Global Onshore Wind Market Review

2022

CLEANBRIDGE

About

The report provides an insight into the Global Onshore Wind market. The findings of the report are based on research conducted by CleanBridge and its research partner Alchemy Research and Analytics. The report provides an overview of the Global Onshore Wind industry with insights on prevailing market conditions encompassing recent trends and drivers, challenges, and outlook in major countries across Europe and Americas. The report starts with a high-level view on the dynamics of the industry, touching upon the regional variations and analysing the implications of the same. It then profiles the major markets country-wise, to provide a holistic view of the state of the industry in these countries, highlighting the growth opportunities, demand drivers and prevalent challenges. Macroeconomic data was sourced from the publications of multilateral institutions such as the International Monetary Fund (IMF). The industry-specific data is attributed to industry associations, Government authorities / statistical departments, Bloomberg New Energy Finance (BNEF) and International Energy Agency (IEA). This was supplemented by news reports, trade journals and related sources.

The report is an outcome of a collaboration between CleanBridge and its research partner Alchemy Research and Analytics and was completed between June and September 2022.

We would like to thank the following executives for their contribution in preparing the report:

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Introduction

The ongoing global energy crisis is a reminder of the long-pending resiliency in energy systems. It points to the critical role of a renewable energy-led transition. As per the International Energy Agency, global energy investments could rise by 8% during 2022 to reach USD2.4 trillion, driven primarily by clean power generation resources. Much more is needed to address the emerging complex tradeoff between demand and sustainability in energy generation and consumption cycles.

The demand pressures are playing out in the short-term, through high fossil fuel prices and a competitive scramble for supplies. The urge for the expedient solutions is understandable – countries need to address near-term issues first. Globally, oil and gas companies are witnessing almost 10% higher investments this year, with cumulative profitability projected to cross USD2 trillion. The longer-term priorities of sustainability and resilience must find space in such a scenario, based on a deliberate and focused policy push.

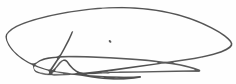
The accelerated push for renewable energy projects in several markets is an encouraging sign. Utility-scale power projects, such as those based on wind and solar are the most important, considering the burden on power generation for its fossil fuel dependence and emissions. Mature renewable energy technology options, as in onshore wind, are instrumental to scale-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 – there are apparently terrawatts of 'shovel-ready' onshore wind capacity locked-up for want of permissions or interconnection requests. A similar potential also gets crowded out by apparent competitive choices (wind versus solar), when in fact, complementarity can resolve the need of the hour (complementary use is 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 supply chain – all contribute towards an uphill path. This is a phase that will have to borne out, till 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. It is thus our view that the investment commitments are unlikely to change course drastically.

CleanBridge's Annual Primer series aims to provide a high-level view of the demand drivers, opportunities, challenges, and outlook prevalent in major markets for the different renewable energy technologies such as solar PV and onshore wind.

We hope you will enjoy reading our annual review of the Global Onshore Wind Market. We look forward to briefing you on other renewable energy technologies in the coming months.



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Partner, & Sr. Managing Director

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Executive Summary

Executive Summary

The onshore wind industry has gradually been approaching maturity across markets globally. It is an established technology with minimal scope for changes. The project cost is range-bound after providing for local factors, while most resource-rich locations are exhausted. In such a backdrop, the industry's dynamics assume importance, especially as competitive options in solar and offshore wind are poised to tip the scales in the renewable energy mix.

At 769GW, the installed onshore wind generation capacity held a quarter of the global renewable energy mix by the end of 2021. It has been significant progress since 2012, when the share was 18%. But considering recent years' growth, the relative share of onshore wind is somewhat stagnant – 23% between 2017 and 2019. The pace and volume of capacity addition lagged in recent years. In leading European markets, such as Germany, the challenges have been in permitting delays. In contrast, for others, competitive options in renewable energy (mainly solar) puts wind capacity under pressure.

For practically all countries, competitive auctions are the preferred route for capacity allocation. There are technology-neutral auctions where onshore wind developers are pitted against utility-scale solar and other renewable energy forms. Yet, based on the factors at play, the onshore wind projects appear to be holding on their own. The Spanish auctions in November 2021 had onshore wind developers winning the bid in a technology-neutral tender. The price discovery process through the auctions is seen mainly across the markets, with project bids aligned to general average capital costs adjusting for the local development factors. The focus is on efficiency.

Both developers and equipment manufacturers chase narrow project margins to achieve cost and returns. Such a trend got reinforced as markets ditched the subsidies in favour of auctions. In technology and equipment, the discernible shift has been the improvisations done in wind turbines – larger sizes, higher capacity ratings, taller structures, and increased rotor diameters, to cite a few. The developers, meanwhile, are adopting hybrid wind power generation, mostly involving attached battery-based storage. The US is one of the leading markets in this regard. In 2021, 41 hybrid plants (worth 2.4GW) were in operation in the US. Regulatory authorities are also taking note of hybridisation, as observed in the Indian wind power auctions.

While the demand side of the business is intact (due to policy objectives in renewable energy), the supply side faces challenges, albeit of short-term nature. The leading equipment manufacturers face profitability challenges due to years of narrow margins and aggressive pricing. This is being reversed. There are expectations that this could dampen some demand for the time being till the equilibrium reaches. It could also mean that, in some cases, the cost advantage of the onshore wind power plants is eroded. In the long-term, though, it will help the equipment business align to market realities for growth.

The market outlook for onshore wind business points to a recovery in capacity addition rate by the end-2022. As per the BNEF estimates, new onshore installations could be 90GW – 97GW between 2023 and 2025. The European region's urgency to accelerate renewable energy projects (due to the energy crisis imposed by the Russian conflict) acts as a fillip for the onshore wind segment. Furthermore, repowering is emerging as a preferred option in certain pockets, as developers are keen to capitalise on the higher market prices in the aftermath of the energy crisis.

The potential is much higher than most project pipeline trackers suggest – the critical bottlenecks arising from procedural delays, local community issues, or transmission interconnection constraints impact capacity realisation. The onshore wind industry's growth will, therefore, be through many factors, spanning energy transition policies, equipment supply chain and technologies, project development costs, and investment commitments.

