into the repowering segment and replace decommissioned turbines with more advanced technologies that can increase installation capacities.

Integrating renewable installation and repowering capabilities with the electricity grid is becoming increasingly important. Considering the intermittent nature of renewable energy sources, the energy storage market has huge growth potential. Companies have already started to address this, with Roll-Royce announcing in November 2023 that it will build a 60MWh battery-based energy storage system, which is the largest battery storage project in the EU (PV Magazine, 2022). In a similar development, S4 Energy and ABB installed a hybrid battery-flywheel storage facility in the Netherlands in Q4 of 2022. The project features a 10MW battery system and a 3MW flywheel system (PV Magazine, 2022). With growing renewable energy projects and the need for better grid advancements, the potential of the energy storage market has yet to be fully realized, presenting a broad scope for exploration. It is estimated that between 29GW-54GW of energy storage will be required to support flexibility requirements in the country (Energy Institute, 2022).

The Netherlands

Outlook

The Netherlands' Projected Onshore Wind Builds



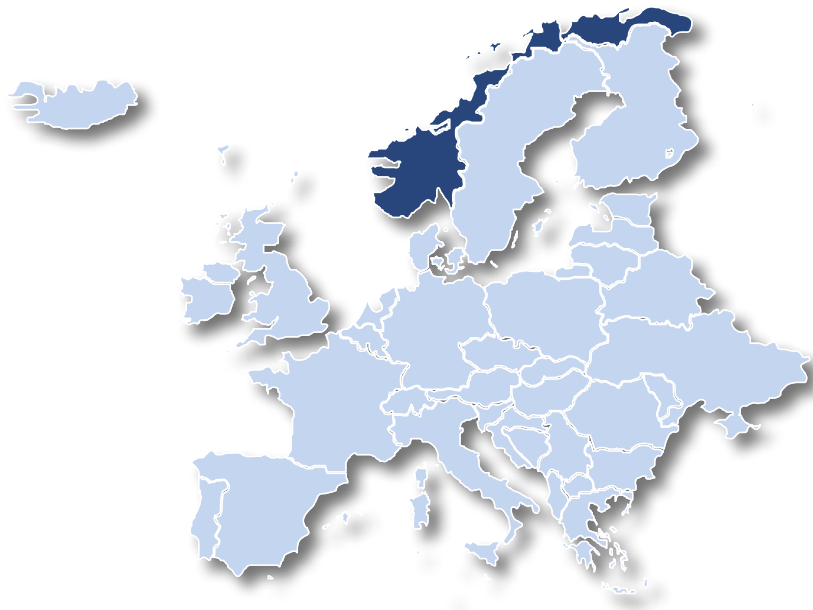
Source: BNEF Global Wind Market Outlook

The onshore wind industry in the Netherlands, despite having ambitious goals and promising development opportunities, is facing regulatory uncertainty and policy changes that are expected to impact its growth prospects. The Netherlands Enterprise Agency's new Onshore Wind Monitor predicts the installation of 835MW onshore wind capacity per year by 2023, but Bloomberg New Energy Finance (BNEF) projects only 736MW to be added this year. After 2023, the capacity addition is expected to stagnate, with an average of 325MW of onshore wind capacity to be added between 2024 and 2030. This could be due to the unresolved court proceedings surrounding the Nevele Judgement case and competition from the offshore wind sector.

The onshore wind industry's overall outlook indicates a lack of growth in new installations due to prolonged disputes. Obstructions include increased policy focus and funding in offshore wind, local opposition, and the complexity of permit procedures. Increased concern about public health and local protests against onshore wind have also reduced its significance in the clean energy mix. In 2022, approximately 1.3TWh of projects were cancelled due to protests, which has impacted the government's goal to reach 35TWh by 2030 (Energy Monitor, 2022). Such logjams are causing project delays and cancellations by local authorities, which poses a serious threat to the onshore wind market.

Despite these challenges, previous policies on onshore wind remain in force, indicating the market's viability. The government aims to increase local inclusion in project approvals, which can further boost the segment. With increased government financing and assistance, such bottlenecks could be overcome to restore the Netherlands' onshore wind market stature.

Norway



Norway is a leading European country in the transition towards becoming an emission-free nation. They have achieved an impressive 98.2% share of renewables in their total power mix (IRENA, 2023). Norway has set targets of reducing greenhouse gas (GHG) emissions by 90%-95% by 2050 and 50%-55% by 2030 from the levels of 1990 (IEA, 2022). The country's renewable energy base is mostly composed of hydropower, followed by onshore wind, and other renewable technologies have a minimal share. Despite this, Norway is one of the most significant locations for wind power generation in Europe, thanks to its abundant wind power resources and advanced turbine technology, which leads to lower development costs (Thommessen, 2022). Therefore, it is essential to increase onshore wind development persistently, with strong policy support, to meet the rising energy demands and achieve the ambitious climate objectives.

GDP (Current Prices) USD (2022)	579.27bn
GDP Growth Forecast (constant prices) (2023-2027)	1.87%
Currency	Norwegian Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	39.7GW
Onshore Wind Share in Renewables (2022)	13%
Renewable Energy Target	Ambitious targets to eliminate 90%-95% of GHG by 2050 and 50%-55% by 2030 from the levels of 1990

GDP Source: IMF WEO, S&P and IRENA

5.1GW Onshore Wind Capacity

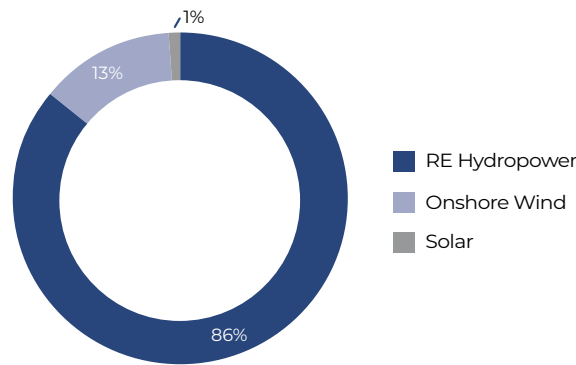
✓	High wind power potential hedges the risk of power generation variability and poses downward pressure on wholesale power prices
✓	The Norwegian government's decision to revoke wind farm bans acted as a significant driver for the industry
✗	Regulatory uncertainty caused by the Resource Rent Tax and Production Tax
✗	Increased public opposition to wind projects makes solar PV and offshore wind technology an attractive option

Norway

Renewable Energy Mix

Norway has made significant strides in achieving a carbon-neutral energy base, with hydropower accounting for 86% of the renewable energy mix in 2022. Onshore wind power is the second-largest contributor, making up 13% of the overall installed base of approximately 40GW in 2022 (IRENA, 2023). This is a notable increase from its 2% share in 2013 and is the result of climate change plans and strict targets. Although the sector has the potential to expand to twice its current capacity, the development of land-based wind power is hindered by policies that prioritize public welfare and offshore wind deployment. Despite these challenges, the sector's growth is expected to continue due to licensing procedure amendments that involve public participation.

Current Renewable Energy Mix 2022

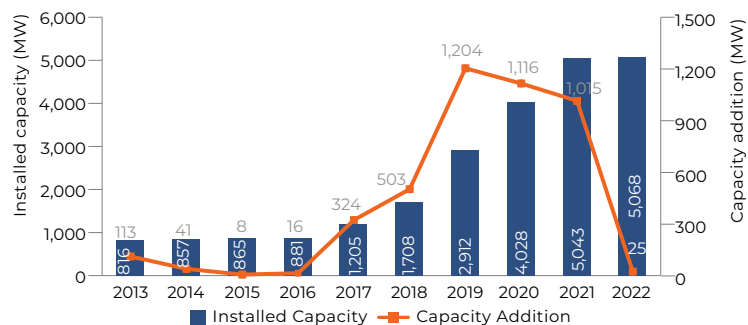


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

In the last decade, capacity addition for onshore wind in Norway has been uneven. There was a stagnant period during the first half of the decade, but from 2017, capacity addition started to pick up. Unfortunately, it dropped back to the earlier level in 2022 due to some projects stagnating because of controversial protests related to the Saami community (Time, 2023). Additionally, in 2022, the announcement of the Production Tax and the resource rent tax on onshore wind power signalled a negative outlook that paused new project approvals (Government Norway, 2023). However, recognizing the importance of onshore wind farms in the country's power sector, Norway's government is working to streamline licensing and involve local communities to ease opposition.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Norway

Demand Drivers

Despite being a major producer of oil and gas, Norway is strongly committed to achieving its decarbonization goals and reducing its reliance on traditional energy sources. According to Norway's grid operator's predictions, there will be a 60% increase in energy consumption demand from the current 140TWh, necessitating increased capacity from onshore wind (Reuters, 2023). Therefore, Norway has agreed to the targets set by the European Union's REPowerEU and Fit-for-55 initiatives. One of these targets is Norway's 2030 goal of achieving 12GW of wind power (Wind Europe, 2023). The Fit-for-55 scheme also includes the renewal of existing carbon emission plans. Despite the focus on offshore wind development, onshore wind's cost competitiveness and price differentials amongst available technologies make it an attractive option for resource development. This would benefit consumers by lowering bills. Regulators have already announced that they will begin approving projects for land-based wind power with the municipality's consent to alleviate restrictions.

The lifting of the 2019 ban on new onshore wind farms has significantly boosted the onshore wind sector recently. In April 2022, the Norwegian government announced plans to revoke the prohibition and resume licensing for sites that have the approval of locals to increase regional involvement (Reuters, 2022). The government intends to nullify protests by accommodating reindeer herding with onshore wind power to ensure local buy-in for project development. The primary objective behind lifting the ban and promoting coexistence is to bridge the demand-supply gap, reduce reliance on conventional sources, and mitigate planning risks for developers and investors. As of 2022, around 2.2GW of onshore wind projects are in the permitting pipeline stage and approving them in line with community standards could potentially increase the total installed base of onshore wind power (Wind Europe, 2023).

Market Opportunity

Norway is well-positioned for wind power due to its advantageous geography and resource-rich positioning. However, accommodating windy weather conditions poses a risk to the generation variability of power producers. In January 2022, wind speeds in the southern Norwegian mountains reached 40.8m/s, causing the output to reach approximately 21GW. This triggered wholesale power prices to decline by 2x from the existing EUR96.29/MWh, making wind power more competitive than other technologies (Reuters, 2022). This creates opportunities for both onshore wind project developers and grid managers, as effective grid management is crucial for high wind power.

The Norwegian grid operator, Statnett, projects that annual onshore wind generation will increase by 10TWh from current levels by 2030. To handle this excess capacity, the company plans to install a 420kV grid nationwide with a projected investment of NOK100 billion by 2030 (IEA, 2022). Increased investment in grid expansion, along with strong networks and interconnectivity with Nordic countries, can enhance the financial viability of wind projects and attract more investors.

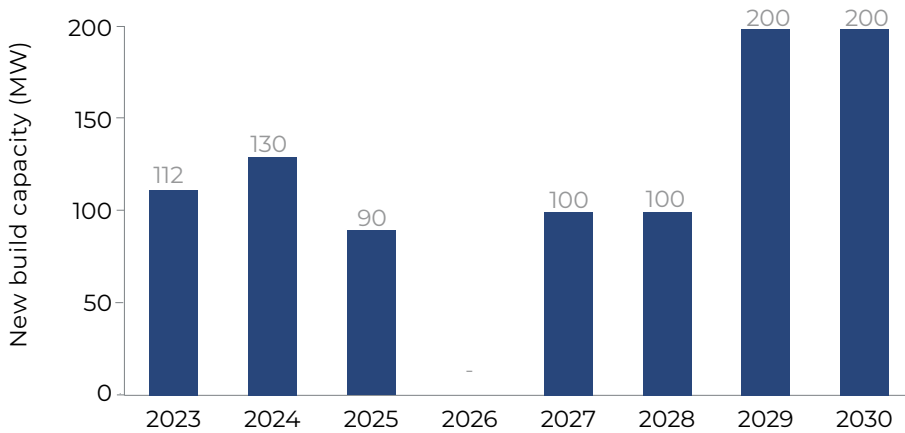
Over the years, corporate buyers and energy investors have shown much interest in Norway's renewable energy segment through Power Purchase Agreements (PPA). One recent development in December 2022 is the construction of a 300MW onshore wind farm by aluminium smelter Hydro, with project developer Zephyr and power company Eviny, in the western region with an investment of NOK3-NOK4 billion (EnergyWatch, 2022) (Reuters, 2022). Additionally, Statkraft announced in 2023 that it will invest about a billion Kroner in the Norwegian onshore wind industry to construct an onshore wind farm in Norway's southwestern county of Rogaland (EnergyWatch, 2023). Hafslund and Eidsiva, two Norwegian companies, have also announced their plans to develop onshore wind projects in Eastern Norway with the support of 28 municipalities (Renews, 2023).

Although merchant projects are still in their early stages, the competitive onshore wind power prices have helped project developers obtain financing support, making a case for more merchant exposure. Norway's robust grid connectivity and infrastructure make it an attractive proposition for project developers, increasing the potential for expanding merchant power and corporate PPA markets.

Norway

Outlook

Norway's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

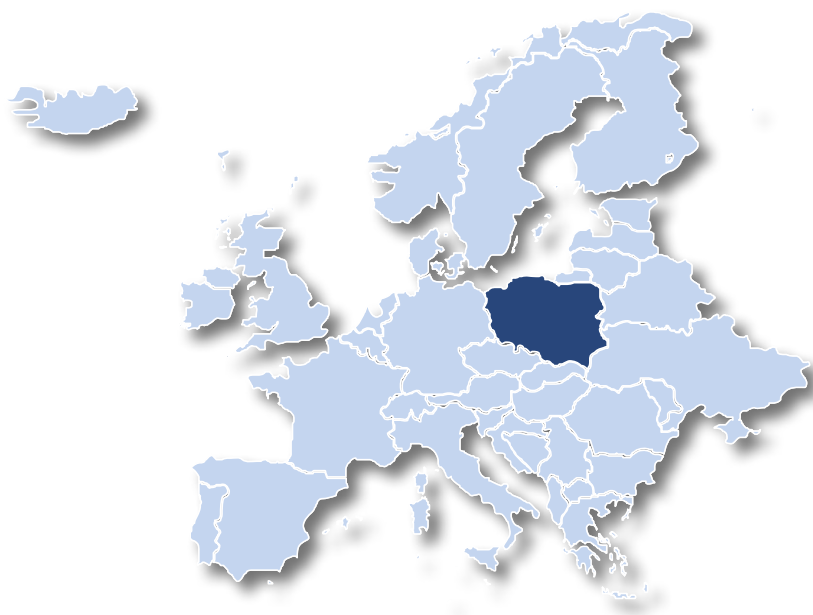
The expansion of the onshore wind industry in Norway is hindered by legislative hurdles, local adversaries, and untapped potential. According to estimates by BNEF, capacity additions are expected to range between 100MW and 200MW, with no new additions expected in 2026. However, this situation is likely to change given the postponement of the resource rent tax and renewal of licensing to wind farms in 2021 (Government Norway, 2023).

To meet the growing energy demand and European standards of decarbonization, the Norwegian government has postponed the resource rent tax to motivate wind power developers. Additionally, in 2022, it streamlined licensing procedures for developers' acceptance of wind power (IEA, 2023). However, to attract local authorities and municipalities, it introduced a Production Tax in 2022, which affected developers' interest in wind power, leading to lower capacity additions in 2022 (Government Norway, 2023). Moreover, concerns following the Saami community's protest can result in the closing of two wind farms in Norway, hampering the installed base.

Furthermore, the increasing interest in offshore and floating wind technologies is shifting policy focus, resources, and funding to these areas, thereby obstructing onshore wind development. Thus, despite having a significant capability, the expansion of Norway's onshore wind industry is expected to be impeded in the coming years.

Over the next decade, the Norwegian land-based wind industry will likely observe steady progression as demand for power consumption surges and the pressure of carbon neutrality rises. Although certain headwinds, such as stiff competition from offshore technology and land restrictions, stymie the expansionary phase, declining wind power costs will likely ebb their impact through continued demand from corporates and utilities.

Poland



Poland has made significant progress in its renewable energy sector in recent years. According to IRENA, the country has seen a 29% increase in its cumulative renewable installed capacity between 2021 and 2022, one of the highest in the last decade. This is due to the installation of about 4.8GW of solar PV and onshore wind, which has taken the renewable installed capacity to 21GW as of 2022 (IRENA, 2023). These positive developments are the result of supportive legislative policies and infrastructural advancements.

The ambitious targets set forth under the 2040 Energy Policy of Poland to phase out coal and reduce greenhouse gas emissions have further encouraged the transition to a renewable-based energy system (ITA, 2019). The onshore wind sector, in particular, has the potential to contribute substantially to this transition thanks to recent amendments to the 10H distance rule and the various incentives and supports offered by the Polish government to developers and investors.