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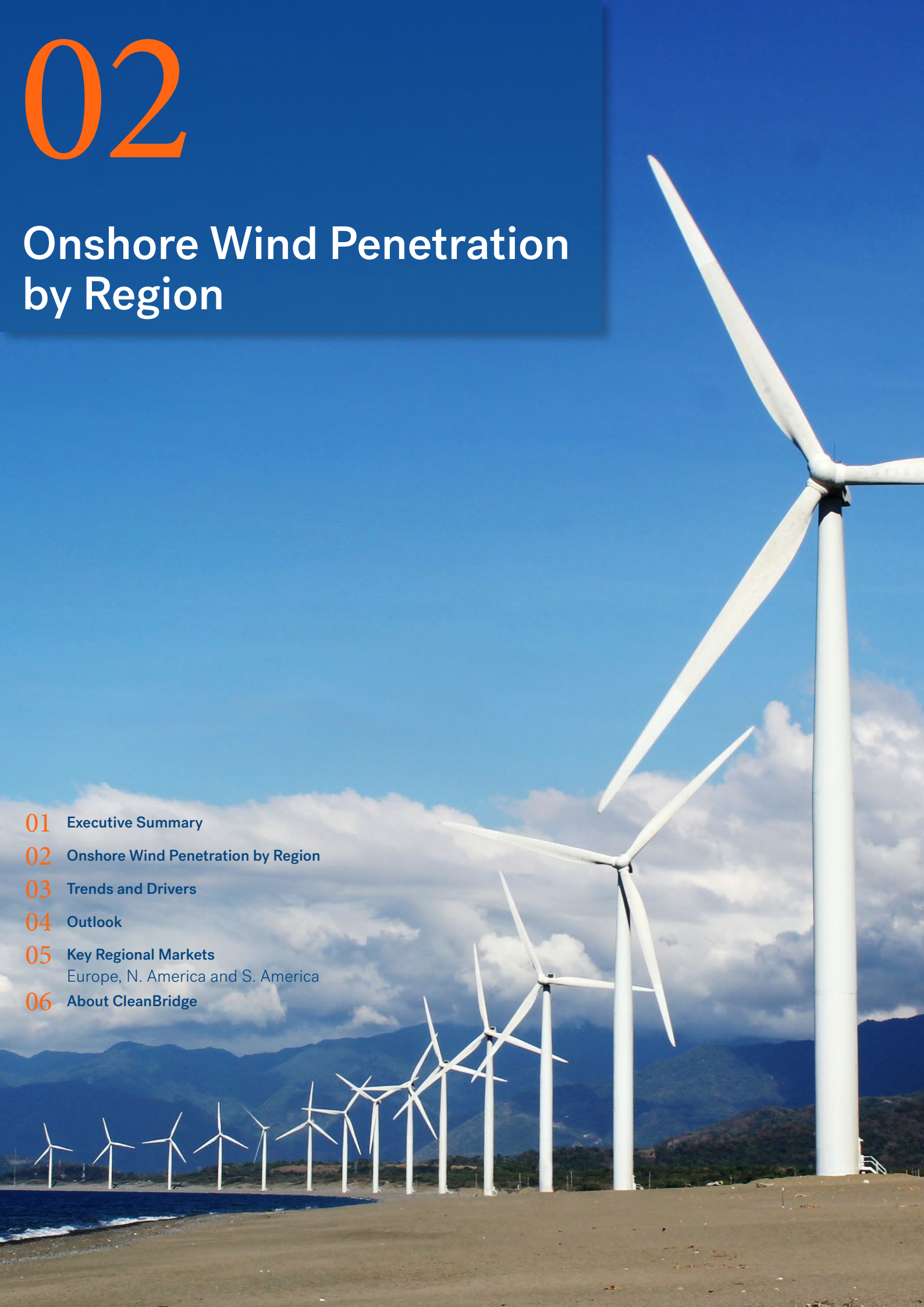
Onshore Wind Penetration by Region



Onshore Wind Penetration by Region

Europe

By end-2021, European region's onshore wind capacity addition amounted to 11GW, contributing to a 6.2% annual growth in installed capacity base. The region's onshore wind penetration, at 30% of total renewable energy capacity, stayed unchanged since 2017. This is partly a reflection of the challenges in accelerating capacity addition. For the steep renewable energy targets set for 2030 (40% share in total energy mix), the existing rate of capacity addition is far lower than the requirement. As per the industry body WindEurope, about 30GW of new wind capacity would be required annually to meet the targets. The bottlenecks arising from permitting delays and transmission connectivity compounds the challenges developers face in timely commissioning. In a backdrop of competitively bid projects, delayed project approvals worsen the already narrow project returns.

Yet, onshore wind is likely to play a vital role in the region's renewable energy capacity growth plan. In 2021, the total investment commitment towards new wind farms was EUR41.4 billion – though 11% lesser than previous year but notable record for the aggregate capacity value it facilitated. Furthermore, during 2021 a record number of corporate power purchase agreements (PPA) were formalized, worth 6.9GW and 41 new PPAs for onshore wind farms. As per WindEurope's estimates, three-quarters of the region's upcoming wind power capacities will be onshore-based. Additional fillip for onshore wind could arise from Europe's rapid transition away from natural gas, in the aftermath of the Ukraine conflict. As per estimates of Bloomberg, a European Union funding worth EUR300 billion could enable Europe to remove gas from the energy mix and enhance the spending on wind and solar in the process.

Americas

Led by the US market, the North American region had the highest onshore wind penetration in 2021. Despite a slower capacity addition during 2021, the US has had a rising share of onshore wind in total power mix. As per the US Energy Information Administration (EIA), in March 2022, onshore wind was the second-largest source of generation after natural gas. While capacity addition is still a concern for this market (due to an impending expiry of tax credit), the sheer size of the market size is a major driver.

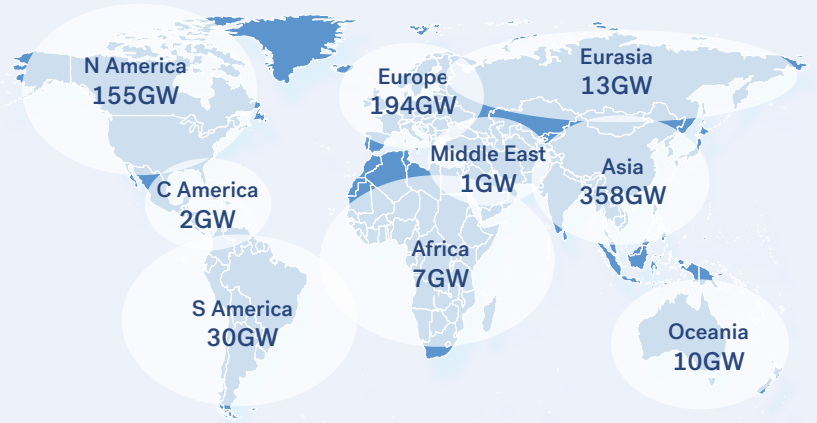
In Latin America, onshore wind is yet to assume any significance among renewable energy resources. Yet, the growth in penetration points to the changing dynamics – the share in 2021 was twice that in 2015. The region is progressively seeking diversification from the dependence on conventional resources. Brazil offers the largest onshore wind market in Latin American region. The country's entire installed wind power capacity is onshore and is the second-largest power generation source. Other key markets include Chile and Argentina where clean energy targets drive the onshore wind capacity growth. Of late, Chile emerged as one of the major markets for the huge untapped potential and emphasis on private sector-led growth in capacities.

Asia

The Asian region's growth is defined by the skewed contribution of China, that leads global onshore wind capacity. Economies of scale have ensured that the wind power capital costs continued to decline even during 2021 due to the competition. This was despite the end of subsidy support by end-2020. A steady demand together with the regulatory focus on auction-based capacity allocation is likely to ensure support for the country's onshore wind power market.

India is the next important market in the region. Policy and regulatory push continue to drive the market. But growth has flagged lately, which is being addressed through a mix of measures. A major policy change under consideration is to do away with the reverse-auction model of capacity allocation to enable better incentives in the market. Other measures being prioritised are dedicated transmission corridors and an efficient power trading market.

Installed Onshore Wind Capacity (GW) by Region



Top Countries by Capacity

Globally, the installed capacity base of onshore wind energy skewed towards a few countries. Historically, the top five countries between them have had 71% -73% of the total globally installed capacity. At a macro level, this indicates that the trajectory of global onshore wind market often can be gauged by the capacity growth in such select markets. This is more so because the ranking of the top five onshore wind markets remained unchanged during the last five years up to 2021.

China maintains an unchallenged global leadership in the installed capacity base, accounting for over half (54%) of the total capacity worldwide. The relative share has risen steadily in last five years, starting with 45% in 2017. This can be understood from the rise in incremental capacity addition each year – from about 18GW in 2018 to over 29GW each year.

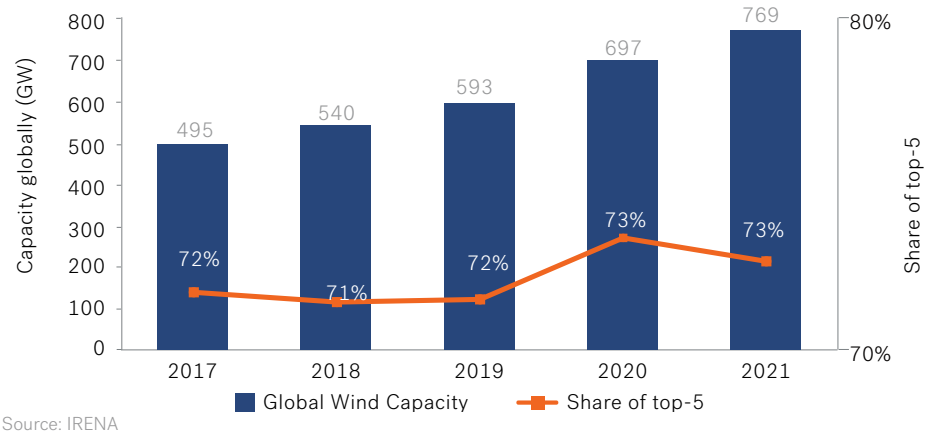
Till 2020, the country's growth could be attributed to the active policy emphasis and support. In 2020, its capacity rose due to the expiring feed-in tariff regime. Since then, it is market-led momentum. All onshore projects are thus treated at grid-parity levels, competing against the conventional generation capacity. The huge domestic demand also sustains a commensurately large backward linkage – China's wind turbine manufacturing corners about two-thirds of the global production capacity in vital components (gearboxes, generators, and blades among others).

While the Chinese global market share remains far from competition, the second largest market by size is that of the US. Wind power has the largest share in the US renewable energy generation. With offshore accounting for a negligible share, the wind power generation so far has been based on onshore capacities. As per EIA, by 2021 wind power generation was 9.2% of the total power supply in the grid. The capacity growth however slowed during 2021. The reasons could be attributed to a mix of key factors such as the base effect of previous year (a spike in 2020), supply chain challenges and the anticipated expiration of production tax credit. Inflationary pressure and the procedural delays (local permissions and power evacuation) add to the developers' challenges in getting timely installations done. It will thus be a while before the capacity addition resumes to a faster clip.

The growth challenges are somewhat similar for the third-largest onshore wind market by size, Germany. In a backdrop where the energy mix is impacted by the Ukraine conflict (resulting in drastic cuts of natural gas supply), and nuclear and coal-fired baseload power generation is phased out, the onshore wind power generation has high expectations of filling in a gap. In 2021, the German onshore wind association reported a 35% rise in installations (including repowering) and marked it less than satisfactory against the requirement to meet climate targets. There are significant challenges in securing timely approvals in siting and other aspects which impact the projects' commercial viability and returns. Progressively this is finding policy focus, as recent instructions for regional-level regulatory changes indicate. Developers could look forward to an expedited route of processing applications for projects. The policy thrust on wind power got an urgency from a looming energy crisis arising from the imminent disruption of Russian gas supply. There are expectations that the country could boost the onshore wind capacity tendering volume to 10GW annually, against the current 2GW.

About 60GW of new onshore wind capacity is targeted in India, the fourth-ranking country in wind power market by size. Realising this target could be challenging, not only due to the constraints involved in critical supply inputs such as land availability but more fundamental aspects such as the prices. Some of the best sites of onshore wind power generation are already developed. With second-best locations, the projects require higher prices for reasonable returns. The aggressive competitive bidding was counterproductive in this regard, as ever lower prices made projects uncertain. The market is thus going through a regulatory transition, as the reverse-auction model of capacity allocation was recently withdrawn for replacement with a better option. All the same, the market fundamentals stay on course as wind energy continues to play a critical role in the country's energy mix.

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



Source: IRENA

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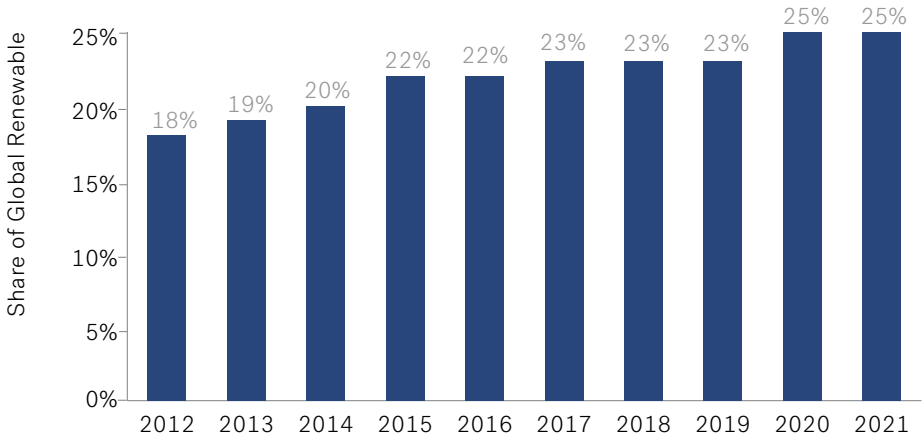
Trends and Drivers

Key Trends and Developments

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

Onshore wind, with a 93% share in total global wind energy capacity continues to play an important role.