GDP (Current Prices) USD (2022)	688.30bn
GDP Growth Forecast (constant prices) (2023-2027)	2.60%
Currency	PLN
Country Credit Rating (S&P)	A-
Renewable Energy capacity (2022)	21.2GW
Onshore Wind Share in Renewables (2022)	38%
Renewable Energy Target	Targets to include 74% of zero-emissions sources for the installed capacity by 2040 and cover around 73% of Poland's electricity demand

GDP Source: IMF WEO, S&P and IRENA

8.0GW Onshore Wind Capacity

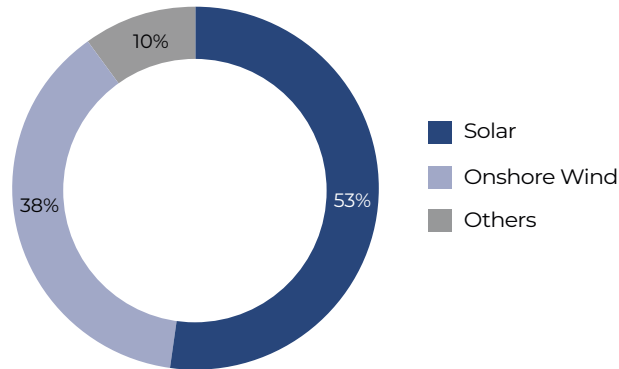
✓	The Government's steps to amend the 10H turbine distance rule to 700 meters
✓	Regulatory initiatives to extend the two-way CfD auction from 2021 to 2027 acted as a significant catalyst
✗	Increased competition from solar PV and offshore with specific policies solely curated for the two technologies
✗	Non-withdrawal of about 99% land restrictions in the advent of streamlining 10H distance rules reflects uncertainty

Poland

Renewable Energy Mix

Over the past ten years, onshore wind has been the primary source of renewable energy in Poland. However, in 2022, solar PV surpassed onshore wind by adding more annual capacity (a 12% increase compared to the previous year), which led to solar PV becoming the leading renewable energy source (IRENA, 2023). Due to the restrictions imposed by the turbine distance rule and the growing significance of solar PV and offshore projects, onshore wind's share in the renewable energy mix decreased by 7% in 2022. Despite this, onshore wind added over 1GW of new capacity, bringing its cumulative capacity to about 8GW. In contrast, offshore wind did not have any presence but is expected to grow between 2023 and 2027, with a projected capacity of 2GW. The government plans to hold four competitive support auctions and aims to achieve a target of 12GW by 2040. The Polish authorities also have plans to hold a series of auctions between 2023 and 2027 to boost onshore wind capacity and have revamped distancing rules to help it regain its lost stature (Recharge News, 2023).

Current Renewable Energy Mix 2022

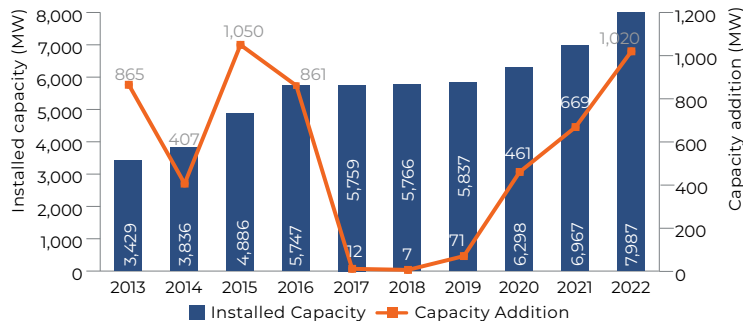


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Onshore wind capacity additions have risen after a historic drop during 2017-2018. In 2022, approximately 1GW of new capacity was installed, the highest in the past six years (IRENA, 2023). This is mainly due to the auctions scheduled by the government and positive investments from public and private institutions. It is worth noting that recent onshore wind installations have remained insignificant due to legislation restrictions on land ineligibility for wind farms, alongside competition from solar PV and offshore wind development. Nonetheless, the industry can rebound following the forecasted 2.2GW of new installations to be commissioned between 2023-2027 (Wind Europe, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

Poland has set stringent targets for decarbonisation in its Energy Policy until 2030 and Energy Policy 2040. The policies include a commitment to reduce greenhouse gas emissions, eliminate conventional energy sources, and increase the share of renewables in final electricity consumption to at least 23% by 2030 (IEA, 2021). However, Poland's onshore wind industry has struggled due to the 2016 10H distance rule for turbine installation. This rule has been liberalized, reducing the distance to 700 meters and allowing developers to access 4-5% more of Poland's land for onshore wind (Wind Europe, 2023). This change will help Poland achieve its target of 20GW of installed wind capacity by 2040.

The 2016 Renewable Energy Act of Poland, amended in 2018, established an auction system for renewable development (IEA, 2016). Between 2016 and 2022, the auction system helped award about 5.34GW to onshore wind, following a two-way CfD scheme (Energy Regulatory Office, 2023). The Polish government has extended the scheme from 2021 to 2027 to facilitate the installation of large-scale onshore wind capacities and ensure a quicker transition. The government plans to auction 13GW of renewables between 2023 and 2027, with 3GW allocated for onshore wind and the maximum allocation for solar PV. The government has an estimated budget of PLN142.38 billion for auctions to be held in the next four years, creating a positive outlook for developers and investors (PV Magazine, 2022).

Market Opportunity

The Polish renewable sector's long-term growth potential is evident from the increase in investment activity. In June 2022, the European Commission approved EUR35.4 billion for the Polish National Recovery and Resilience Plan (NRRP) to support green and digital transition for dealing with the aftermath of the pandemic (European Commission, 2022). Additionally, the European Investment Bank (EIB) granted a Green Loan of PLN304 million for the construction and maintenance of six onshore wind farms in Poland with a total nominal capacity of 150MW in Q12022 (IEA, 2022). Iberdrola, KGAL Investment, Octopus Renewables, and INKA group are some of the corporates that are ramping up their investment activities to increase Poland's onshore wind capacity figures in their sustainable portfolio.

Apart from funds, contracts for difference (CfD) have long been deployed as an opportunity and support for developers in the Polish onshore wind industry (Energy Regulatory Office, 2023). However, the price differentials between conventional power and renewable energy generation have recently caught the attention of corporations and energy developers.

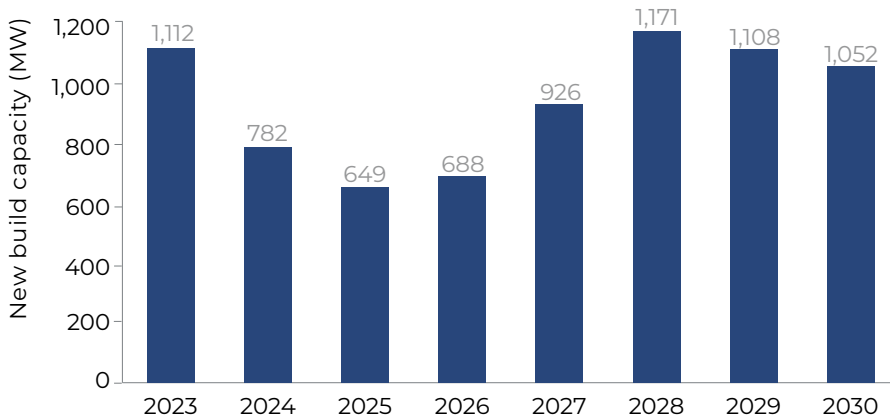
In February 2023, UK-based energy investment firm Renewable Power Capital (RPC) announced the construction

of a 1GW onshore wind farm in a joint venture with Polish renewable energy company Tundra Advisory (Power Technology, 2023). At the end of 2022, Eolus mentioned acquiring an 86MW wind farm in Poland, expected to be commissioned by 2028 (Renewable Energy Magazine, 2022). Corporate PPAs are also expanding in Poland without subsidies since its first-ever PPA in 2018. The segment has significantly grown with recent deals announced and signed by Qair Polska, RWE, and Ecoz in 2023.

Post the liberalisation of old laws and the scheduling of new auctions, large-scale projects are expected to show significant traction. In this regard, the energy storage industry has substantial opportunities as storage utilities will scale up. In July 2022, the Polish State-owned power company PGE mentioned constructing an 800MWh BESS in Poland by 2030 (Energy Storage News, 2022). At the end of 2022, Claritas and system integrator Hynfra Energy Storage (HES) signed a framework agreement to install 500MW of utility-scale BESS in Poland to assist grid management (Energy Storage News, 2022). Therefore, by balancing the effects of intermittent generation, the increase in energy storage capacity is anticipated to promote the expansion of onshore wind and play a critical role in balancing a grid that must adapt to intermittent output.

Outlook

Poland's Projected Onshore Wind Builds



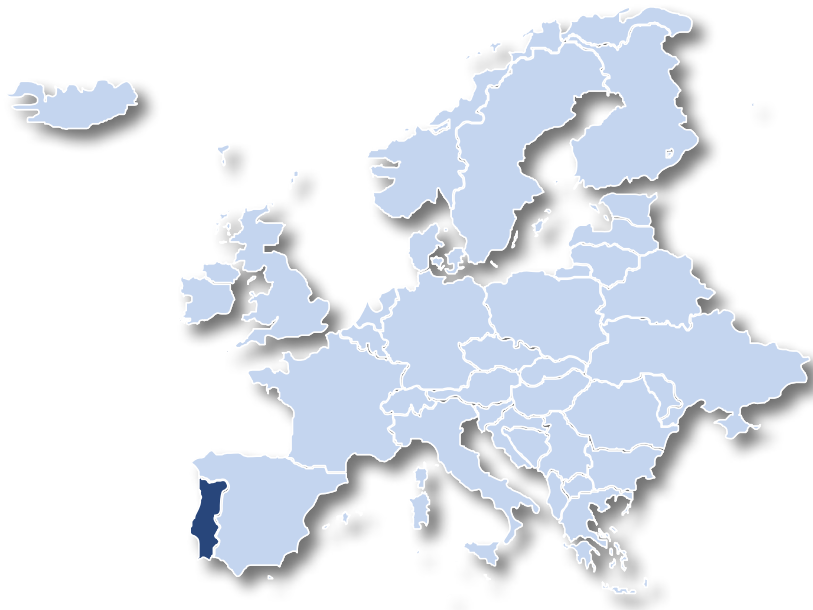
Source: BNEF Global Wind Market Outlook

According to BNEF's projections, onshore wind installation will remain below 1GW between 2024-2027. However, this forecast may no longer be valid as it was made before the announcement of the easing of restrictions on wind farms and the scheduling of new wind auctions. The Polish Wind Energy Association's target of reaching 20GW of onshore wind capacity by 2030 requires elevated contributions of about 1.7GW annual capacity additions (PSEW, 2022).

Poland's onshore wind sector has several challenges affecting its expansion. Following the exemption of excise duty on coal and gas for residential usage, Poland's non-renewable industry began to dominate its energy sector with a 63% share. Renewable contributions are insufficient against the rising energy demand, leading to the resurgence of coal-fired generation and the expansion of nuclear energy. Concurrently, solar PV and offshore wind have become stiff competitors as several policies and funds are solely developed to support these segments. This is evident from the competitive auctions designed to reach a target of 18GW of offshore wind by 2040 (Recharge News, 2023).

Despite these challenges, Poland's land-based wind has a strong outlook as the merchant and PPA segment flourishes in the advent of declining costs for onshore wind development compared to conventional sources.

Portugal



Portugal has become a leading provider of renewable energy in Europe, with 72% of its energy sourced from renewable technologies as of 2022 (IRENA, 2023). The recent Russian invasion of Ukraine caused energy prices to rise, which further emphasized the need for Portugal to decarbonize and become self-sufficient. The country's clean energy mix mainly comprises RE hydropower, followed by onshore wind and solar, accounting for 95% of the total renewable energy production that helped reduce its dependence on energy imports to below 80%. To speed up the process, the Portuguese government has advanced the 80% electricity consumption target from 2030 to 2026 (Electrek, 2022). Currently, wind energy accounts for about 26% of electricity consumption, which is primarily generated from onshore wind (Wind Europe, 2023). Portugal's onshore wind industry has recently made significant progress by implementing strict capacity targets, supportive funds, and well-structured policy initiatives.

GDP (Current Prices) USD (2022)	252.38bn
GDP Growth Forecast (constant prices) (2023-2027)	1.72%
Currency	Euro
Country Credit Rating (S&P)	BBB+
Renewable Energy capacity (2022)	16.3GW
Onshore Wind Share in Renewables (2022)	33%
Renewable Energy Target	Aims to generate 80% of its annual electricity usage from renewable sources by 2026 and carbon neutrality by 2045

GDP Source: IMF WEO, S&P and IRENA

5.4GW Onshore Wind Capacity

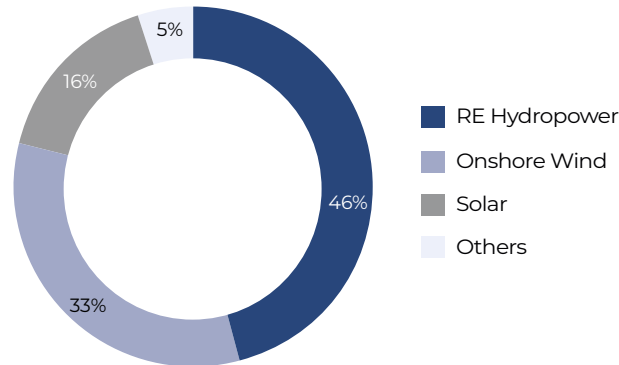
✓	Advancing carbon neutrality and electricity generation targets by 5 and 4 years respectively, for rapid transition
✓	Released laws to streamline permit and approval process for onshore wind, repowering projects and hybrid projects
✗	A major shift in policy designs and funding initiatives for solar PV and offshore wind
✗	Increased local opposition and land availability constraints caused logjams in onshore wind deployment

Portugal

Renewable Energy Mix

Over the past ten years, the proportion of renewable energy sources used in power generation has increased by 16.5%. Among these renewable sources, hydropower has been the largest contributor, accounting for 46% of the total in 2022. Onshore wind comes in second with a 33% share, followed by solar PV with 16%. However, the proportion of onshore wind has declined by 7% from 2012 to 2022 (IRENA, 2023). This is due to problems with inefficient grid infrastructure, land planning, and the delayed permitting process. Additionally, the increased deployment of solar PV has contributed to this decline. On the other hand, offshore wind has been gaining momentum in recent years and is expected to grow further.

Current Renewable Energy Mix 2022

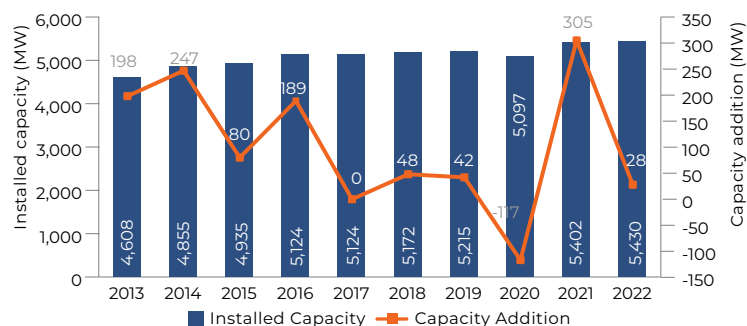


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Over the last decade, there has been a significant fluctuation in the yearly addition of onshore wind power capacity. The pandemic caused record drops in capacity additions, but in 2021, the momentum was regained and reached 305MW, which is one of the highest in the last nine years (IRENA, 2023). This was made possible by The Economic and Social Stabilisation Program, with a budget of EUR4.5 million, which was launched in H2'2020 (IISD, 2020). However, in 2022, annual capacity additions amounted to only 28MW as renewable policies are now mostly focused on the development of solar PV. The annual increase in installed solar capacity between 2021-2022 was 54% (IRENA, 2023). Additionally, auctions and policy attention were diverted away from onshore wind due to the shift in focus towards offshore wind capacity. Despite these challenges, the onshore wind sector is expected to grow as permit procedures have been simplified under Decree-Law No. 30-A/2022, and with prices becoming more affordable, the sector has become an attractive investment option (Chambers and Partners, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Portugal

Demand Drivers

Portugal has historically had a supportive policy framework for onshore wind energy. However, legislative changes and increased competition have limited its expansion capabilities. To address this, Portugal has revised its carbon neutrality targets for a rapid transition. In 2022, it announced that it would renew its 80% clean energy in electricity production target from 2030 to 2026 (Electrek, 2022). Additionally, it plans to amend its 'Roadmap to Carbon Neutrality 2050' to 2045, five years ahead of the initial target (EURACTIV, 2022).

To achieve its goals, Portugal aims to reach 10.4GW of onshore wind by 2030, which is an increase from its previous estimate of 9GW (Recharge News, 2023). This translates to approximately 715MW of annual capacity additions. To accomplish this, the Portuguese government plans to mobilize €25 billion in funds over the next ten years for renewable capacity expansion. Moreover, it aims to attract another €75 billion in investments (Recharge News, 2023). While the funding is not specifically designated for onshore wind, it has a significant potential for development compared to other technologies.

The process of securing environmental licensing for onshore wind farms is complex, which is hindering the expansion of onshore wind energy. To address this issue, the Portuguese government introduced Decree-Law No. 30-A/2022 at the beginning of 2022. This law has simplified some licensing steps, resulting in increased production (Lexology, 2022). It is a temporary measure that allows power plants to operate without an operation license or certificate as long as the grid operator ensures the grid injection conditions. Another change is that Portugal no longer requires an Environmental Impact Assessment (EIA) for wind stations located more than 2 km apart, which has helped to speed up permit procedures. Furthermore, the government has announced another plan, Decree-Law No. 15/2022, which aims to optimize repowering wind farms and hybridizing projects (Lexology, 2022). This streamlined permitting process will focus on solar-wind hybrid projects because of their potential to overcome land availability issues.

The 2026 binding renewable target will drive the future deployment of onshore wind energy, as solar PV and offshore wind alone will not be enough to meet the requirement, even though they have received more policy attention than onshore wind in recent times.

Market Opportunity

Portugal offers significant economic advantages for investors and foreign energy companies to operate without market and trade restrictions. The government has promoted a market for renewable energy, which attracts foreign institutions and corporations for investment. In early 2021, the European Investment Bank (EIB) and BPI provided EDP Renováveis with €112 million in funds to build and operate two wind farms in Portugal with a total capacity of 125MW (European Commission, 2021). In September 2023, the European Commission enabled funds of €22.2 billion for a recovery and resilience plan, out of which about 41.2% is allocated to attain climate goals to improve energy efficiency through the expansion of renewables, including cost-effective onshore wind (European Commission, 2023).