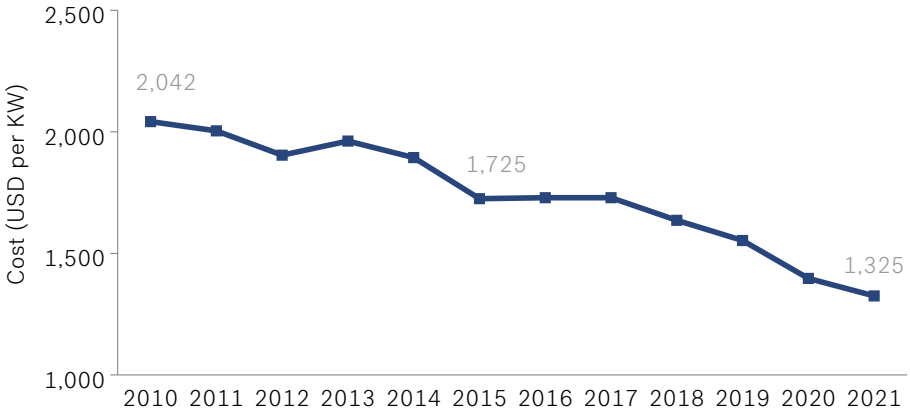
Trend in Share of Onshore Wind in Global Renewable Energy Capacity



Source: IRENA

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

Trend in Weighted Average Installation Cost of Onshore Wind Power



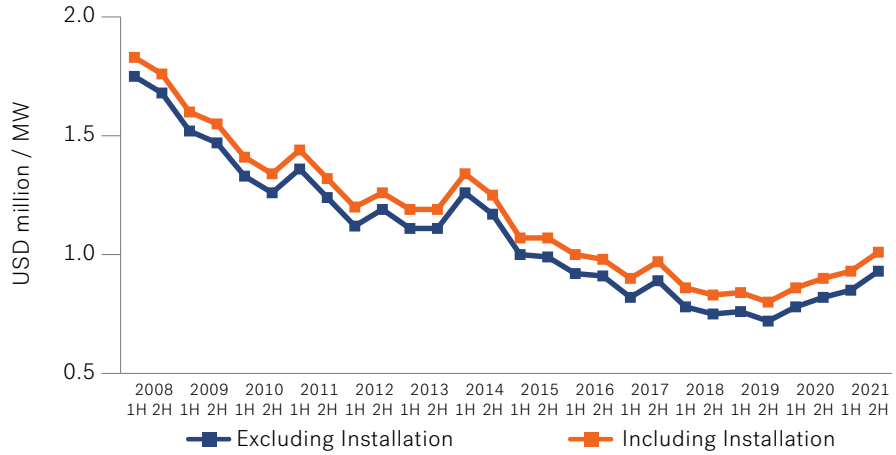
Source: IRENA

Trends and Drivers

Led primarily by the demand strength and economies of scale, equipment manufacturers over the years could maintain and pass on the benefits of cost efficiency. An aggressive competitive scenario helped as well. The historical trend in wind turbine prices confirms the same. Typically, the prices are locked-in on the signing date with the concerned developers, meaning short-term cost pressures get transmitted with a lag – new project orders face higher price to recover the costs in a preceding period. Onshore wind industry's original equipment manufacturers (OEM) are going through the same, and prices are gradually inching upwards as sustaining profitability and margins becomes a challenge.

By end-2021, the average onshore wind turbine prices indicate a reversion to the level in 2016.

Trend in Onshore Wind Turbine Pricing Tracked by Signing Date



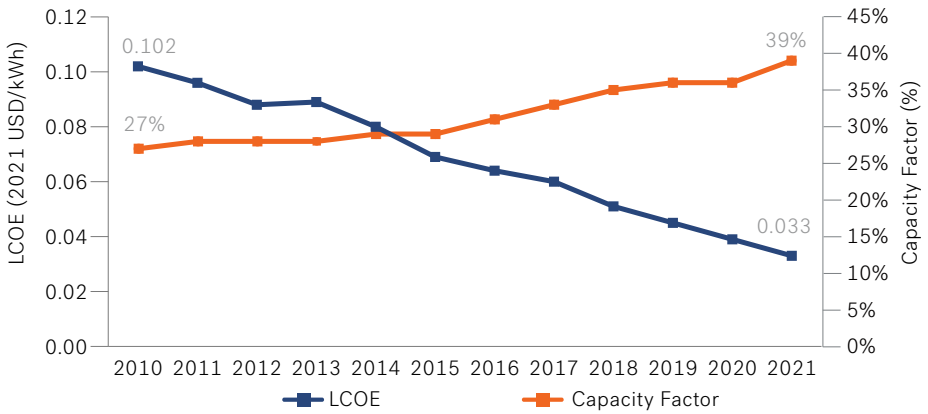
Source: BNEF 1H 2022 Global Wind Market Outlook

By end-2021, the average onshore wind turbine prices, as per BNEF estimates, indicate a reversion to the level in 2016. While aggressive competitive bidding and rationalization in subsidy support set the stage, it was the pandemic of 2020 that aggravated the challenges through supply chain bottlenecks and rapid rise in raw material and basic commodity prices thereafter. Some of the leading global OEMs in the market, such as Vestas, GE Renewable Energy and Siemens-Gamesa cite common factors in their recent releases – material shortages, freight/procurement costs, late deliveries and even breaches of contracts.

There is a near-consensus that the challenges are likely to persist at least through 2022 and early 2023. It could also result in leading suppliers chasing lesser projects than before, to rationalise the cost structure and streamline the product offerings. Notably, such a restructuring phase comes in at a time when the market faces a bullish demand. The same OEMs are also in agreement about the strong demand. For most of the prospective developers therefore, the emerging issue could be potentially of a restricted supply against buoyant demand.

Trends and Drivers

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



Source: IRENA

The trend in onshore wind's levelized cost of energy (LCOE) is that of a consistent decline over the years.

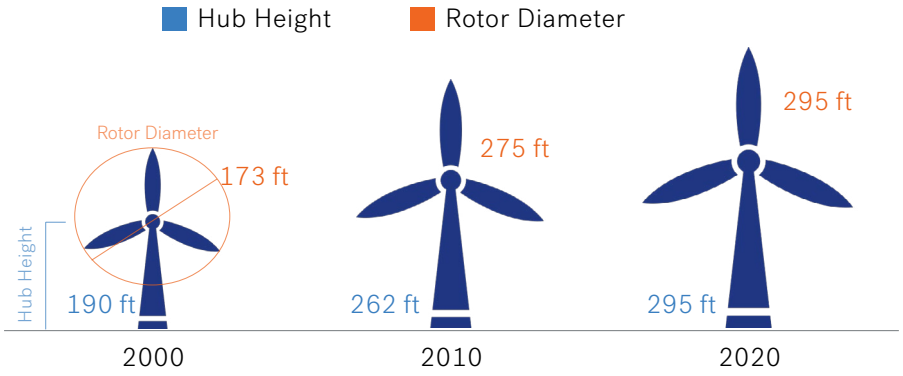
Notably, the trend in onshore wind's levelized cost of energy (LCOE) is that of a consistent decline over the years. Competition and improvisation in the wind turbine equipment technology/grade are some of the major catalysts. OEMs for instance have been launching progressively larger and efficient onshore wind turbines that are cheaper for the wind farm developers to install and maintain. One manifestation of such improvement is the steady rise in wind farm capacity factors. The challenge of wind farm efficiency magnified with each year, as resource-rich locations got taken and developers went ahead with the next-best options.

In fact, wind farms are increasingly expected to operate in low wind-speed conditions. As per a survey of US Department of Energy, wind power experts and researchers project global annual average wind speed for new onshore projects to decline from 7.9 m/s in 2019 to 7.5 m/s by 2035. The Danish entity Ørsted attributed lower-than-normal wind speeds for the impact on its third quarter earnings in 2021.

The trend thus has been to enhance efficiencies in the equipment through a mix of measures including rise in hub heights, larger rotor diameter, or other improvements. In May 2022, the Danish OEM Vestas launched a new offering for medium and low wind-speed, within its 4MW turbine platform. GE Renewable Energy had a similar launch involving a 3.0-3.4 MW platform in low wind-speed, catering specifically to the North American market.

Trends and Drivers

Long-term Trend in the Wind Projects' Configuration



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

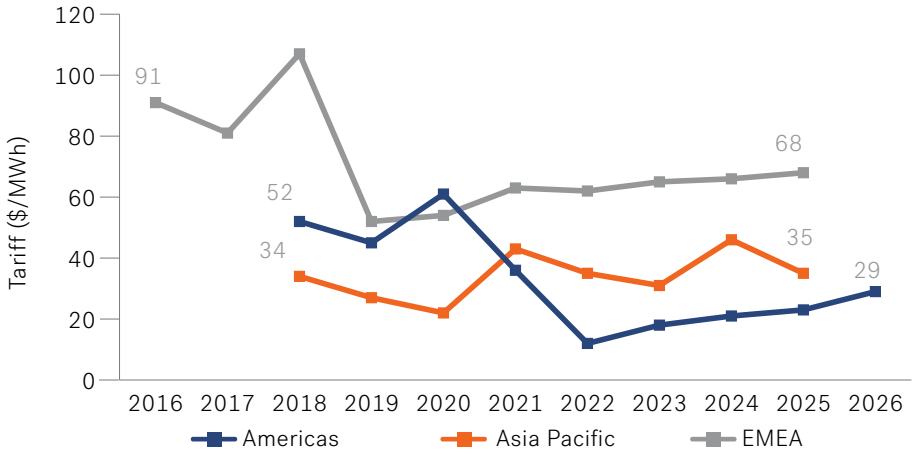
An auction-led project allocation has been the biggest institutionalized driver for efficiency in the onshore wind business.

The continual development of higher equipment ratings in line with the wind resource assessment is one of the major drivers behind the competitive generation cost of the projects. Corresponding to the rising heights and rotor diameters, the average equipment ratings are on a rise. As of end-2021, the average rating of ordered onshore wind equipment in Europe was 4.9MW. In 2018, the same average rating stood at 2.7MW. Further enhancements are likely to be undertaken to meet higher efficiency standards.

An auction-led project allocation has been the biggest institutionalized driver for efficiency in the onshore wind business. The shift away from subsidy led to developers and OEMs chasing very narrow margins for securing winning bids at large-scale capacity allocations. The trend shows that the auction route largely held up its promise of enabling a price discovery. In the process, it also contributed to pricing benchmarks in the energy mix of grid power supply. Notably, as per IRENA's estimates, onshore wind power projects are increasingly achieving LCOE less than 0.040/kWh. The most competitive ones have been observed across regions including Asia (India and China), Europe (Finland and Sweden), Africa (Egypt) and Americas (the US, Argentina and Brazil). The response to auctions undertaken by regulatory authorities globally is encouraging despite the prevalent challenges in the project development space.

Trends and Drivers

Levelized Tariffs in Onshore Wind Auctions by Commissioning Schedule

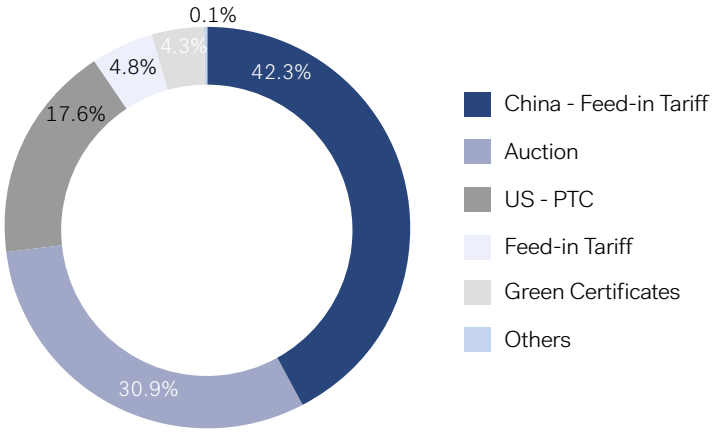


Source: BNEF 1H 2022 Global Wind Market Outlook
Note: Data Points for each year is the average of Levelized Tariffs in Onshore Wind Auctions

Competitive bidding is set to be the default option of capacity allocation in all the renewable energy markets.

In some of the recent auctions undertaken, the role of onshore wind power was notable. For instance, in Spain, a total capacity worth 2,258MW was allocated as of November 2021. This was a technology-neutral auction in which bids based on onshore wind power won the capacity award at an average price of EUR30.18/MWh. A similar bid price (EUR30.15/MWh) came up in the Polish wind power auction in December 2021. But in general, there is a wide variance in auctioned bid prices, suggesting specific local project development factors. UK's auctions in July 2022 had onshore wind power awarded at average strike price of around EUR50/MWh. In June 2022, Germany's Federal Network Agency allocated 931MW (as part of an ongoing tendering) at a volume-weighted average price of EUR58.5/MWh.

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



Source: Global Wind Energy Council

As a market mechanism, competitive bidding is set to be the default option of capacity allocation in all the renewable energy markets. This is borne out not just by the experience so far, but also by the several auctions planned or in pipeline in major markets globally. But the auction-based mechanism could be due for revision in some cases to ensure end objectives are met.