Apart from regulatory and lending institutions, companies receive assistance from international lenders to raise funds to develop projects in advantageous locations to meet their decarbonization targets. For example, Aquila Clean Energy raised €1 billion from EIB under InvestEU to develop 50 onshore wind and solar PV projects in Portugal and Spain. The total investment accounts for €2 billion with a total capacity of 2.6GW (European Commission, 2022). This indicates an increased presence of international energy producers in the Portuguese renewable sector, joining hands to bridge the investment gap for renewable project expansion. Furthermore, after streamlining licensing

procedures, hybrid (Solar-Wind) projects are gaining significant traction to generate larger volumes in limited land. To this, an investment of €600 million in a hybrid project was announced in 2022 by Endesa Generación Portugal, combining solar, wind, green hydrogen and a 168.6MW battery energy storage system (BESS) as a replacement for Portugal's last coal power station (Energy Storage News, 2022).

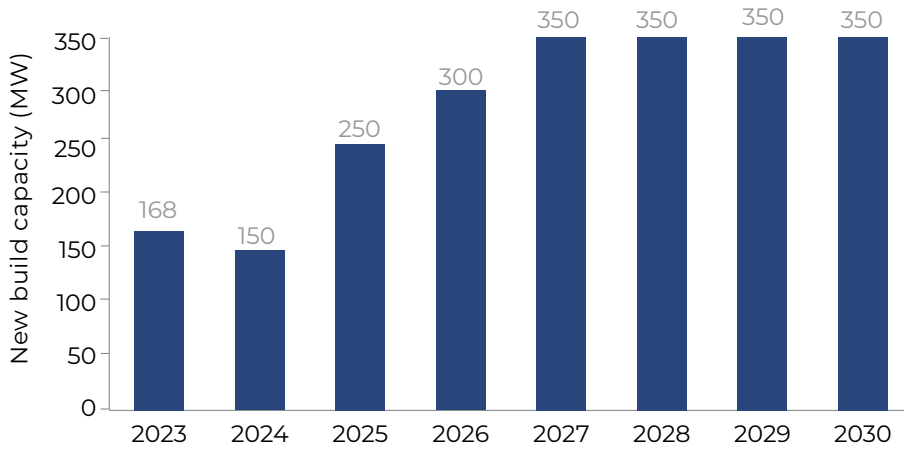
Attention is also being given to improving the grid infrastructure and transmission networks to accommodate the increased capacity building of renewable projects. The EIB has already announced lending €450 million to a Portugal-based energy company, Redes Energéticas Nacionais (REN), to upgrade the transmission network (EIB, 2023). This aims to enhance efficiency and modernize the electricity transmission to handle the deployment of 4.2GW of extra capacity by 2026. Such initiatives can raise the penetration of renewables in Portugal.

Another segment that has assisted in the growth of renewables in Portugal is the PPA (power purchase agreement) and merchant power projects. Although the PPA market has recently been skewed towards solar PV and offshore wind, the onshore wind sector has the potential to take off and show a strong presence on the back of declining project costs.

Portugal

Outlook

Portugal's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

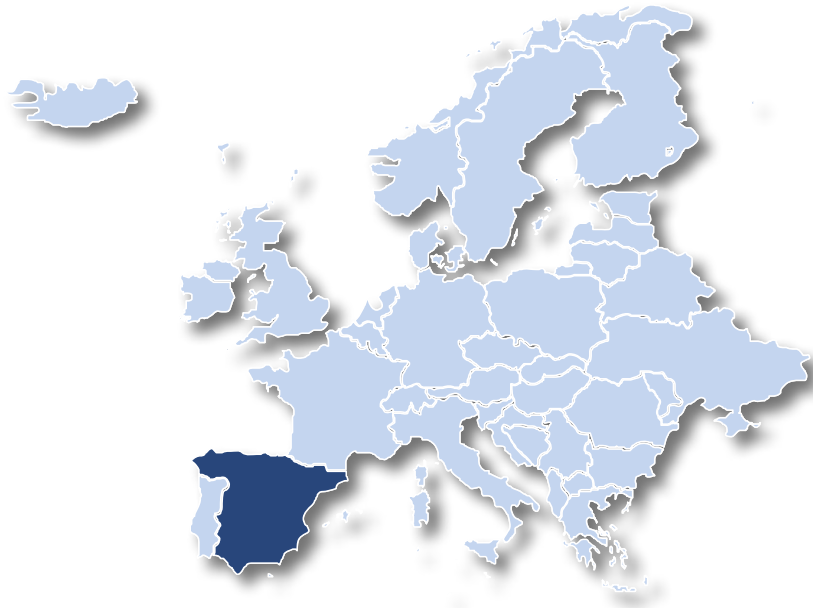
The potential expansion of Portugal's onshore wind sector is being hindered by competition from other renewable technologies. According to BNEF predictions, annual installations of onshore wind will remain below 500MW and will not make significant progress until 2030.

Significant funds and initiatives are being directed towards solar energy, such as the "Vale Eficiência" program (an efficiency voucher program) and the "Apoio Edifícios + Sustentáveis" (Support + Sustainable Buildings program) designed to support solar PV installations (Fundo Ambiental Portugal, 2023). Similarly, 1GW of auctions are designated for offshore wind in Portugal (Renewables Now, 2023). Such initiatives are attracting robust financing for solar park construction and the expansion of offshore and floating wind farms, indicating a clear shift of resources and capital away from onshore wind. Furthermore, opposition from local communities due to the ecological footprint and the health impact of wind farms adds to the challenges in granting licenses for large-scale wind projects.

To tackle these challenges, the Portuguese government has streamlined the licensing procedures. Additionally, the government has allowed grid expansion through tenders, resulting in investments in the upgrading of grid transmission and providing a positive outlook for energy developers. Further, the growth prospects for hybrid solar are expected to provide a turnaround for the industry as the government proposes hybridization initiatives. Another notable market segment is repowering, as Portugal has the oldest wind fleets, which could be repowered, signalling an opportunity for OEMs.

Regardless of the headwinds, the onshore wind sector can increase its capacity by addressing some of the prevailing obstacles through regulatory reforms to assert the technology's substantial role in the decarbonization of the Portuguese power system.

Spain



Spain is one of Europe's forerunners in renewable energy, with 68GW of cumulative installed base, accounting for 58.2% of the total electricity mix (IRENA, 2023). Onshore wind leads among all renewable technologies (ranks second in Europe after Germany), as market-led auctions and investments assist in developing a steady pipeline of projects. In association, the Spanish government is committed to achieving 160GW of installed renewable capacity by 2030 with 59GW of onshore wind (Recharge News, 2023). To move further, the government has initiated plans to ease the convoluted permitting process by streamlining environmental approvals. It also changed grid access rules for hybrid (solar-wind) projects to secure permission quickly and expedite project development (Rodl & Partner, 2022).

GDP (Current Prices) USD (2022)	1,400.52bn
GDP Growth Forecast (constant prices) (2023-2027)	1.78%
Currency	Euro
Country Credit Rating (S&P)	A
Renewable Energy capacity (2022)	67.9GW
Onshore Wind Share in Renewables (2022)	43%
Renewable Energy Target	Achieve 74% of electricity supply from renewable sources by 2030 with 160GW of installed renewable capacity

GDP Source: IMF WEO, S&P and IRENA

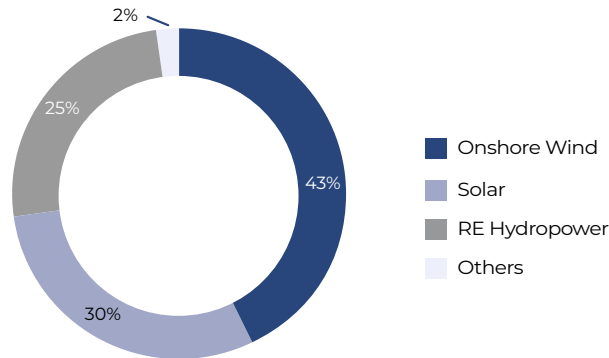
29.3GW Onshore Wind Capacity

✓	Market-led auctions and ambitious targets to decarbonise the electricity grid laid foundation for steady project pipeline
✓	Plans to streamline permitting under the Royal Decree-Law 6/2022 are anticipated to drive the market
✗	Largely undersubscribed renewable auction attributable to the failure to deal with increased costs of new renewable energy projects
✗	Lack of governmental support in the advent of global inflation and supply chain bottlenecks

Renewable Energy Mix

In 2022, onshore wind generated 43% of the total renewable energy generation. Contrariwise, offshore wind's share is still negligible and has stagnated at 5MW of cumulative installed capacity since 2013 (IRENA, 2023). Although solar PV witnessed rapid evolution, with more than 3x growth in the last decade, the onshore wind segment has a preceding edge against its competitors. In 2022, about 25% of the total electricity demand was covered by onshore wind, with more auctions in line, supported by other government initiatives, Spanish onshore wind is expected to expand in the coming years (Wind Europe, 2023).

Current Renewable Energy Mix 2022

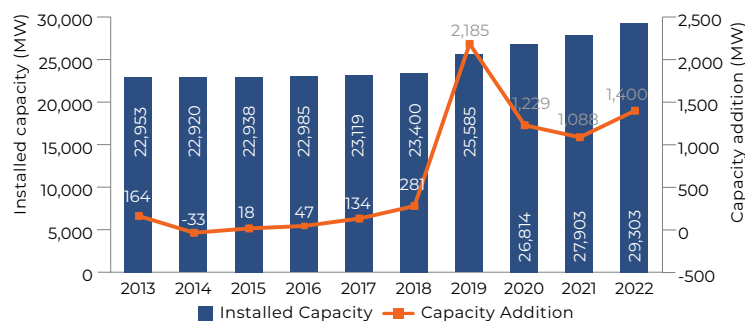


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Although the Spanish onshore wind industry is one of the strongest in Europe, its installed capacity growth indicated a sluggish trend during the first half of the last decade. Between 2013 and 2018, capacity additions were minimal, with a stagnation perceived in cumulative installed capacity. Post-2019, a spike in capacity additions is recorded owing to the commission of projects bid earlier, which dropped in 2020 and beyond due to permit delays and pandemic-related disruptions. However, a spike in installation capacity is expected post-Q22023 as the recently bid projects are anticipated to come online gradually. The government is planning another round of onshore wind auctions, which can further accelerate new additions. Moreover, it is expected that as permitting procedures are streamlined for wind projects in 2023, the existing projects in the permitting phase can add to capacity installations in the coming years (Wind Europe, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

The Russia-Ukraine conflict accelerated the initiatives and efforts on renewable energy generation, specifically onshore wind and solar PV, across the EU. Moving in line, in 2023, Spain raised its renewable energy target to 160GW by 2030 from the previous 123GW of installed capacity (Recharge News, 2023). The progress in the targets has been encouraging, considering that the country achieved the targets of 2020 (in terms of share of renewable energy in total consumption). Further progress is observed from over 1GW of onshore wind capacity installations in 2021 and 2022 after additional targets were announced in 2021 to phase out coal energy by 2025, oil power plants by 2030, and nuclear energy by 2035 (Power Technology, 2021).

For a long time, auctions worked as a market-led capacity growth for onshore wind in Spain. The auctions were allocated through a competitive, market-driven mechanism that acted as a driver for project financings. However, a slower permitting process with supply chain bottlenecks and inflations resulted in highly unsubscribed auctions. To deal with permitting delays, the Spanish government mentioned simplifying the project approval procedures through Royal Decree-Law 6/2022. The decree mentions streamlining the environmental approval process of projects

with low or medium ecological impact. The changes in permitting rules include mainland wind farms (except for those with self-consumption of less than 100kW), which will accelerate the permitting of wind projects with capacities up to 75MW (Eversheds Sutherland, 2022). As of 2022, about 9.9GW of wind projects are in the permitting pipeline, and with faster approvals, the onshore wind installation capacities are anticipated to expand (Wind Europe, 2023).

The Spanish power sector has been evolving due to its PPA-based renewable contracts. PPA in Spain took off mainly in the post-pandemic era, as manufacturing expansion staggered, and supply chain bottlenecks were reduced. Besides, higher interest rates assisted inflation to fall gradually in the current recessionary phase, signaling a positive outlook to developers for renewables PPA. Yet, the PPA contracts in Spain are mainly for short-term, less than ten years. However, with PPA prices becoming more competitive for buyers, large-scale renewable investment could play a key role in expanding the market. Among wind power PPAs in 2023, notable mentions are 51MW signed between StarKraft and Capital Energy (Renewables Now, 2023) and another 54MW between EDP Renovaveis and Inditex (ZARA) (Renewables Now, 2023).

Market Opportunity

The European Investment Bank's (EIB) project financings for sustainability and climate change have long contributed to the impetus for corporate investments in the Spanish renewable energy market. In 2022, EIB signed climate action and environmental sustainability-related financings in Spain to support its renewable sector of EUR5.18 billion (EIB, 2023). In March 2023, the EIB signed a EUR55 million green loan for a joint venture between Iberdrola and Caja Rural de Soria to construct a wind farm with a capacity of 100MW in Spain (EIB, 2023). Again, in June 2023, Iberdrola signed a EUR1 billion loan with EIB to fast forward Europe's energy transition by constructing a portfolio of projects comprising 19 solar power plants and three onshore wind farms in Spain, Portugal, and Germany (EIB, 2023). In this, some projects are aimed to be hybrid with the integration of battery storage systems. In another development, EIB, ICO and Endesa joined forces where EUR500 million of financing has been provided to support Endesa's current renewable projects and also further expansion plan in Spain (EIB, 2023). Such global finance plays a critical role in accelerating the achievement of renewable energy objectives for the nation.

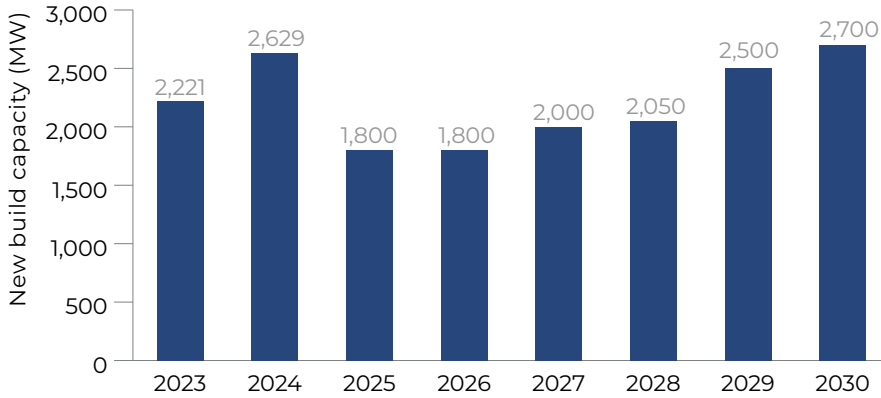
Over the years, competitive and market-led auctions assisted the Spanish onshore wind to secure broad investment prospects. Despite being technology-neutral auctions, onshore wind's response was commendable among available options. However, sudden regulatory

changes can dampen investor sentiment. For example, in September 2021, a 'gas tax' was imposed on windfall gains of wind farms (Windpower Monthly, 2021). It left an impression on investors about the regulatory risk that future projects could face, and consequently, the 2022 auctions remained largely undersubscribed. Despite such outcomes, the Spanish government will auction 1.5GW of onshore wind annually until 2025. This can further strengthen the PPA and merchant markets as permit procedures are further simplified (Wind Europe, 2023).

With the active support for expanding renewable capacity installation, the requirement for transforming the grid infrastructure has also become imperative. Earlier, the authorities approved EUR6.96 billion in investments to construct an advanced network during 2022-2026 to accommodate two-thirds of renewable energy in the grid power supply (IEA, 2022). About EUR1.5 billion could be allocated for the submarine interconnectors with non-mainland territories, while another EUR1.26 billion is expected to be spent for cross-border interconnector lines. Notably, Endesa secured a second round of EUR250 million in financings from EIB for smart grid installation in Spain (Smart Energy International, 2023). In 2023-2025, the company plans to allocate EUR2.6 billion to the distribution networks out of a total investment of EUR8.6 billion.

Outlook

Spain's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

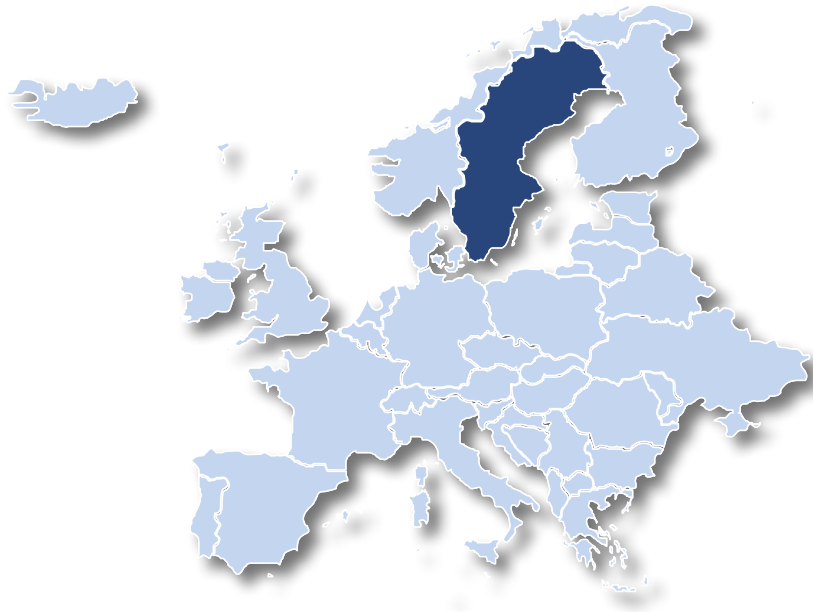
Spain's onshore wind project pipeline has been strong due to the momentum generated by successive auctions. The government has planned a series of further auctions, which can bring robust results in the capacity installation base. The BNEF forecasts indicate that from 2023 to 2030, capacity additions to remain above 2GW annually, if attained, can take the onshore wind to above 45GW by 2030. To achieve this, well-structured policy measures coupled with funding initiatives need to be injected.