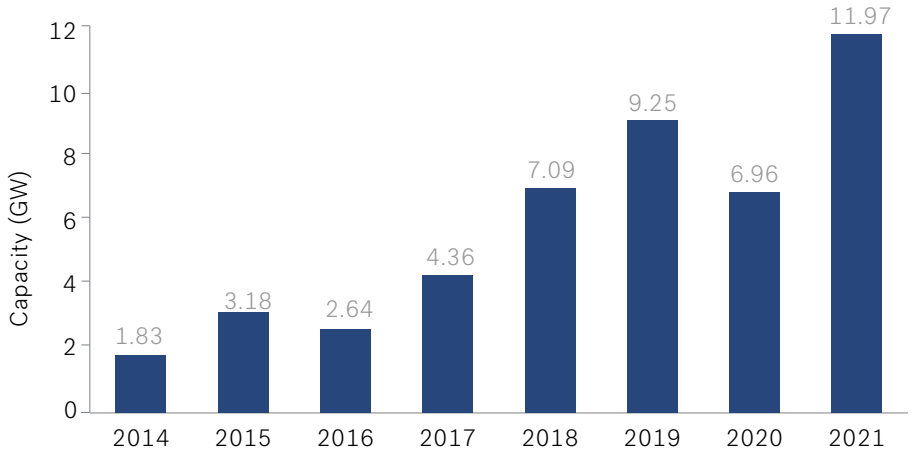
Trends and Drivers

In Ireland the auctions for wind power capacity (both onshore and offshore) had the opposite result of what was intended – average bids have been way higher when compared against the regional counterparts in France, Germany and the UK. Apparently, the reason for this is the additional risk burden on Irish developers such as in terms of inflation and system constraints. A similar case is in the Indian market, where reverse auction process was recently suspended. The government took note of the unsustainable bids that led to artificially lower price quotes. This not only killed the competition but also led to uncertainty in project development and capacity commissioning.

All the same, the market forces continue to shape the growth trajectory. One important result of the rising commercialization is the traction in subsidy-free onshore wind power projects. It has gained ground in the mature wind market of European region. Projects set up under such arrangement typically contract the total generation for the merchant or wholesale power market. The merchant power sales often take the route of power purchase agreements (PPA) with corporate buyers as well as utilities. PPAs help the generators overcome cost of financing subsidy-free projects while managing the generation side on the grid. A recent example is the Finland's 211MW Piiparinmaki wind farm commissioned in June 2022, with a 10-year PPA with Google and a separate agreement with Swedish utility Vattenfall. The trend shows that between 2017 and 2021, corporate PPAs based on wind power tripled in terms of linked capacity.

Between 2017 and 2021, corporate PPAs based on wind power tripled in terms of linked capacity.

Trend in Global Corporate PPA based on Wind Power



Source: BNEF Corporate PPA Deal Tracker

Rising prices in the wholesale power market has also opened the scope of profitability for those projects which are not part of any subsidy support scheme. In present circumstances, this is most clearly observed in case of Europe, where the wholesale power prices surged due to the crunch in natural gas (worsened by the Russia-Ukraine conflict). By end-2021, the value of such PPAs (especially those signed with utilities) rose manifold as cost of grid power spiked. This is also one reason why commercial and industrial entities are considering onshore wind PPAs as part of their options to rationalise total energy costs.

One important fallout of the attractiveness of subsidy-free onshore wind projects in a high wholesale price scenario, is the focus on repowering of old wind power projects. By end-2021, a total 396MW worth of capacity was decommissioned in Europe, while 515MW of repowered onshore wind capacity was brought online during the same year. Most of the repowering during the year took place in Germany and Austria.

Trends and Drivers

Meanwhile, different other technical configurations are under considerations, as developers seek to make the most of the resources available. One such popular one is the hybrid wind farm project that combines energy storage or solar PV, or in some cases even both. Such projects help tap into the best of both technologies. The US market is particularly leading in this space. As per Lawrence Berkeley National Laboratory report, by end-2021 about 19GW worth of wind farm capacity that applied for grid connection, had a storage capacity paired with it. Tri-hybrid projects involving solar, wind and storage are gradually gaining ground. One such project was commissioned in 2021, in which NextEra Energy Resources owned 50MW solar PV, 30MW battery storage and shared a 300MW wind farm with Portland General Electric.

Other markets demonstrate examples of hybrid involving wind and solar. In May 2022, the company Adani Green Energy commissioned India's first wind-solar hybrid generation capacity. Notably, the Indian policy and regulatory authorities took note of the hybrid projects and included the same in the auctions. As of May 2022, a total 5.5GW worth of capacity was auctioned in India for hybrid wind-solar power projects.

European region is gradually picking up the pace. In May 2022, Shell announced the setting up of a 100MW hybrid project in The Netherlands, with capacity equally divided between wind and solar. In Portugal, Endesa (part of the Italian utility Enel) plans to construct Europe's largest wind-solar-storage hybrid power plant, comprising a 365MW solar PV, 264MW wind farm and 168MW of battery storage. It is also important to highlight that this proposed project is meant to replace an existing coal-based power plant.

The emerging technology improvements or improvisations are encouraging for the onshore wind power market. Yet, the business also faces certain basic challenges arising from the lack of timely infrastructure, namely the grid connectivity. In the US, as of April 2022, over 70% of the total wind power generation capacity awaiting grid connectivity was from onshore-based projects. The grid constraints are apparently posing an imminent risk of emerging as a bottleneck in the country's project pipeline. Partly to address such concerns, in June 2022, the US Federal Electricity Regulatory Commission (FERC) issued norms to expedite the existing process for providing power projects' grid connectivity. Similar steps are underway in other countries. The German transmission system operator 50Hertz announced investment plans worth EUR5.6 billion towards expanding and strengthening the transmission assets for upcoming renewable energy projects.

A key focus in grid infrastructural investment is for high voltage transmission systems. Considering that most of the power generation sites are located far away from the demand centres, long-distance and high-voltage power transmission is the key for efficient power evacuation. SuedLink, which is regarded as the world's longest underground power transmission, is a 700km long link based on High Voltage Direct Current (HVDC) technology to connect wind energy to the German grid. The line, to be commissioned by 2027, entails an investment of around EUR10 billion. Power transmission investments is likely to emerge as one of the important factors that could potentially catalyse or hinder the growth potential of onshore wind as well as other renewable energy-based power projects.

A key focus in grid infrastructural investment is for high voltage transmission systems.

04

Outlook

Outlook

The market outlook on onshore wind changed significantly in recent years. While the importance of this segment stays largely unchanged, the underlying market conditions shifted drastically. The Russia-Ukraine conflict made policymakers place the energy transition objectives on a much higher priority. This means a drastic upward revision in the onshore wind capacity requirement for European region. Yet, the strong demand does not automatically guarantee the growth. A multitude of challenges and constraints are likely to impact growth, such as in the permitting delays, rising queues for transmission linkage and the supply chain uncertainties. The net impact on the global market will thus be a combination of both positives and negatives.

Globally, onshore wind will play an important role in meeting the energy transition and net-zero emission objectives.

Following is a review of some of the major factors involved in shaping the onshore wind market outlook.