With the Russian-Ukraine war causing a threat to the global energy market and prices, the urge to meet the rising demand with supply has ignited rapid renewable market growth. Although the onshore wind has key advantages related to cost competitiveness and efficiency in generating power, the demand for utility-scale solar projects can outweigh the onshore wind projects in the future. Competition would only increase over time since Spain will likely pursue technology-neutral bidding instead of having separate auctions for different technologies.

In association, regulatory uncertainty and opposition from local communities due to the associated ecological footprint of wind farms can further hinder the expansion route. Global inflation and supply chain bottlenecks with unsupportive governmental initiatives are triggering unsubscribed auctions in Spain, as evident by its 2022 auction results, with only 45MW of wind awarded out of 1.5GW (Wind Europe, 2023). Again, changes in the grid access rule might create a trail in the previous headwinds, as only hybrid projects are eased.

On a brighter note, merchant and PPA projects, led by a set of utilities through large renewable-based investment funds, can retain the growth impetus of the Spanish onshore wind industry. This indeed needs a stable legislative backup so that the corporate off-takers can make steady inroads.

Sweden



Sweden is a leading nation in Europe for renewable energy, with government initiatives aiming for carbon neutrality by 2045 (Euro News, 2023). In 2022, it became the largest exporter of power in Europe, with exports of 33TWh to neighbouring nations (Bloomberg, 2023).

Hydropower has been the dominant renewable energy source to date, but onshore wind power is expected to take over as the primary source of electricity in the near future. By 2030, it is projected to overtake hydropower as the country's largest source of electricity. In 2022, wind power generated 33.07TWh of electricity, which is 5.7TWh more than in 2021 (Statista, 2023). Sweden will rely on structured policy planning and regulatory support to continue being the renewable powerhouse.

GDP (Current Prices) USD (2022)	585.94bn
GDP Growth Forecast (constant prices) (2023-2027)	1.56%
Currency	Swedish Krona
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	38.04GW
Onshore Wind Share in Renewables (2022)	38%
Renewable Energy Target	Targets 65% of generation capacity from renewable sources by 2030 and 100% by 2040

GDP Source: IMF WEO, S&P and IRENA

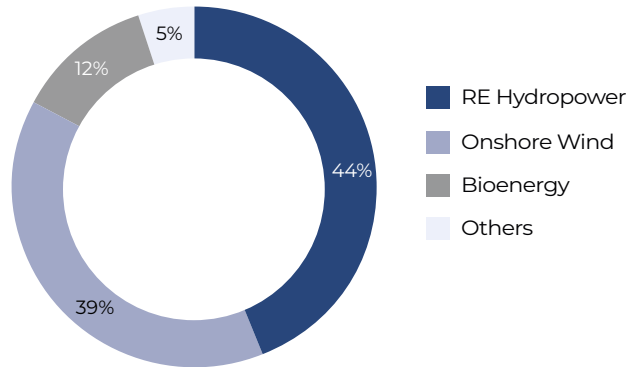
14.4GW Onshore Wind Capacity

✓	The Swedish government decided to ease rules under 'Municipality Veto' for a smoother project approval
✓	Favourable wind and price dynamics increased demand for the technology making subsidy-free wind projects attractive for corporate off-takers
✗	Increased communal opposition with convoluted permitting process led to withdrawal of several wind projects
✗	Strenuous political uncertainty caused by difference of opinion between the ruling and opposition parties for wind farms

Renewable Energy Mix

Sweden is one of Europe's prominent renewable enablers and has a 77.5% share of renewables in the total power mix, which the regulators want to make 100% by 2040. In this, hydropower has prolonged domination with 43% in 2022. Thereafter, onshore wind stands with a 38% share, showcasing a steady growth in the last decade, posting a CAGR of 24% between 2012 and 2022 in cumulative installed capacity (IRENA, 2023). This is possible due to government incentives and staggered ideas to shift from conventional sources to renewable energy, generating an array of opportunities for renewable developers and investors. Thereafter, bioenergy and solar follow, with offshore wind still at a very nascent stage, stagnating at 1%.

Current Renewable Energy Mix 2022

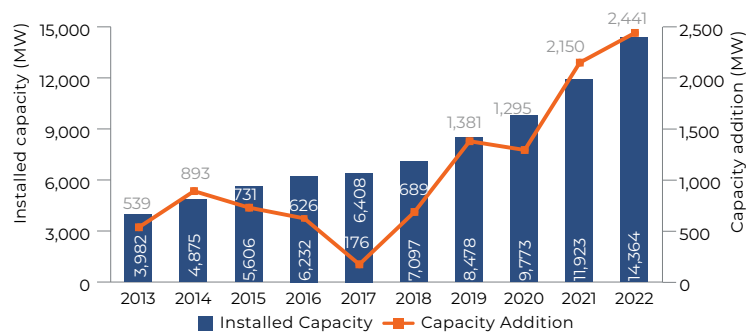


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Installed capacities of renewable energy sources have been steadily increasing since 2018, exhibiting a stark contrast to the sluggish growth observed between 2013 and 2017. However, the year 2020 witnessed a small decline in the installations due to the COVID-19 pandemic. Nevertheless, the renewable energy sector recovered rapidly and reached its highest capacity additions of over 2.4GW in 2022. As evident from the latest data, there was a 4% year-on-year increase in the onshore wind's share in the renewable mix, thanks to the record installations in 2022. This has taken the cumulative installed capacity of onshore wind energy to c.14.4GW (IRENA, 2023).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

Sweden has set ambitious targets towards decarbonization, which is driving the renewable sector. The government aims to fully decarbonize the electricity system by 2040 and achieve zero emissions by 2045, five years ahead of the EU target. In the wind sector, the goal is to achieve 100TWh of power capacity, out of which 80TWh will be contributed by onshore wind farms by 2040 (Swedish Wind Energy Association, 2021). These targets have boosted activity in the wind sector and resulted in record installations in 2022. BNEF anticipates that onshore wind's cumulative installations will increase by 22% and its generation will rise by 42% by 2024 from 2022 levels.

The Swedish onshore wind industry has faced significant challenges due to permitting delays and community veto powers in the project approval process. However, the government is taking steps to address these issues by limiting the "Municipality veto" to the early investment phase, thus reducing the risks for investors (Baltic Wind.EU, 2021). The government has outlined a four-point strategy. One aspect of this strategy involves introducing a new law that will prevent local government from obstructing wind parks during the final stage of project planning. Additionally, in November 2022, the Swedish authorities proposed investing in their energy supply by streamlining the permit process for grid connections, allowing renewable projects to obtain grid approvals more quickly. If such approvals are simplified, about 8.8GW of onshore wind will come online in the coming years.

Sweden's onshore wind industry has been facing significant

challenges with permitting delays and community veto powers in the project approval process. However, the government has taken steps to address these issues by limiting the "Municipality veto" to the early investment phase, thus reducing the risks for In an effort to accelerate the growth of wind power, the Swedish government has outlined a four-point strategy. One aspect of this strategy involves introducing a new law that will prevent local government from obstructing wind parks during the final stage of project planning. Additionally, in November 2022, the Swedish authorities proposed investing in their energy supply by streamlining the permit process for grid connections. This will allow renewable projects to obtain grid approvals more quickly (IEA, 2023). If such approvals are simplified, about 8.8GW of onshore wind will come online in the coming years (Wind Europe, 2023).

In February 2023, Sweden recorded its highest-ever wind power generation of 4TWh, accounting for 27% of electricity generated, which triggered the average wholesale electricity price in Sweden to fall to €0.007/kWh from €0.23/kWh in December 2022 (Ember Climate, 2023). Besides, the electricity demand covered by wind accounted for 25% in 2022, which is expected to surge owing to technological development and infrastructural support (Wind Europe, 2023). On a brighter note, this has made subsidy-free wind power projects beneficial as participation in projects through PPA has increased. Global companies like Microsoft, Google, GE Renewable Energy, Volvo Group, and NTR PLC have entered the Swedish power segment utilizing PPA, resulting in rising market competitiveness.

Market Opportunity

Sweden's favourable market dynamics are enhancing investment opportunities for renewables both at the domestic and international levels. The supportive environment has underlined that the wind sector can now be built without subsidy support. The acquisition of a 528MW onshore wind portfolio in mid-2022 by RPC with an investment of EUR800 million attests to this (Power Technology, 2022).

Merchant power developers are agreeing to project financings with the route of loans to develop new wind farms. Among notable developments, at the end of 2022, a EUR50 million loan agreement was signed by the Nordic Investment Bank (NIB) and Kolvallen Vind AB for developing a 277MW onshore wind farm (NIB, 2022). A further investment of EUR4.7 million for a 17MW onshore wind farm in Sweden occurred, which was jointly acquired by Keppel Corporation and Keppel Infrastructure, holding a 16.3% stake (Energy Global, 2023). All these deals imply a positive investment outlook skewed towards the wind sector.

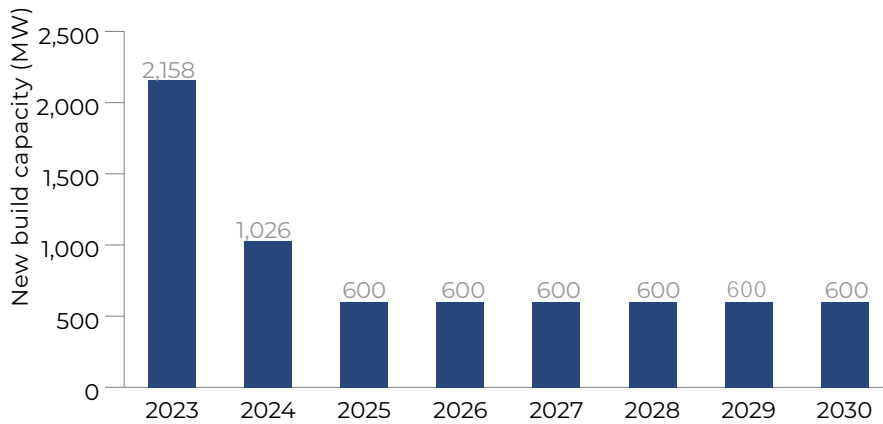
Apart from investments and financing deals, subsidy-free merchant projects through PPA have a strong presence.

Moreover, in the absence of auctions, the current growth of the wind market is owed to its strong PPA deals. Some noteworthy PPAs of 2023 include a 10-year agreement between Vattenfall and Volvo Group for 140MW onshore wind farm (Renews, 2023) and another signed between Rottneros and EnBW for 116MW for 8.5 years (Renews, 2023).

Conversely, with the acceleration in capacity installations, there is an urgent need for electricity grid expansion and the upgradation of old lines. In this regard, Sweden's national grid operator plans to strengthen and expand the electricity network with EUR1 billion in investments. The expansion strategy aims to increase the current capacity by 5GW and aims for the connection of an extra 4GW of renewable energy production (Digital Infra Network, 2022). In addition to strengthening the network, the rising concern related to energy security has necessitated the utilization of energy storage in power plants. To facilitate growth, BW group announced investing SEK1 billion in Swedish battery energy storage with developer Ingrid for 400MW storage (INGRID Capacity, 2023). Storage systems tagged to renewable power plants would be essential to reduce intermittency and ensure energy security over the long run.

Outlook

Sweden's Projected Onshore Wind Builds



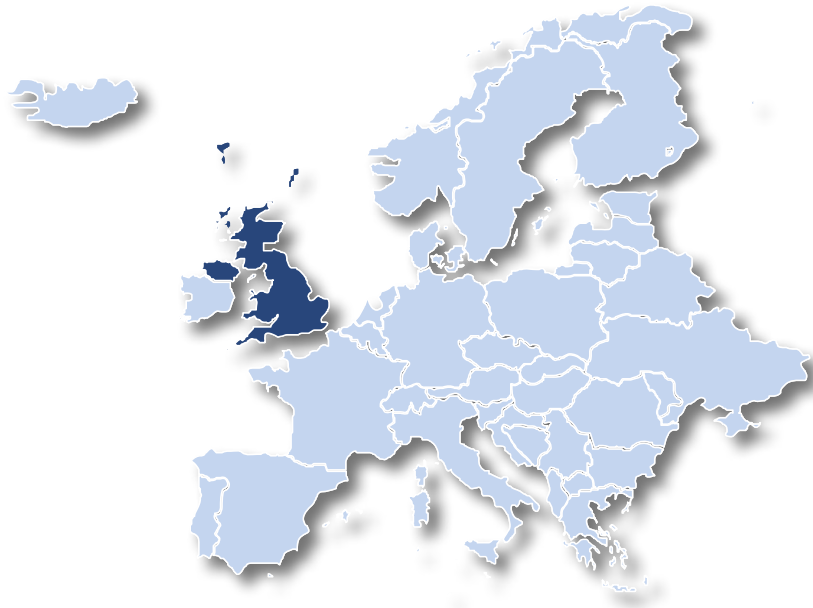
Source: BNEF Global Wind Market Outlook

It is evident that Sweden has significant potential to ramp up its wind power installed base owing to supportive government policies and the burgeoning PPA market. Moreover, the government's ambitious goals for attaining 100TWh of wind power by 2040, noting the high potentiality of wind power conditions, encourage developers and investors. In February 2023 alone, about 27% of electricity was generated from wind power, accounting for 4TWh (Swedish Wind Energy Association, 2021). In association, BNEF estimates that Sweden's onshore wind will witness record additions in annual capacities of more than 2.1GW in 2023. Later, it would add 1GW more in 2024 before stagnating at 600MW from 2025 onwards.

Regardless of such a strong presence, certain logjams continue to obstruct onshore wind expansion. Local opposition against onshore wind installation, backed by political support, is a notable issue. As recorded, between 2020-2022, about 54 wind projects were rejected on the grounds of communal opposition, popularly known as "Municipal Veto", which is the municipalities' right to object to the construction of wind farms (Argus, 2023). To this, the convoluted and tedious permitting process is associated, causing many projects to stagnate in the permitting pipeline. New rules were introduced to ease the approval process in 2021, where objections are limited to an early investment stage. As of 2023, more changes to the law are expected as the government announced to derail the veto power to expand wind energy following the transition target. Other than these factors, a constant uncertainty related to policy formulations prevails, as the ruling party and opposition party have convoluted opinions on wind farm expansion owing to ecological disturbances ignited by wind turbines (The Local se, 2022).

Despite obstructions stymying the expansion of Sweden's onshore wind industry, it is performing exceptionally well in adding incremental capacities. Further, compared with its neighbours, it is speedily marching towards its carbon neutrality targets as per milestones set. Till now, its resourcefulness amalgamated with government support held growth prospects. Yet, to pacify challenges, the government needs to scrutinize the situation.

United Kingdom



The UK is one of the leading countries in renewable energy in Europe. As of 2022, it has a total installed capacity of 53GW, which has grown by 7.6% YoY. Over the years, the UK has become one of the largest markets for wind energy production. In 2022, wind energy accounted for 54% of the country's total renewable energy mix (IRENA, 2023). Although onshore wind has historically led the offshore segment in capacity, the offshore segment is expected to overtake after the latest energy security strategy set an ambitious 50GW target for the technology by 2030 (Government of UK, 2023). The growth of the renewable energy sector can be attributed to various factors such as increased investments, policy support, and the British government's commitment to phasing out conventional energy sources. They aim to achieve 100% decarbonization of electricity generation by 2035 and net zero emissions by 2050 (The Guardian, 2023).

GDP (Current Prices) USD (2022)	3,070.60bn
GDP Growth Forecast (constant prices) (2023-2027)	1.33%
Currency	Pound Sterling
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2022)	53GW
Onshore Wind Share in Renewables (2022)	28%
Renewable Energy Target	Targets 50GW of onshore wind capacity by 2030 and fully decarbonise UK's electricity generation by 2035

GDP Source: IMF WEO, S&P and IRENA

14.8GW Onshore Wind Capacity

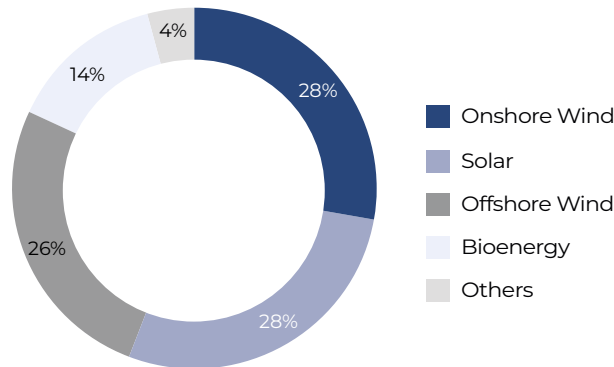
✓	Announcement of AR CfD auctions to catalyse capacity led growth by 2028
✓	Streamlining approval rules for EIA of wind turbines and plans to eliminate 'De Facto' ban on wind farms
✗	Economic uncertainty and inflationary pressure to hamper new project deployment
✗	No new onshore wind capacity in the new energy security plan amidst rising communal opposition

United Kingdom

Renewable Energy Mix

Historically, onshore wind has been the main source of renewable energy in the UK, but now it shares the top spot with solar PV, with both accounting for 28% of the renewable energy mix in 2022. Over the last decade, the proportion of onshore wind in the energy mix has decreased by 10%, which is in part due to the removal of subsidies for onshore wind projects (IRENA, 2023). The percentage of onshore wind farms declined post-2016 due to a ban on new installations in 2015. This ban hindered expansion and shifted focus to other technologies (Britain Remade). On the contrary, offshore wind has grown significantly due to suitable CfD schemes and government initiatives (Wind Europe, 2023). The onshore wind industry in Britain is expected to improve with plans to ease approvals and the current government's efforts to increase its contribution to generating low-cost electricity. Notably, the UK government plans to reverse its 2015 de facto ban on onshore wind to encourage development (The Guardian, 2023).