Policy Objectives and Targets

Globally, the policy targets by the respective governments set the agenda for renewable energy capacity growth. The growth of onshore wind energy will be accordingly placed in the scheme of things. The regions with significant growth trend and outlook are also the ones where policy push played a vital role.

China is thus an important one to highlight and track. The country's renewable energy targets refer to the share in total energy consumption – non-hydro renewables to contribute 18% of total consumption by 2025. It is also notable that the country phased out the feed-in tariff regime for onshore wind by 2021, thus having all new projects on grid-parity levels. While the technology-specific targets are not specified, China's focus on gigawatt-scale projects are expected to drive the next batch of large-scale projects in onshore wind by 2025.

The next key onshore wind market in the Asia-Pacific region is India. The growth outlook however has been an uncertain one due to the policy and regulatory environment. While aggressive competitive bids concentrated the project development to limited provinces, restrictions in sale of power, or the lack of timely evacuation continues to be drag. Further uncertainty was added with the government cancelling the auctions without specifying the alternative market mechanism for capacity allocation.

A better example of renewable energy targets is found in European region. The current target (an updated one as per European Parliament Industry Committee) is to have 45% of total energy production based on renewable energy. This target is a revised one (from 40% earlier), formulated in response to the ongoing energy crisis. It imposes a huge requirement for achieving the required transition. As per WindEurope, an industry association on European wind power, the required annual wind power capacity addition will be about 30GW to help achieve the regional targets. The capacity addition rate so far has been lagging by a far margin. Growth might be restricted to limited markets. For instance, Germany is poised to emerge as a major wind power market due to their thrust on the accelerating capacity addition.

Capacity Growth

Globally, onshore wind will be playing an important role in meeting the energy transition and net-zero emission objectives. The recent ambitious climate mitigation goals and the energy security challenges may have just hastened the process. Even with competition from the offshore wind segment as well as other renewable energy technologies, there are significant tailwinds to drive the momentum.

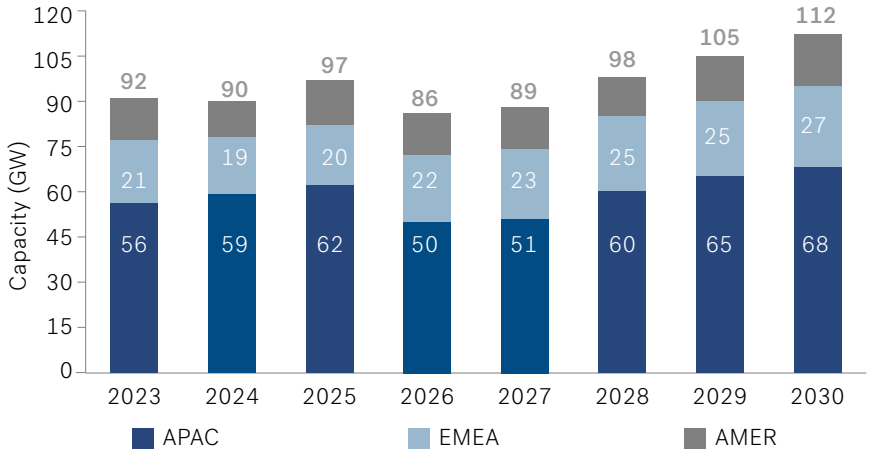
Onshore segment dominates the wind capacity addition projections by various agencies. All of them point to a recovery in capacity addition rate from 2022 onwards. BNEF's estimates indicate new onshore installations of capacity ranging 90GW

Outlook

– 97GW during the years of 2023 through 2025. Notably, these estimates were revised upwards to reflect the changed conditions after European energy scenario (due to Russia-Ukraine armed conflict). Yet, the European share is just second to the Asia-Pacific region's outsized contribution propelled by China. The latter accounts for over half of the onshore capacity addition projection till 2030, due to a combination of factors including competitive turbine costs, gigawatt-scale project clusters and the renewable energy targets.

Auction-based capacity allocation is expected to be the dominant role across markets.

Projected Global Onshore Wind Installations



Source: BNEF 1H 2022 Global Wind Market Outlook

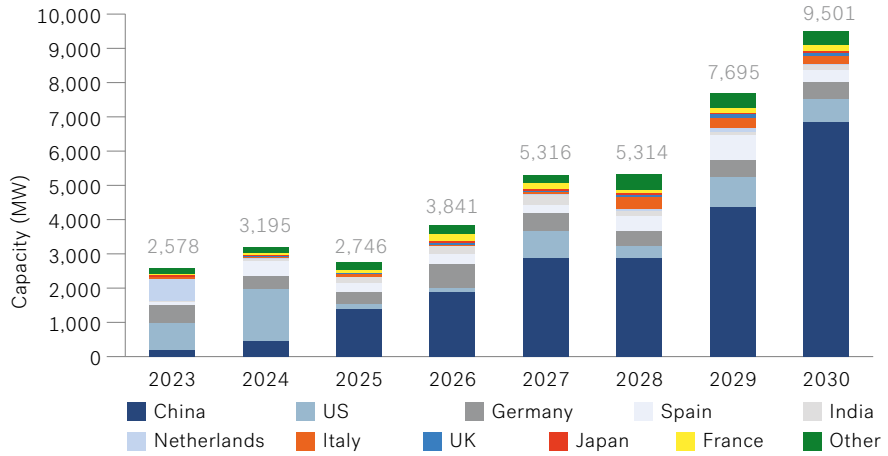
Auction-based capacity allocation is expected to be the dominant role across markets. This is despite the developers' challenges in costs and profitability. The variations will include across auction models of wind-only, hybrid, overall renewables, and technology-neutral auctions. The success of each model would be contingent on the country-specific factors such as in terms of permitting norms and market design. In each case, the prices will be reflective of the local market conditions. This includes factors such as the available wind resource, time lag in approvals, access to financing, timely evacuation facilities, etc.

The European energy scenario in its current state of pressure found reflection in the relatively higher average bid prices (as per recent auctions of Spain, France, Italy, and Germany). Such a pricing pressure is expected to persist in the region for some time through end-2022 and beyond. In some cases, auction norms are being tweaked to signal an incentive structure. For instance, In January 2022, the authorities in Greece notified that wind farms and PV projects with over 10MW in capacity along with storage, will get to participate in the auctions till end-2025. For most part however, the focus is to scale up the capacity. Spain for instance plans a 1.3GW auction-based allocation in onshore wind by November 2022.

The focus on capacity growth, together with the lack of adequate attractive wind resource-rich locations are driving a renewed push towards repowering of onshore wind projects. After the phaseout of the feed-in tariff and subsidy-based regimes across major markets, a significant share of the existing capacity base is nearing the end of useful life. In a usual business case scenario, such assets are retired. In the current circumstances, however, old onshore wind power plants are worth reconsidering for the potential returns. In fact, the spike in European wholesale power prices have made a strong case for developers to consider repowered wind projects.