Current Renewable Energy Mix 2022

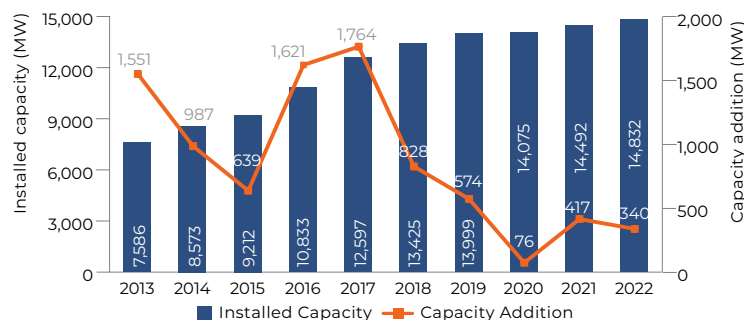


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Between 2013 and 2017, the installed capacity of onshore wind power increased consistently by 13%. However, the growth rate has slowed down since then, with a CAGR of 3% between 2018 and 2022. In the same period, the yearly capacity additions have been very unstable, with the COVID-19 pandemic causing a record-low addition in 2020 (IRENA, 2023). The decline in new onshore wind farm additions began in 2017 due to a ban on their construction and the absence of subsidies. Although subsidies were renewed in 2020, the pandemic restrictions further widened the gap. However, there has been a recent increase in onshore wind capacity, with 14.8GW added in 2022, and this trend is expected to continue as it is the most cost-effective renewable technology with efficient turbine expertise for power generation. To further accelerate the growth of onshore wind, new permitting rules, streamlined development regulations, and eased EIA rules can help stabilize the effect of rising electricity bills.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

United Kingdom

Demand Drivers

One of the main demand drivers for onshore wind in the UK is the auctions designed through the Contract-for-Difference mechanism. The government announced the AR 4 CfD auction with a total budget of GBP345 million, where GBP15 million was allocated for onshore wind, solar, and hydropower for a max of 3.1GW. The auction results marked a comeback of the onshore wind sector, as the round secured almost 1.5GW of onshore wind power, including 900MW of mainland projects (Wind Europe, 2022). The government confirmed that it would continue to support onshore wind through annual Contracts for Difference auctions. Subsequently, as part of the Energy Security Plan, in March 2023, the government announced plans to launch CfD AR-5 with an initial budget of GBP205 million for both established and emerging technologies, including onshore wind (Government of UK, 2023).

The expansion of onshore wind industry in England is driven not only by CfD auctions but also by the strategy

to revoke bans and tackle the adverse effects of wind farm opposition. Such announcements have attracted the interest of developers and investors, as evidenced by the substantial number of projects commissioned after the subsidy ban was lifted in 2020 (The Guardian, 2020). Here, the government reallocated subsidies for onshore wind farms and to participate in government contracts. In September 2022, the regulators announced streamlining onshore wind permitting procedures by relaxing rules of environment approvals and simplifying the Environmental Impact Assessment (EIA) for wind turbines (IEA, 2023). Besides this, the government further eliminated the 'De Facto' ban on wind farms, allowing easy approvals and loosening restrictions (The Guardian, 2023). In association, it aims to include local communities for rapid approvals by allowing ownership, which is expected to ease approvals and stimulate investments in the technology, thus paving the path for robust expansion in the coming years.

Market Opportunity

The wind energy sector has significant potential in the UK, as in 2022, the country produced one-fourth of its electricity from wind energy (Wind Europe, 2023). As onshore wind farms are confined to Scottish land due to limited land availability, repowering with advanced turbine technology can surge capacity installations in other parts of the UK (IEA, 2023). To encourage repowering, the British government in 2023 mentioned providing steady support to the repowering segment under the Energy Security Strategy. Besides, onshore wind farms are not eliminated from the CfD mechanism, which guarantees a minimum strike price to renewable developers, and repowered farms can compete in CfD allocations (Government of UK, 2023). Thus, OEMs have a vast opportunity as instead of installing new wind farms, regulators focus on expanding the current legacy wind farms. Among notable developments, Octopus Energy, in partnership with EWT, plans to repower 1,000 onshore wind turbines in the UK (CURRENT, 2022) and Hagshaw Hill wind farm is set for repowering with a capacity of 80MW and a 20MW battery storage facility (The Guardian, 2023).

Even though to regain momentum, the regulators reinitiated subsidies on onshore wind projects, subsidy-free projects through the PPA route have a strong presence that offsets the need for public funding. For example, Vattenfall inaugurated one of the largest onshore wind farms in 2023. When fully commissioned, it will have a total

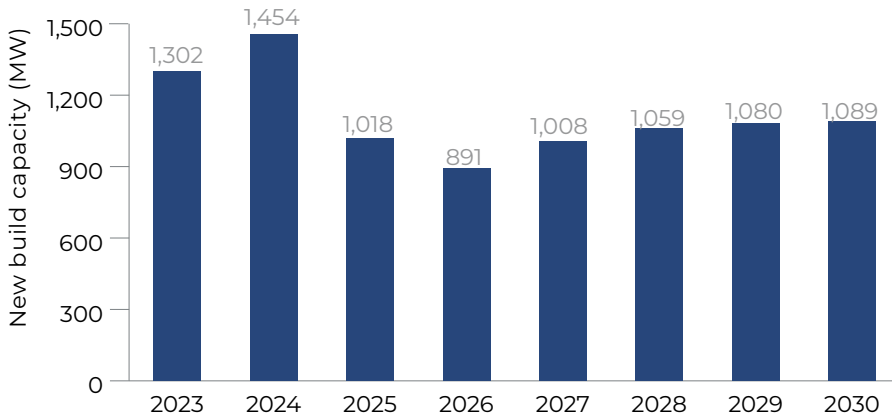
capacity of 240MW. The energy will be provided through a route-to-market PPA to South Kyle for 15 years (Vattenfall, 2023). Another unsubsidised onshore wind farm with a capacity of 50MW came online at the end of 2021, Amazon's first renewable project in the UK. This is the first of the four projects, where all together, it will provide 529MW of renewable energy to AWS data centres, fulfilment centres, and corporate offices by 2025 (Amazon, 2021). Further, UK telco BT has signed a 10-year PPA with the Renewables Infrastructure Group TRIG to procure renewable energy from a 35MW Scottish wind farm (DCD, 2023). Thus, with simplifying permitting procedures and the announcement of remote island wind farms, PPAs are also expected to expand for the onshore wind sector.

Energy storage is another area with substantial expansion potential for its ability to address the system instability caused by intermittent nature of onshore wind turbines. In order to accelerate the commercialisation of innovative longer-duration energy storage projects, in Q4 2022, the government awarded GBP33 million to successful projects under the Longer Duration Energy Storage programme (Government of UK, 2023). Further, the UK Infrastructure Bank commits to providing GBP62.5 million to support battery storage development (ETN, 2023). Private sector capital is also making inroads in the space, such as DIF Capital providing GBP200 million in funding for grid-scale battery energy storage project developments (DIF, 2023).

United Kingdom

Outlook

UKs Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

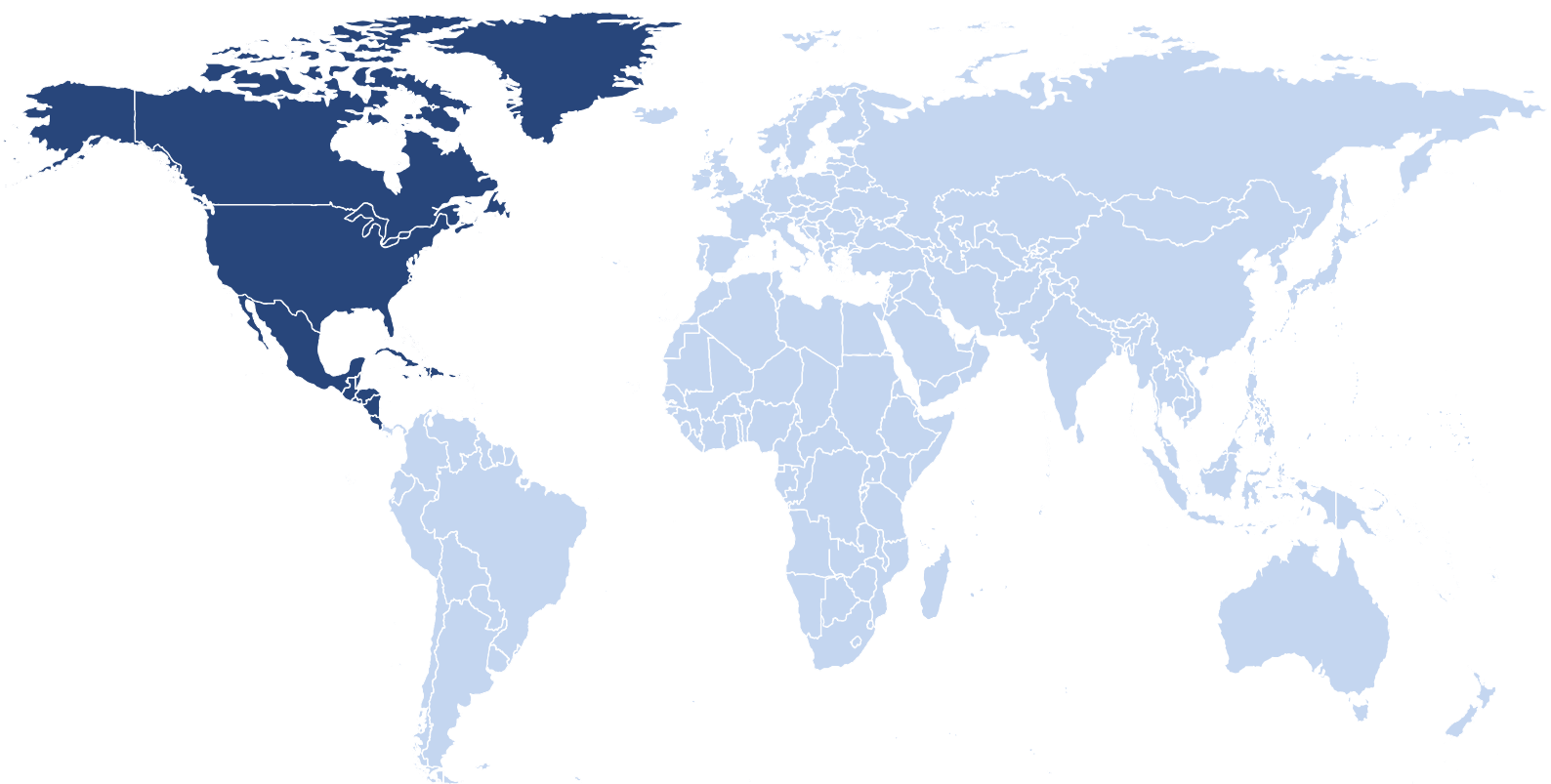
Owing to legislative initiatives, onshore wind in the UK has a strong project pipeline. As per data from Renewable UK, the total onshore wind capacity pipeline has grown to 37GW as of 2022, with projects under construction, consented, and operating stage, indicating an optimistic market condition (Renewable UK, 2022). As per BNEF forecasts, onshore wind cumulative annual installation is expected to grow 6% by 2030, reaching c.24GW of cumulative capacity, signalling favourable market conditions to investors. However, this is well short of the target the Climate Change Committee set of 29GW of onshore wind capacity by 2030 (CCC, 2020).

Major hindrances in the industry's expansion path include opposition from local communities resulting in bans, political clashes on revoking wind farm bans, and skilled worker shortage. Though cheaper electricity provided by onshore wind turbines amidst rising energy prices is attracting the support of commoners in the UK, the constant opposition due to the environmental effects of wind turbines delays deployment at scale. This has resulted in the absence of an ambitious target for onshore wind in the 2023 Energy Security Plan. Despite this, the government has taken steps to repower existing wind farms and plans to reformulate bans and gather communal support through incentives. Further, it also plans on the Net Zero Skills and Workforce Action Plan by 2024 to withstand the skilled workforce challenges in the renewable industry (Government of UK, 2023).

Besides this, variability in generating location and consumption location creates VRE curtailments, as wind farms are in Scotland and consumers are in the southeast. This requires proper networking and grid management, to which the national energy regulator plans to build a high-voltage direct current (HVDC) link on the East Coast to increase interconnections (IEA, 2023).

Overall, the UK has yet to be able to utilise its full onshore wind potential due to logjams. The country's decarbonisation plan is anticipated to be supported by technological advancements in response to the rising demand for renewable energy, and onshore wind energy has the potential to play a significant part in that process. In this regard, crucial actions are required, such as strategic government initiatives to create a pipeline of future projects and significantly upgrading the UK grid to support incremental capacities.

Key Regional Markets - North America



Canada



Canada stands as a prominent leader in renewable energy, boasting a cumulative renewable capacity exceeding 106.8GW, with approximately 80% of its electricity generation sourced from renewable and non-emitting methods, including nuclear energy (IRENA, 2023). Among these sources, hydropower has historically held a predominant position, closely followed by onshore wind, with solar power making smaller contributions.

In Canada's ambitious pursuit of carbon neutrality by 2050, onshore wind power plays a pivotal role (CanREA, 2021). It is regarded as a cost-effective technology, enjoying favourable market conditions and strong support from provincial authorities, notably in regions like Alberta. Presently, there is a high demand for onshore wind energy among corporate entities, facilitated through Power Purchase Agreements (PPAs). Moreover, the growing popularity of wind plus storage projects is set to further bolster the onshore wind pipeline, promising a robust expansion in the sector.

GDP (Current Prices) USD (2022)	2,139.84bn
GDP Growth Forecast (constant prices) (2023-2027)	1.76%
Currency	Canadian Dollar
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	106.9GW
Onshore Wind Share in Renewables (2022)	14%
Renewable Energy Target	Canada aims to decarbonise the electricity grid by 2050 and reach 90% of electricity generation from renewable and non-emitting resources by 2030

GDP Source: IMF WEO, S&P and IRENA

15.3GW Onshore Wind Capacity

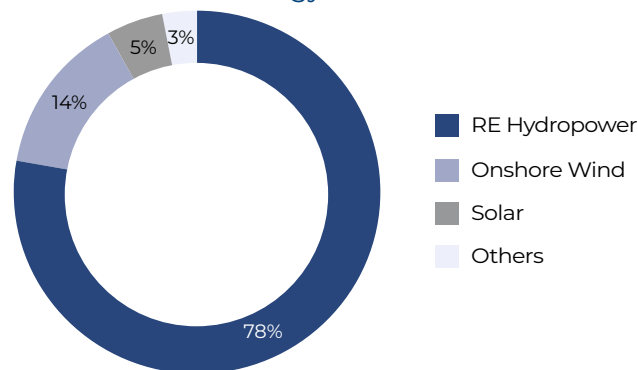
✓	Investment tax credits (ITCs) of up to 30% for renewable energy technologies and 15% refundable ITC to clean energy investments made by non-taxable entities
✓	Robust funding programs, including CAD3 billion for developing smart grids and upgradation of grid transmission network
✓	Significant traction of corporate PPAs for wind plus storage projects
✗	Delay in environmental approvals affecting project cost, hurting potential developers
✗	Inadequate transmission infrastructure to connect renewable powerplants to major cities

Renewable Energy Mix

Canada boasts one of the world's cleanest electricity mixes, with renewables constituting approximately 70% of the generation mix as of 2022 (IRENA, 2023). This impressive share is primarily driven by hydropower, which is the dominant contributor, alongside onshore wind, and solar energy. Onshore wind power, in particular, has emerged as a significant player, marking a doubling of its contribution from 7% in 2012 to 14% in 2022 (IRENA, 2023). Notably, offshore wind energy has yet to make its presence felt in the Canadian energy landscape.

The rise of onshore wind can be attributed to proactive government initiatives and the positive market approach of regions like Alberta, where a substantial portion of wind farms is located (CanREA, 2023). Despite this growth, the sector faces challenges stemming from regulatory hurdles that hinder its full potential.

Current Renewable Energy Mix 2022



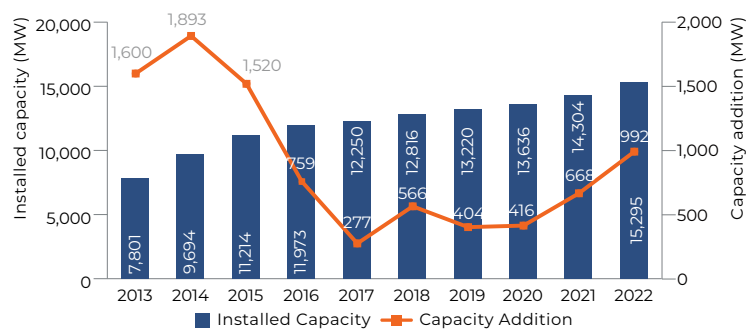
Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Canada's onshore wind industry has experienced stagnation in cumulative installed capacity since 2015, with only 4.1GW added between 2015 and 2022, reaching a total of 15.3GW. Capacity additions remained modest, staying below 1GW annually since 2016 (IRENA, 2023). However, there was a notable uptick in 2022, with 992MW added, marking the highest increase in the last six years. Alberta Province led the way in these new capacity additions, followed by Saskatchewan and Quebec (CanREA, 2023).

Alberta, in particular, has become a hotspot for renewable investments, primarily due to its deregulated market for excess power sales. Additionally, the province has a well-established market for the valuation and exchange of carbon credits, further incentivizing renewable projects. Despite these advantages, the industry faces challenges (Calgary Herald, 2023). Procedural delays in obtaining environmental approvals, heightened competition from hydropower and solar energy, and a lack of policy adjustments regarding bulk auctions have hindered the industry's robust expansion. Addressing these challenges is crucial to ensuring sustained growth and harnessing the full potential of onshore wind energy in Canada.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

The growth of Canada's onshore wind industry can be attributed to the strategic initiatives and policy support put in place by the Canadian government. Key efforts include the ambitious goal of decarbonizing the electricity grid by 2035 and collaborative efforts between federal, provincial, and local authorities to achieve a national carbon-neutral economy. To attract investor interest, the government introduced an Investment Tax Credit (ITC) system in Budget 2023. This system offers substantial incentives, providing up to 30% tax credits for renewable technologies such as wind, solar PV, and energy storage systems. The tax credit, starting at 30% in March 2023, is set to decline to 15% in 2024 and will conclude in 2034. Additionally, the budget outlines a 15% refundable ITC on investment capital costs made by non-taxable entities, including indigenous communities, municipally owned utilities, and Crown corporations, with an estimated value of \$25.7 billion (CanREA, 2023).

In alignment with the goal of increasing renewable energy penetration by 2030, the government is investing CAD 3 billion over 13 years in smart grid programs, upgrading transmission networks, supporting indigenous clean energy

projects, and initiating offshore wind projects starting from 2023-24 (CanREA, 2023). Plans for a cross-Canada grid transmission are also in progress to enhance security and affordability. Provincial governments are actively implementing grid management policies, with initiatives such as Alberta's Electricity Grid Displacement Factor (EGDF) introduced in March 2022. This policy incentivizes wind energy developers to renew and support their EGDF for the entire 8-year offset credit period, encouraging sustained investment in renewable energy (OSLER, 2022).

Another significant initiative outlined in Budget 2023 is the carbon contract for difference (CCfD), designed to facilitate investment in a flourishing clean economy. This comprehensive CCfD strategy, complementing the existing CfD provided by the Canada Growth Fund, aims to enhance the predictability of carbon pricing, and stabilize revenues for renewable energy projects (Budget Canada, 2023). This initiative creates a favourable market environment for both developers and investors, ensuring a stable and lucrative landscape for the renewable energy sector in Canada.

Market Opportunity

The collaborative efforts of Canadian federal and provincial governments have established a fertile ground for renewable investments in the country. Initiatives such as the Smart Renewables and Electrification Pathways Program, with a substantial allocation of CAD 1.56 billion over eight years, bolstered by additional funding from Budget 2022, reflect the commitment to clean energy objectives (Government of Canada, 2023). Funding support for established technologies, including wind power, up to CAD 25 million with a maximum of 10% of the project cost, has attracted significant interest. Moreover, a dedicated investment of CAD 50 million in indigenous-led wind power projects in Saskatchewan highlights the focus on empowering indigenous communities in the renewable sector (Newswire Canada, 2023).

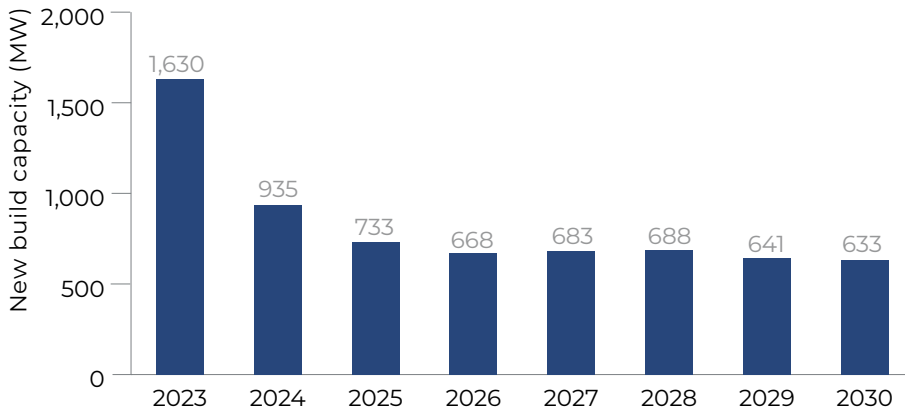
Provincial governments have proactively set ambitious targets to promote regional adoption of renewables. Alberta leads the way with its target to generate 30% of electricity from renewable sources by 2030, supported by 31 ongoing renewable projects representing substantial investments

(Calgary Herald, 2023). Nova Scotia, aiming for 80% electricity from clean sources by 2030, has made significant strides by awarding power contracts to onshore wind farms and attracting substantial corporate investments, exemplified by EverWind's \$1 billion commitment to renewable energy projects (REUTERS, 2023).

Renewable energy's increasing prominence is also propelling the energy storage sector. Canada's energy storage market, buoyed by supportive regulations and pioneering initiatives, is witnessing significant developments. Landmark announcements, such as Ontario's 2.5GW competitive energy storage procurement in 2022, have paved the way for transformative projects like the 250MW Oneida Energy Storage site, the country's largest battery storage endeavour, led by Toronto-based Northland Power Inc (ENR, 2023). These developments underscore Canada's commitment to sustainable energy solutions and position the nation as a robust player in the global renewable energy landscape.

Outlook

Canada's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Canada's onshore wind industry faces notable challenges in the pursuit of its 2050 decarbonization goals. Projections by BNEF suggest a slow growth trajectory, with an average annual capacity addition of 712MW between 2024-2030, showing a declining trend in capacity additions year-on-year. This sluggish progress is primarily attributed to a weak project pipeline, hampered by cumbersome environmental approval processes that lead to delays in project commencement. Stringent ecological assessments, as exemplified in Nova Scotia, have caused significant setbacks, impacting project costs and discouraging potential developers and investors.

Furthermore, the onshore wind sector is impeded by inadequate grid and transmission infrastructure, limiting its expansion potential. However, Canadian authorities are taking steps to address these challenges. Budget 2023 focuses on strengthening grid management and initiating a cross-Canada electricity grid, aiming for increased sustainability, energy security, and affordability (CanREA, 2023). Additionally, the sector's growth prospects are bolstered by the rise of hybrid projects, including wind plus storage and wind plus solar and storage initiatives, gaining momentum in the market.

The future dynamics of Canada's onshore wind industry hinge on several factors: streamlined project construction facilitated by policy support, a substantial increase in battery storage capacity, the proliferation of hybrid projects, and a rise in clean power offtake through PPAs. These developments, coupled with enhanced grid infrastructure, hold the key to unlocking the full potential of Canada's onshore wind market and accelerating its contribution to the nation's decarbonization efforts.

Mexico



Mexico is gradually shifting towards a clean economy that relies on renewable energy sources, as opposed to traditional fossil fuels. Over the past decade, the power matrix has seen a decline of 8% in non-conventional energy usage thanks to the government's Energy Transition Law. This law has set up a strong growth trajectory for renewable energy deployment, targeting a 50% increase in electricity generation from renewable sources by 2050 (Power Technology, 2022). Wind and solar energy, in particular, will play a significant role in helping Mexico achieve this target since the country has resource-rich locations perfect for wind power generation.

GDP (Current Prices) USD (2022)	1,414.10bn
GDP Growth Forecast (constant prices) (2023-2027)	1.79%
Currency	Mexican peso
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2022)	31.9GW
Onshore Wind Share in Renewables (2022)	23%
Renewable Energy Target	35% of electricity generation from renewable sources by 2024 and 50% by 2050

GDP Source: IMF WEO, S&P and IRENA

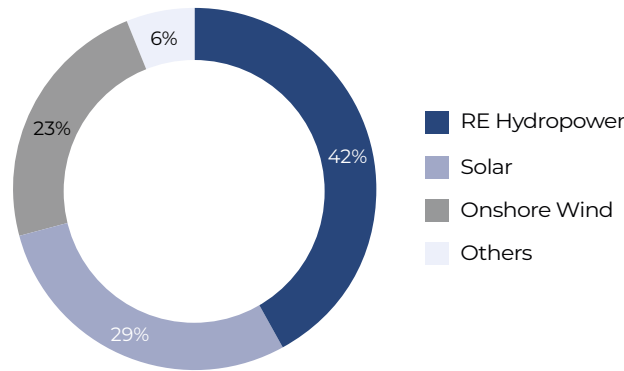
7.3GW Onshore Wind Capacity

✓	Small-scale renewable projects are seeking corporate interest as distributed generation is gaining significant traction
✓	Significant funding initiatives for renewable project deployment and upgradation of transmission network
✗	Unsupportive government policies with increased involvement of administration in renewable energy sector
✗	Lack of funding initiatives, prolonged permit delays and inadequate transmission networks discourage private sector participants from developing renewable energy projects

Renewable Energy Mix

As of the end of 2022, Mexico has a cumulative installed capacity of 32GW for renewable energy sources. While hydropower is currently the leading renewable energy source, it is gradually being overtaken by onshore wind and solar, which have seen a combined increase of 20% YoY since 2018 (IRENA, 2023). Onshore wind has doubled its share of the energy mix in the last decade. However, in recent years, policy changes regarding the private sector's role in renewable energy deployment have caused a slowdown in capacity growth and investment inflows.

Current Renewable Energy Mix 2022

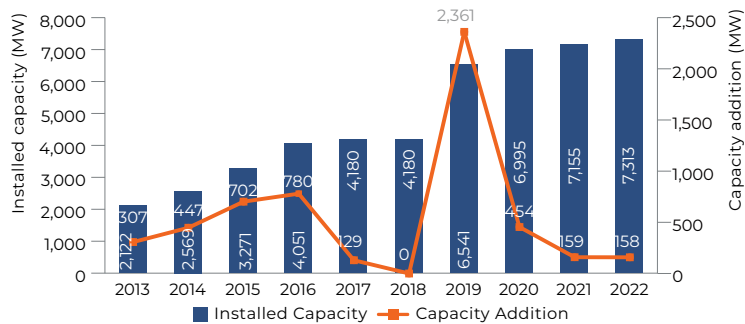


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Mexico's cumulative onshore wind capacity saw a sharp rise in 2019, with over 2GW of capacity added by developers who entered the market via auctions in 2017. However, capacity additions fell dramatically below the 500MW mark in 2020 due to pandemic restrictions and new government policies. The López Obrador administration has focused on expanding fossil fuels and transferring control to state-owned entities (CFE), which has hindered the growth of the renewable energy sector. Despite these challenges, onshore wind cumulative capacity had reached 7.3GW by 2022 (IRENA, 2023) (The Guardian, 2021).

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

Mexico's renewable sector is primarily driven by climate change legislation adopted in 2012 that aims to generate 35% of electricity from renewables by 2024 and 50% by 2050 (Power Technology, 2022). The latest figures suggest that Mexico is well on track to meet the interim targets, as it is only 9% behind the 2024 target. To increase capacity addition, Mexico pledged at COP27 to expand combined solar and wind capacities from the current 16GW to more than 40GW by 2030, with \$48 billion of investment earmarked for this purpose (Gobierno De Mexico, 2022). The investment will focus on expanding unexploited wind and solar potential, primarily in the south-eastern region, which is the richest in this regard. Such locations also offer the scope for cross-border export to meet demand in the Central American region.

In recent years, distributed generation (DG) has gained significant momentum in Mexico compared to large-scale wind and solar projects, which stalled due to

policy uncertainty. According to the Energy Regulatory Commission (CRE), nationwide distributed generation grew by 30% between 2021 and 2022, with installed capacity by the end of 2022 standing at 2.6GW. DG projects do not require generation permits, and securing approvals requires only a week's time, making them more attractive than utility-scale renewable projects.

Although space and capacity are restricted, distributed generation has recently become highly competitive, and municipal incentives surrounding it are expanding swiftly. Therefore, corporates are showing significant interest in small-scale renewable projects to amplify their renewable portfolio while bypassing regulatory convolutions in Mexico. Hence, in 2022, distributed generation assisted Mexico in attracting \$3.5 billion in investments (Mexico Business News, 2023). This segment is expected to be a key driver for onshore wind growth.

Market Opportunity

A study published in April 2022 by NREL suggests that Mexico has a strong pipeline of renewable energy projects. The study reveals that the combined pipeline of wind and solar projects amounts to 15.3GW, with 4.8GW in the construction phase, 3.9GW in the permitting stage, and 6.5GW in the early development stage (BNAMERICAS, 2022). Despite the lack of public support for renewable projects, Mexico's renewable sector has seen remarkable growth due to private sector investments. The untapped regions of Mexico present an opportunity to attract more investments from private sector developers despite the current issues of permit delays, project suspensions, and regulatory uncertainties.

Recently, the Mexican government has shown its intention to address investors' concerns about market risks by signing renewable energy deals themselves and increasing the Federal renewable portfolio. In June 2022, President Andrés Manuel López Obrador's office announced that it had signed a deal with 17 US renewable energy companies to build around 1.8GW of wind and solar energy projects in Mexico (PV Tech, 2022). Some of these projects are planned for cross-border energy exports, with an aim to develop transmission interconnections alongside. To further alleviate the uncertainties, in April 2023, the Mexican energy association AME announced its acquisition of Mexico Iberdrola's 13 power plants with an investment of \$6 billion. These efforts were made to attract more investments in the clean energy sector (Iberdrola, 2023).

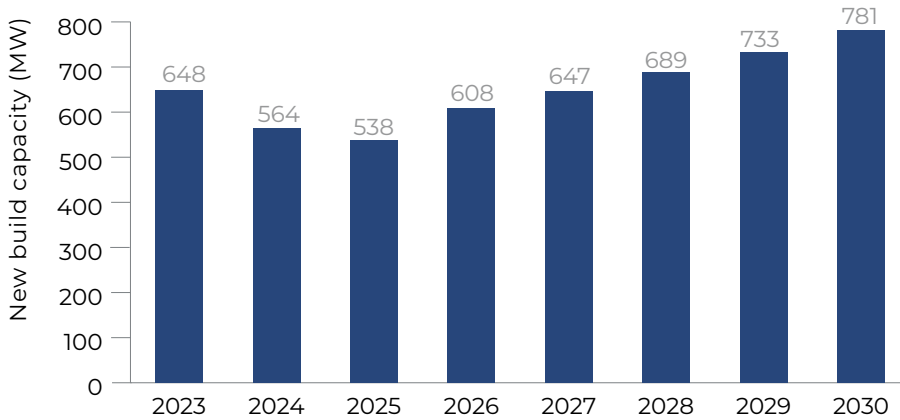
Mexico presents a significant opportunity for renewable energy developers, as the country's energy regulator, CFE, aims to maintain a 50% renewable project market share. Mexican authorities plan to add wind farms to industrial parks, with four out of ten parks being solely powered by wind farms. In May 2023, Mexico plans to launch tenders for six industrial parks built along the 300km rail corridor to power the Tehuantepec isthmus rail corridor between Oaxaca and Veracruz states (BNAMERICAS, 2023).

In addition to supporting the energy sector, the authorities are focused on strengthening Mexico's transmission network. Developing grid infrastructure and transmission lines is of utmost importance, given the increasing demand for grid and transmission lines from various renewable energy projects. To assist in this regard, the Secretariat of Energy (SENER) announced its plans to upgrade the electric system by developing transmission, distribution projects and commercialisation of the electric system on June 1, 2022 (ITA, 2023). Furthermore, state-level initiatives are also underway to ramp up transmission line development. For instance, Mexico's Querétaro state plans to build 900MW (140km) of new transmission capacity next year, investing \$300 million (BNAMERICAS, 2023).

Additionally, Mexico has all the necessary elements to become a significant market for smart grids. The energy regulator for Mexico, CRE, created a smart grid Roadmap in 2020, indicating how the smart grid market could grow to \$12.1 billion by 2023. The annual investment in this sector is expected to increase from \$205 million in 2014 to \$2.1 billion in 2023 (Energy Digital, 2020).

Outlook

Mexico's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Mexico's renewable energy industry has a crucial role in transforming the country's electricity system, leveraging its geographic advantages. According to NREL estimates, the southeast region alone has a technical potential of 3,669GW of wind (NREL, 2022). However, the projections by BNEF paint a less optimistic picture, with only 5.2GW of capacity expected to be added cumulatively between 2023-2030, with an average annual capacity addition of 651MW. This is due to the slow growth phase caused by regulatory uncertainty.

The current administration's preference for fossil fuels has resulted in regulatory hurdles that impede renewable energy deployment. Mexico has twice as many gas projects (13.7GW) as prospective wind and utility-scale solar projects combined (6.7GW), according to the Global Gas Plant Tracker (Global Energy Monitor, 2023). Additionally, newly introduced regulations give state-owned utility CFE 54% of the power to control the energy market, while the private sector has access to only 46%, resulting in contract and certificate cancellations and permit delays, which further hinder the expansion of renewables.

In June 2022, CFE cancelled EDF Renewables' 252MW wind power project on the grounds of violating community norms (Business & Human Rights Resource Centre, 2022). Due to constitutional uncertainty, the Mexican Association of Wind Energy ("AMDEE") expects to add only 1GW to the existing wind capacity based on the current project pipeline awaiting commercial authorization (Bloomberg Linea, 2022). This has increased project development risks and triggered financial turmoil, hampering investor appetite.

The renewable energy market of Mexico is negatively impacted by policy formulation that favours conventional sources, and investment momentum in the space has been slowed. The planned legislative changes in the power market need to be amended, and many of these proposed legislative changes are currently being contested in court, delaying their enactment. The outlook of Mexico's renewable energy market will depend largely on the government's legislative measures to facilitate the energy transition.

United States



The US is the second-largest renewable energy market globally after China. Onshore wind has the maximum share of renewable energy portfolio in the US, placing the country in second position globally after China. Currently, the country stands at 352GW of total renewable installed capacity, of which 141GW is from onshore wind (IRENA, 2023). Historically, its renewable energy mix was headed by renewable hydropower until 2017, when onshore wind surpassed it and took the leading position. This robust surge in the renewable energy market is dedicated to tax credits, corporate investments, and fiscal backups. Especially the state aid and investments driven by the Inflation Reduction Act ("IRA") of 2022 helped catalyse renewable technology expansion. Further, the administration aims to reach 80% of renewable energy generation by 2030 and decarbonise the electricity grid by 2035 (NPR, 2023). Such ambitious targets and initiatives can result in amplified deployment of onshore wind, supported by declining levelized cost of energy.

GDP (Current Prices) USD (2022)	25,464.48bn
GDP Growth Forecast (constant prices) (2023-2027)	1.71%
Currency	US Dollar
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2022)	351.7GW
Onshore Wind Share in Renewables (2022)	40%
Renewable Energy Target	80% renewable energy generation by 2030 and 100% carbon-free electricity by 2035

GDP Source: IMF WEO, S&P and IRENA

140.8GW Onshore Wind Capacity

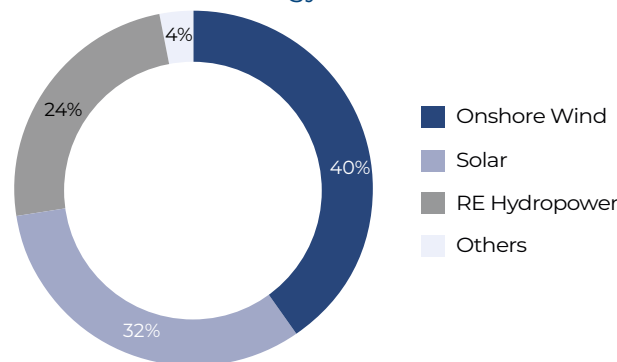
✓	Combination of ITC and PTC under the 2022 IRA opened doors to new opportunities for onshore wind sector
✓	Significant fiscal incentives for renewable deployment play a crucial role in shaping the sector's growth trajectory
✗	Increased transmission backlogs causing delay in project commissionings
✗	Increased PPA prices amidst supply chain issues are likely to stagnate project pipeline

United States

Renewable Energy Mix

Since 2017, onshore wind has directed the US' renewable installed base with a current share of 40%. In 2019, it surpassed the 100GW mark of cumulative installed capacity, currently stationed at 141GW (IRENA, 2023). Its share has risen consistently in the last decade, triggered by policy-level push and private investments. Thereafter, it is followed by solar PV and renewable hydropower. Although offshore wind is almost non-existent, recent policy amendments under IRA can drive its untapped potential. Despite this, electricity generation from conventional sources controls the power demand. On a positive note, the share of coal-fired generation decreased by 3% from 2021-2022. Contrariwise, the combined share of wind and solar energy increased by 2% during the same period (Mercom, 2023). This will amplify in the coming years as projects delayed due to supply chain bottlenecks are expected to come online in 2023-2024. As per EIA forecasts, wind generation will increase from 11% in 2023 to 12% in 2024 (EIA, 2023).

Current Renewable Energy Mix 2022

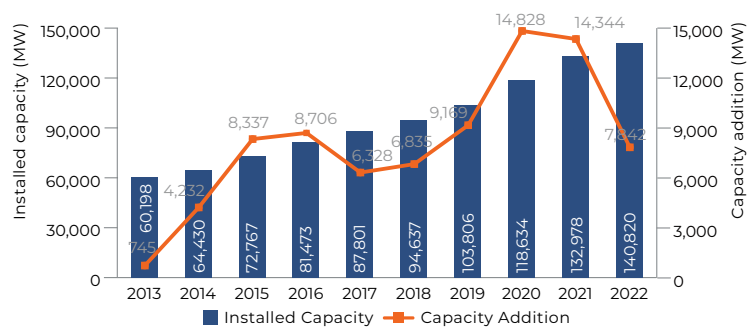


Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Onshore wind annual capacity additions have generally been on an upward swing. The wind sector accounted for 22% of new electricity capacity installed in the US in 2022, representing \$12 billion in capital investment. The outgrowth came from repowering projects, further driven by tax benefits and competitive prices of onshore wind technology. However, in 2022, capacity additions fell by 45% due to supply chain constraints birthing project delays, sinking tax breaks for developers, and rising project costs (IRENA, 2023). Despite this, the new tax regime, PTC extension, and state aid under IRA are expected to boost the wind sector, as already 4.7GW of additional wind power capacities are deployed in Q12023, with the highest contribution from Texas (WindExchange, 2023). In terms of generation, by the end of 2021, wind power generated 9.1% of electricity, with South Dakota leading the segment (Energy Government, 2022). This is expected to surge further as delayed, and repowering projects are expected to be commissioned in the coming years.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

United States

Demand Drivers

Fiscal aid and financial incentives have been fundamental drivers for onshore wind deployment. In August 2022, the IRA became a law that expedites tax credits for wind energy projects. Under this, the Investment Tax Credit (ITC) allows 6% to 30% tax credits for land-based wind projects depending on project size and labour factors. Besides, projects above 1MW capacity must satisfy new apprenticeship and existing wage requirements to obtain the 30% ITC for projects that begin construction before 1st January 2025 (US Department of Energy, 2023).

Historically, the Production Tax Credit (PTC) has supported onshore wind energy by assisting developers. However, its phase-out in 2021 affected capacity installations in the subsequent year. In August 2022, IRA significantly boosted onshore wind power producers by renewing the PTC. This allows developers and owners to claim a federal income tax credit on every kilowatt-hour of electricity supplied to the grid annually for ten years (US Department of Energy, 2023). Thus, utility-scale wind projects can choose between PTC and ITC to assist project visibility and maximise efficiency. In association, the new PTC provides credits for manufacturing and supplying wind power project components, thus providing a fillip for the domestic equipment manufacturing and supply chain.

Market Opportunity

The Inflation Reduction Act sets the stage for a fundamental transformation of the US renewable sector. IRA is expected to accumulate \$114 billion in total investments in the US renewable sector by 2031 (PV Magazine, 2023). In the latest announcement, the Biden-Harris administration has committed to providing \$20 billion through grants that will be deployed through two separate and complementary competitions (\$14 billion through the National Clean Investment Fund (NCIF) and \$6 billion through the Clean Communities Investment Accelerator (CCIA)), each aimed at mobilizing a national-scale clean energy financing network (The White House, 2023). Further, in 2023, the US Agriculture Department announced providing \$11 billion to rural communities to bring them clean energy under the Powering Affordable Clean Energy programme. About \$1 billion is allocated to finance renewable energy projects, including large-scale wind, solar and geothermal projects, through partially forgiving loans available for renewable energy enterprises and electric utilities (NPR, 2023). Although not specifically for onshore wind, the declining LCOE prices for wind power can make project financing available for the technology.

The PPA prices are on a rise in the US. This effect of supply chain constraints ignited a halt in project development in 2021-2022 (Mercom, 2023). Curtailing this depends on state

Other than fiscal initiatives at the Federal level, state-level incentives assist the development of renewable technologies. An executive order by the Biden Administration mentions establishing a federal-level goal for decarbonisation by 2050. Following the same target, in November 2022, a renewable portfolio standard (RPS) was designed for 36 states and the District of Columbia. This encourages electricity suppliers to give their customers a minimum share of electricity produced from eligible renewable resources. Among these, 12 states and the District of Columbia mandate the RPS obligations to attain 100% clean electricity by 2050 (EIA, 2022).

Policy impetus has also helped wind power generation to gain a competitive position through economies of scale. Thus, it is progressively competitive to build a new wind power plant instead of a new coal or gas-based one. The wind developers also benefit from the high wholesale power prices in the US market (Mercom, 2023). Particularly during summer, such a trend of rising prices has been a major propelling factor. While long-term PPAs are the conventional way for wind power offtake, many projects also keep some capacity aside for the wholesale power market.

aid and plans to reshore supply chain constraints under the IRA, as the paused projects are anticipated to come online by 2024. Such changes can stabilise PPA prices that can thrive renewable deployment as hybrid projects get significant PPA attention. Besides, heightened energy price uncertainty will compel businesses and off-takers to seek long-term contracts to guarantee stability.

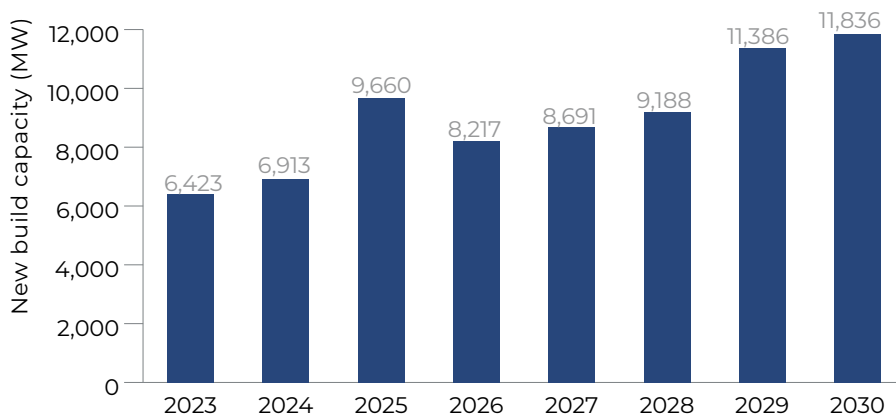
In association with deploying new projects, repowering is another segment in the US with a significant scope considering the ascending age of wind turbines. GE Renewables has topped this market by repowering more than 4GW of wind capacities in the US (GE, 2019). In 2023, Vestas bagged a 139MW order to repower a project in Pennsylvania. Further, it is forecasted that the repowering of age-old wind turbines has a scope of attracting \$25 billion by 2030, indicating a wide array of opportunities for OEMs to stack revenue (WindESCo, 2023).

Lastly, the OEMs operating in the onshore wind sector will particularly benefit from the advanced manufacturing production (AMPC) credit from the IRA (US Department of Energy, 2023). This will help OEMs reverse declining equipment sales margins in the short term and incentivize investment in manufacturing capacity for the US onshore wind power market, thereby creating an opportune pricing environment for manufacturers.

United States

Outlook

US Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Although the USA is expected to witness balanced growth in onshore wind capacity additions, the BNEF estimation marginally contradicts its potentiality. It indicates a dampening momentum between 2023-2028. This could be an effect of the shift of policy focus on offshore technology, as evident from IRA 2022, which has given much attention to this emerging technology. Besides, solar is only a few gigawatts behind onshore wind and is expected to rise as a stiff competitor.

However, post-2028, it is expected to add more than 11GW owing to a rising repowering capacity and hybrid wind-solar and storage projects. The extension of PTC and amendment of ITC amalgamated with advanced transmission networks can further aid the sector. Besides, the rapid fall in LCOE for onshore wind power will substantiate the investment for the sector to level up the energy transition nationwide (IEEFA, 2023).

Irrespective of this, headwinds, like the location-wise variability of wind speed and inefficient transmission infrastructure, are expected to restrain the expansion prospects of onshore wind projects. Especially, varied PPA prices in several regions of North America are an effect of delayed permit processes and higher interconnection costs. PPA prices rose by 20.7% in the Southwest Power Pool (SPP) and 9.4% in the Midcontinent Independent System Operator (MISO), highlighting unfavourable market dynamics in the SPP and MISO regions. However, wind PPA prices decreased by 10.3% in the Electric Reliability Council of Texas (ERCOT), implying an affirmative outlook (Mercom, 2023). Owing to high wind conditions, steady project prospects are making inroads in Texas as corporates seek to invest in the region, like ACEN, acquiring eight operating wind projects.

Besides, the US faces logjams from its inefficient transmission connectivity. Developing new grid lines and transforming the old ones is a long-term process, and the deployment of \$5 billion prescribed under the IRA towards improving transmission infrastructure needs to be expedited (S&P Global, 2022). Owing to such obstructions, about 1GW of renewable projects are waiting for approval. This needs urgent addressing as late project commissioning would also impact the project returns in a competitive market.

Key Regional Markets - South America



Brazil



Brazil has long been a leader in promoting renewable energy within the Latin American region. Its primary renewable energy source is hydropower, followed by onshore wind and solar photovoltaics. The Brazilian Energy Planning Agency (ITA, 2023) aims to increase the share of renewables in the energy matrix to 50% by 2031, achieve an 88% coverage of electricity demand from renewable sources by 2030, and ultimately attain full decarbonization by 2050 (Politica Por Inteiro, 2022).

In response to these targets, Brazil has witnessed a recent surge in wind energy initiatives, capturing the attention of foreign investors and developers. This increased investor interest could drive significant growth in wind power capacity, with projections suggesting it could exceed 200GW by 2050 (InterSolar). Brazil's commitment to renewable energy and its favourable conditions make it a promising and attractive market for the expansion of wind energy in the coming years.

GDP (Current Prices) USD (2022)	1,924.13bn
GDP Growth Forecast (constant prices) (2023-2027)	1.67%
Currency	Brazilian Real
Country Credit Rating (S&P)	BB-
Renewable Energy capacity (2022)	175.3GW
Onshore Wind Share in Renewables (2022)	14%
Renewable Energy Target	Achieve 50% renewable power in the energy mix and 88% of electricity demand from renewable sources by 2030

GDP Source: IMF WEO, S&P and IRENA

24.2GW Onshore Wind Capacity

✓	Implementation of new policy frameworks and PPA promotions for onshore wind deployment
✓	New transmission investment set to unlock new hybrid capacity to allow for greater renewables penetration
✗	Lack of operational performance amplifies the issues in energy pricing and transmission connectivity
✗	Shift in regulatory planning towards green hydrogen and offshore wind tend to threaten onshore wind pipeline

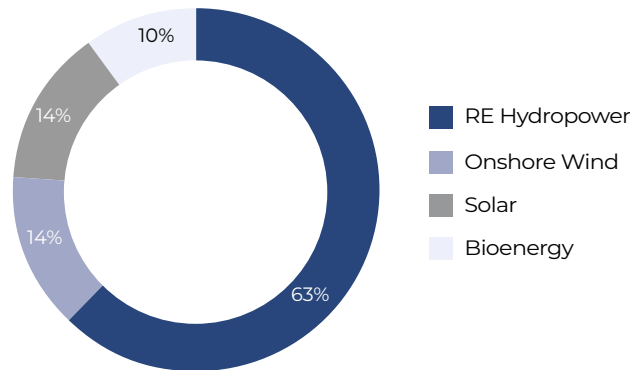
Brazil

Renewable Energy Mix

As of 2022, Brazil boasts a robust renewable sector, with an impressive installed capacity of over 175GW (IRENA, 2023). The clean energy landscape's traditional reliance on hydropower has lately declined due to frequent droughts and stringent policies regarding floods, which hindered the progress of hydroelectric projects. The share of hydropower in Brazil's energy mix has thus declined over the years as investment in other sources increased.

Amongst the notable increase in the contribution of non-hydro renewable technologies, a key component is onshore wind energy. Over the last decade, onshore wind's share of the energy mix has surged by 12%, making Brazil a leading wind energy producer in the Latin American (LATAM) region. Remarkably, in 2022, a staggering 80% of the new capacity additions in the LATAM region came from Brazil's wind energy initiatives (IRENA, 2023).

Current Renewable Energy Mix 2022



Source: IRENA Renewable Capacity Statistics July 2023

Despite these advancements, Brazil's renewable portfolio still needs diversification. To attain a more diversified and sustainable energy landscape, Brazil must focus on enhancing existing technologies, investing in research and development, and fostering innovation within the renewable energy sector. These initiatives are crucial to meeting the nation's ambitious goals and ensuring a resilient, low-carbon future for Brazil.

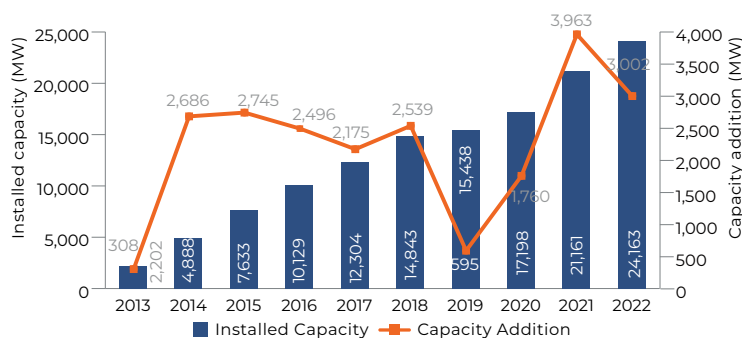
Installed Capacity: Status and Trend

Over the past decade, Brazil's onshore wind installed capacity has experienced remarkable growth, increasing by 11-fold from 2013 to 2022. Despite facing challenges such as the cancelled auctions between 2015 and 2017, the sector demonstrated resilience, bouncing back with an average annual capacity addition of approximately 3.5GW in 2021 and 2022 (IRENA, 2023). This consistent growth led to a cumulative installed capacity surpassing 24GW in 2022.

In 2022, there was a slight dip in capacity additions. This decline was influenced by reduced interest from corporate off-takers and investors, primarily due to rising costs, low ceiling prices, and a transition towards solar PV and offshore wind (Energy Global, 2023). Despite this, the onshore wind sector shows significant promise for expansion.

By the first quarter of 2023, the industry had 1.4GW of wind capacity addition. Furthermore, the Brazilian government's plans to auction onshore wind projects in 2023 could expedite capacity additions (GreenTechLead, 2023). These initiatives, coupled with ongoing efforts to address challenges and create a conducive environment for investment, are anticipated to sustain the growth momentum of Brazil's onshore wind industry.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Brazil

Demand Drivers

Strategic regulatory measures have bolstered Brazilian renewable energy initiatives in recent years. Brazilian lawmakers introduced a ground-breaking incentive program in early Q1 2022, allocating R\$500 million to promote wind and solar photovoltaic projects nationwide. Furthermore, the Energy National Plan 2030 outlined comprehensive strategies to expand sustainable energy cost-effectively over the next decade (DPC BRAZIL, 2022).

Building on these initiatives, the National Bank for Economic and Social Development (BNDES) announced significant financing for the renewable sector in early 2023. This funding encompassed two wind farm complexes and one solar farm complex, collectively boasting a capacity of 1.5GW and requiring a total investment of R\$10.6 billion. Notably, R\$3.5 billion of this funding was channelled through the BNDES FINEM program, signalling a substantial commitment to renewable energy expansion. Robust transmission infrastructure and focus on local sourcing support project development (BNDES BRAZIL, 2023).

Brazil's unregulated free energy market is a linchpin for the growth of onshore wind projects. This market dynamic, bolstered by bilateral Power Purchase Agreements (PPAs), has instilled confidence among investors. To achieve its ambitious target of adding approximately 17.8GW of onshore

wind capacity between 2023 and 2035 (Energy Global, 2023), Brazil is actively leveraging bilateral PPAs. According to Clean Energy Latin America (CELA), a substantial portion of Brazil's wind and solar PV capacity, around 10.7GW (41%), operates under bilateral PPAs (PV MAGAZINE, 2022). This dominance of the free market signifies a promising trend expected to outperform in the years ahead.

Brazil's demand for International Renewable Energy Certificates (I-REC) has increased remarkably (Argus Media, 2023). In Q1 2023 alone, the I-REC market witnessed a significant uptick, reaching 13.96TWh compared to 8.5TWh in 2022. This surge catapulted Brazil to the top position globally, surpassing even China. Over the last three years, the issuance of I-REC certificates more than doubled, rising from 4 million to 9.5 million (Atlas Renewable Energy, 2022). Wind power projects have been pivotal role in this growth, accounting for half of the issued certificates.

The I-REC demand could soar higher with rising corporate carbon disclosure requirements and stringency in carbon credit regulations. Such a trend could drive significant growth in generation capacity as companies focus on reducing their carbon footprint, with the added benefit of certificates' revenue.

Market Opportunity

Brazil's wind industry has attracted about US\$35.8 billion in investments over the past decade (EVWIND, 2023). In 2023, BNDES announced a R\$907 million investment to develop four wind farms in Rio Grande do Norte (IEA, 2023).

International collaboration also plays a pivotal role in Brazil's renewable energy expansion. Brazil's Neoenergia secured EUR200 million in assistance from the European Investment Bank (EIB) for a major project encompassing a 715.5MW wind park and solar power plant (EIB, 2022). An expanding project pipeline will drive the next wave of investment. There are 86 onshore wind projects at various stages of development, collectively amounting to \$35 billion in investment (AirSwift, 2023). Major corporations like Engie, AES, Enel, and Iberdrola have ambitious expansion plans in the country, further enriching the project pipeline.

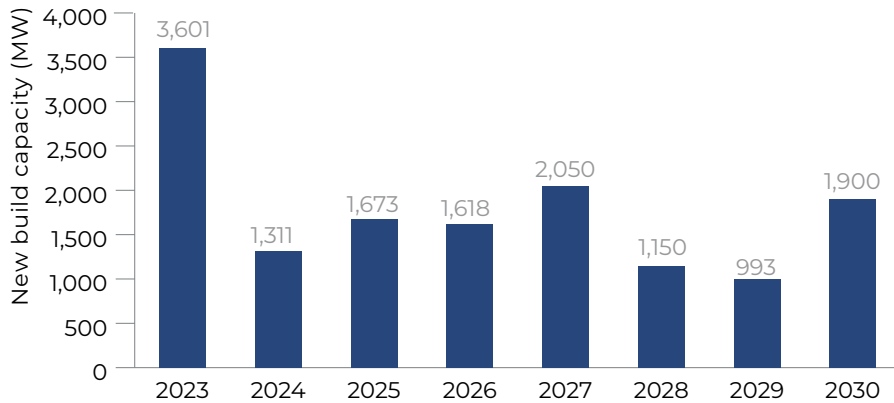
The renewable energy sector's resilience is evident through various mergers and acquisitions. Equinor, a prominent energy company, acquired 200MW of a wind farm in July 2023, adding to its impressive portfolio, which includes a 1.2GW capacity pipeline of onshore wind and solar projects

in Brazil (Power Technology, 2023). Similarly, Engie Brasil Energia made a strategic move in 2022 by acquiring the 846MW Serra do Assuruá onshore wind farm from PEC Energia SA for B\$265 million (Wind Power Monthly, 2022), underscoring the industry's stability and positive trajectory.

The country's transmission network may impose a constraint on the planned wind power capacity addition. To address this issue, the Brazilian government unveiled an ambitious plan in March 2023, outlining a R\$50 billion (US\$9.5 billion) investment in developing new transmission lines and related infrastructure (PV TECH, 2023). The focus of the planned power transmission projects is to support upcoming wind and solar projects, including hybrid (wind-solar) deployments. Furthermore, foreign companies such as Iberdrola and Singaporean investment firm GIC signed agreements in 2023 to develop extensive transmission networks spanning thousands of kilometres in Brazil. These initiatives, including a US\$13.4 million investment by ENGIE in a 1,006km transmission line in the northeastern region, would enhance power offtake capabilities and ensure grid stability (NS ENERGY, 2023).

Outlook

Brazil's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Brazil's onshore wind sector has gained significant momentum due to favourable government regulations and untapped resource potential, particularly in the Northeast region (EVWIND, 2020). Brazil ranks sixth globally in terms of cumulative installed capacity, with a strong focus on onshore wind technology. Despite varying projections from different energy agencies regarding future capacity additions, onshore wind remains a key player in Brazil's energy mix.

However, the sector faces challenges such as supply chain bottlenecks, fluctuating exchange rates, a shortage of skilled labour, high inflation, and interest rates (RIGZONE, 2022). These factors have impacted project costs and profitability. Additionally, inefficient grid infrastructure has hindered project development, leading to decreased investor interest. The emergence of offshore wind and hydrogen technologies, along with the competitive rise of solar energy, further complicates the landscape for the onshore wind power market.

Nevertheless, falling Levelized Cost of Energy in the Latin American region ensures the long-term viability of onshore wind projects (STATISTA, 2023). The Northeast region's abundant wind potential continues to attract investors and developers, offering a promising outlook for the sector's growth. Despite challenges, Brazil's onshore wind industry remains resilient, driven by its economic viability and the nation's commitment to renewable energy.

Chile



In the past decade, Chile has experienced a significant transformation in its energy sector, shifting from conventional energy sources to renewables. Its impressive transition can be attributed to legislative support, advancements in renewable technologies, and the rise of public-private partnerships. The Chilean government has made ambitious commitments. Their goal is to achieve 70% of energy consumption from renewable sources by 2030 and fully decarbonize the system by 2050 (World Economic Forum, 2023), focusing on non-hydro renewable technologies like wind and solar.

Chile's renewable energy sector, especially wind energy, holds vast untapped potential. To fully harness this potential, the government recognises the need for stringent policy reforms and infrastructural advancements. These efforts are crucial to accelerate the growth of wind energy in the region and solidify Chile's position as a frontrunner in the renewable energy landscape of Latin America.

GDP (Current Prices) USD (2022)	300.72bn
GDP Growth Forecast (constant prices) (2023-2027)	1.53%
Currency	Chilean Peso
Country Credit Rating (S&P)	A
Renewable Energy capacity (2022)	18.8GW
Onshore Wind Share in Renewables (2022)	20%
Renewable Energy Target	Sourcing 70% of its total energy consumption from renewables by 2030 and decarbonise the electricity grid by 2050

GDP Source: IMF WEO, S&P and IRENA

3.8GW Onshore Wind Capacity

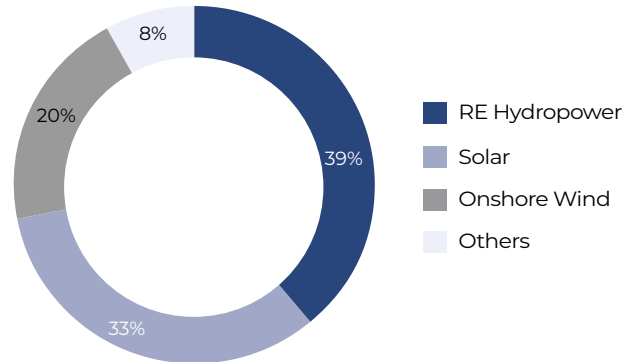
✓	Renewable auctions predefined for long-term PPAs and amendments of PPA power supply contract duration are set to uptake the sector
✓	Amplified funding initiatives especially for onshore wind projects to increase its capacity growth
✗	Increased VRE curtailment in the advent of inadequate transmission network to stymie onshore wind growth trajectory
✗	Increased opposition from Indigenous communities for wind farms led to the rejection of consecutive projects and delayed commissions of existing ones

Renewable Energy Mix

Over the last decade, Chile has witnessed a transformative shift in its renewable energy landscape, transitioning from a heavy reliance on renewable hydropower to embracing wind and solar energy. This shift was necessitated by recurring instances of drought that hampered power supply, leading to a 43% decline in the share of renewable hydropower between 2012 and 2022. During this period, onshore wind energy's contribution to the renewable mix surged by 17%, rising from 3% in 2012 to an impressive 20% in 2022 (IRENA, 2023).

Authorities are now focusing on ramping up renewable projects by developing electromobility and transmission infrastructure. Strategic initiatives like the Just Transition Strategy have been introduced to accelerate the deployment of onshore wind energy (IEA, 2020). These forward-thinking policies and investments are pivotal in ensuring Chile's continued progress towards a sustainable, carbon-neutral future.

Current Renewable Energy Mix 2022



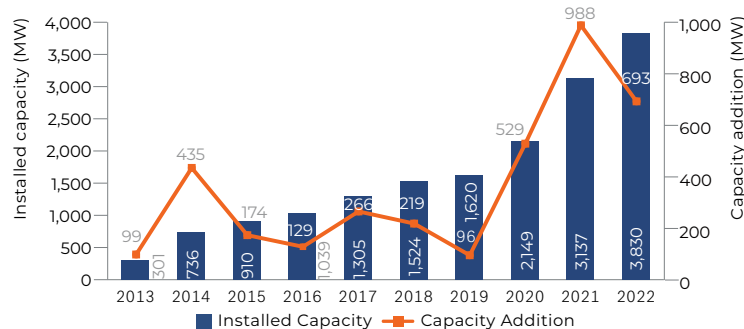
Source: IRENA Renewable Capacity Statistics July 2023

Installed Capacity: Status and Trend

Chile's onshore wind capacity experienced a notable acceleration in growth from 2020, marking a departure from previous years of moderate or near-stagnant annual expansion rates. The peak installations were recorded in 2021, showcasing a significant surge in the country's wind energy infrastructure. Despite a minor dip in 2022, where capacity additions remained above 500MW (IRENA, 2023), rising project costs and fluctuating interest rates were identified as key factors influencing this decline (IEA, 2023).

One of the challenges faced in the onshore wind sector involves the integration of communal and indigenous approvals, which often leads to procedural delays in the commencement of wind farm projects. These delays have contributed to a slower-than-desired pace of growth in the industry. Furthermore, onshore wind's contribution to the Small Distributed Generation Facilities (PMGD) segment remains relatively low. As of April 2023, data from the National Electricity Coordinator indicates that out of 2.2GW of PMGD capacities, only 3% is derived from wind energy sources (Electromineria, 2023). This highlights the need for robust policies and strong local support to bolster the onshore wind sector, ensuring consistent gigawatt-scale annual additions and reinforcing Chile's position as a frontrunner in renewable energy adoption.

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics July 2023

Demand Drivers

Chile's energy landscape is undergoing a profound transformation, with ambitious targets to phase out coal usage by 2030 and decommission coal power plants by 2040. Already, significant progress has been made, with 7 out of 28 coal-fired plants retired and plans to decommission three more by 2025 (Energy Partnership, 2021). The government's commitment to boycotting investments in coal power plants without carbon capture and storage has catalysed a shift in the energy sector. Over the past decade, there has been a 19% decline in electricity generated from non-renewable sources, matched by a 19% increase in renewables, according to IRENA. This transition has created a significant power generation gap of 65%, providing a ripe opportunity for renewable technologies like wind and solar to fill the void. To expedite this transition, a strategic policy push is essential, encouraging rapid project allocation and development.

Chilean authorities have introduced technology-neutral auctions for long-term Power Purchase Agreements (PPAs) exceeding 15 years to support the renewable energy sector. The 2021 auctions were oversubscribed, and the 2022 auctions exclusively featured bids from wind, solar, and storage technologies (Renewables Now, 2022), indicating

a clear shift away from hydropower. This market-oriented approach, devoid of subsidies, has garnered substantial investor interest in Chile. In 2023, the government plans to auction 5,400GWh of electricity tender in two rounds, encompassing wind, solar, hydropower, storage, and non-variable renewables. Notably, bid rules have been modified, extending the PPA power supply contract duration from 15 to 20 years, mitigating developers' price risks and incentivizing storage projects (PV Magazine, 2023).

A notable initiative is Chile's focus on ramping up green hydrogen production using low-cost renewable sources. To support this effort, Chile's Economic Development Agency (CORFO) has allocated \$50 million for six projects, including one powered by a local wind farm in the Magallanes region in the south (ENLIT, 2022). The World Bank has also approved \$150 million in loans for green energy development in Chile (World Bank, 2023). As investments in green hydrogen generation accelerate, Chile aims to leverage affordable technologies like wind and solar for electrolysis, further boosting their demand and integration into the country's energy mix. These strategic initiatives underscore Chile's commitment to a sustainable and renewable energy future, positioning it as a leader in the global energy transition.

Market Opportunity

Chile stands out as one of the most attractive emerging markets for renewable energy development, supported by its swift transition towards clean energy. Structured renewable auctions, ambitious targets, and grid management initiatives have made Chile a magnet for investments, drawing approximately \$20.8 billion over the past seven years for renewable energy projects. Its organised electricity system bolsters, enables standardized PPA auctions in USD denominations (BloombergNEF, 2022). Developers can engage in bilateral contracts outside the regulated market with major consumers, leading to substantial investments. Noteworthy PPAs include agreements between Atlas and Enel for 417MW (Power Technology, 2022) and AES and Google for 110MW (Renewables Now, 2022), showcasing Chile's potential as a hub for renewable energy collaborations.

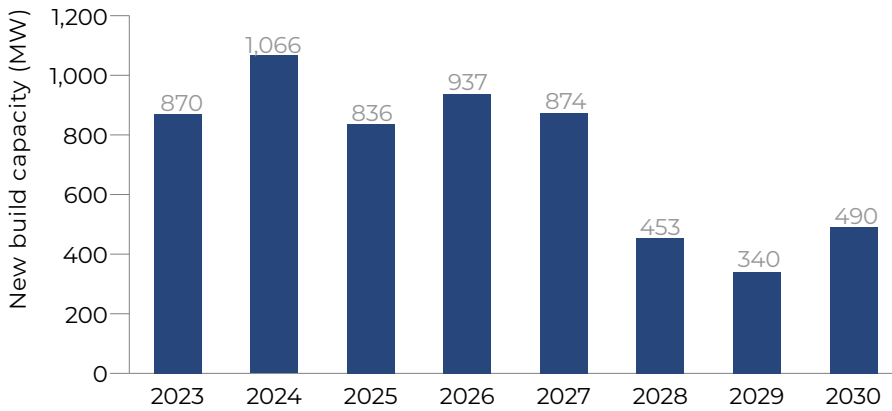
Hybrid projects, particularly those integrating wind, solar, and storage technologies, have gained significant traction in Chile. The capital expenditure in the country's renewable energy projects is projected to reach \$7.9 billion, primarily focused on constructing over 9GW of non-hydro renewable projects, predominantly in the Atacama Desert in the northern Antofagasta region. A substantial portion of these upcoming projects adopts a hybrid approach, combining wind and solar elements. For instance, a 1.2GW wind plus solar project, along with 500kV transmission lines and substations developed by Spain's Grupo Ibereólica, represents a major investment of \$874 million

(BNAMERICAS, 2023). Additionally, Energía Eólica Paposo has received approval for an 862.5MW wind-solar-battery storage hybrid project involving a \$750 million investment (Renewables Now, 2023). Companies like EDPR and Enel Power Chile have also obtained approvals for separate hybrid wind-plus-solar farms with a combined capacity of 609MW, highlighting the growing trend towards integrated renewable energy solutions.

However, the rapid deployment of renewable projects has exposed challenges related to inefficient transmission networks, leading to issues like electricity dumping. In response, the Chilean government has taken proactive measures, passing a bill to accelerate energy storage and electromobility investments. Plans are underway to tender two storage systems with a combined capacity of 2GW in 2024 (BNAMERICAS, 2023). The energy sector regulator, CNE, has also outlined initiatives to expand electricity transmission, earmarking a total investment of \$1.45 billion for 48 grid infrastructure projects (BNAMERICAS, 2023). Moreover, a 1,500km High-Definition Variable Current (HDVC) powerline is set to become operational by 2028, with an estimated cost of \$1.4 billion, aimed at alleviating the curtailment of Variable Renewable Energy (VRE) sources (AX LEGAL, 2023). These strategic interventions underscore Chile's commitment to overcoming infrastructure challenges and consolidating its position as a renewable energy powerhouse.

Outlook

Chile's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Chile's onshore wind sector is poised for significant growth, with projections indicating the addition of over 4.5GW capacity between 2023-2027. These forecasts highlight the country's rapid expansion in renewable energy, specifically in wind power. However, despite these optimistic prospects, the sector faces several challenges that impede its growth.

One major obstacle is the inadequacy of the transmission network. Chile needs advanced distribution infrastructure, transmission lines, and storage facilities to effectively support the increased deployment of renewable energy. Estimates suggest that retiring 5.5GW of coal power would require more than 22GW of renewable capacity and storage systems. Additionally, the disparity between power generation and consumption locations has led to Variable Renewable Energy (VRE) curtailment, reaching 6% in 2022. To address this issue, the authorities have planned the construction of a major north-south power line, Kimal-Lo Aguirre, expected to enter service by 2030 (BNAMERICAS, 2023). However, more storage and transmission networks are crucial to fully resolve this challenge.

Furthermore, there is opposition from indigenous communities against wind farms, leading to delays in permitting and commissioning. Recent instances, such as the Kudawfe Peñi Indigenous Community's veto against the Parque Eólico Viento Sur wind project, have resulted in setbacks (Electrominera, 2023). Additionally, onshore wind faces stiff competition from solar energy, which outperformed wind in recent technology-neutral auctions, adding to the sector's concerns.

Despite these challenges, the untapped potential of onshore wind in Chile continues to shape the outlook for its growth. Moreover, the growing focus on hybrid projects and policy initiatives supporting storage and grid management presents opportunities for the onshore wind sector.

07

About PAF

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Climate Finance



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