Outlook

Projected Capacity to be Realised through Repowering of Onshore Wind Projects



Source: BNEF 1H 2022 Global Wind Market Outlook

The global installed storage capacity is projected to grow by 56% over the five years to 2026.

Demand and Adoption of Energy Storage

The gradual stablisation and commercialization of grid-scale energy storage technologies has been a major development for the entire renewable energy sector. Integration of energy storage systems is key to the decarbonization plans across the global power supply networks, as the resulting system flexibility ensures mitigation of intermittency in renewable power supply.

As per the IEA's estimates, the global installed storage capacity is projected to grow by 56% over the five years to 2026. Majority of the growth in such capacity will be through utility-scale batteries, as costs and technology configuration are both favourable. Competitive bidding in select countries, in addition to the development of power markets, have helped enable growth.

China and US account for majority of the projected battery-based storage capacity growth. The Chinese growth is attributed to the government policy support for energy storage business and falling cost of the batteries. To boost the grid-scale storage demand, developers are required to invest in 1-2 hours' storage capacity, which is equivalent to 5%-20% of the renewable energy project capacity.,

Hybrid onshore wind power projects have been a fallout of the favourable trend in battery-based storage. Such power generation projects are coupled with onsite battery storage. In select instances, regulators have taken the cue. There have been hybrid auctions in India and Germany, for developers to capitalize with contracted prices in the range of USD40-60/MWh. More such capacity allocations are likely to follow.

Equipment Manufacturing and Supply

While the demand outlook gets stronger, the supply side increasingly looks constrained. With the supply chain bottlenecks and the cost pressures, most of the leading original equipment manufacturers (OEM) are unable to maintain the same profitability as before. As of August 2022, Siemens Gamesa Renewable Energy announced a cut in its expected earnings margin (-5.5% for full year). The reasons have been a mix of issues, ranging from higher commodity prices to product development and delivery challenges. A similar view could be obtained from the financial data release of another key OEM, Vesta. While some of the cost pressure is finding its way through higher turbine prices, the impact on profitability has been a culmination of aggressive market competition in recent years.

Outlook

Many of the leading companies undertook contract renegotiations during 2021 for their orders. As per S&P Global Commodity, the four leading OEMs of Europe and the US (Vestas, Siemens Gamesa, GE and Nordex) saw their orders decline by 5.2% during 2021. This was a fallout of the contract revisions, as the costs became unsustainable. Addressing this situation will be key for suppliers to remain in business. This could mean accepting a lower order intake to get profitability back on track. Besides higher turbine prices, other measures include contractual clauses on indexation and price revision and charging logistics on a cost-plus basis.

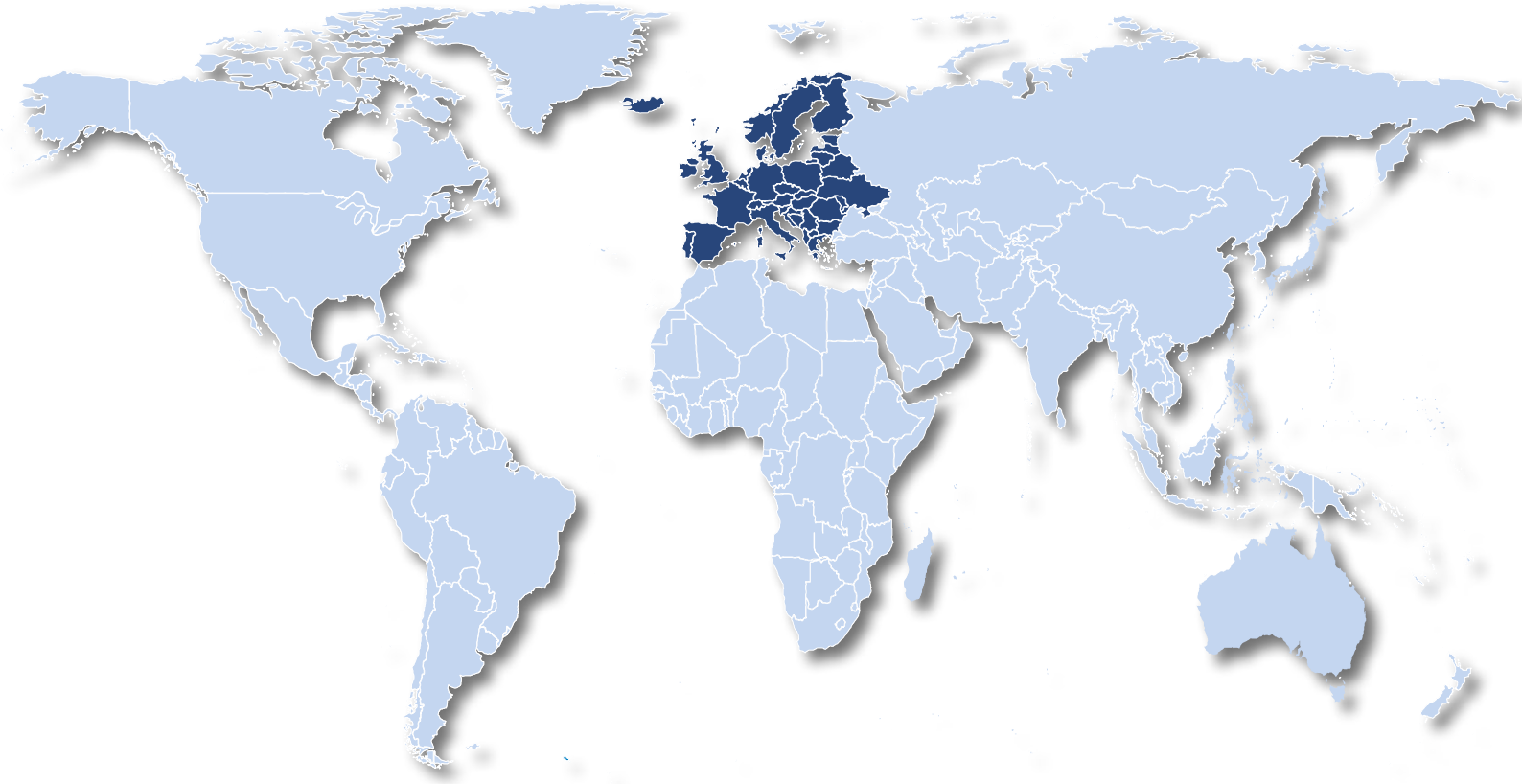
The leading OEMs like Vestas, Siemens Gamesa, GE and Nordex saw their orders decline by 5.2% during 2021.

The cost pressures arising from the commodity prices is transitory. OEMs too are factoring-in the same in their business planning. At the same time, the industry is likely to fundamentally change in terms of the pricing structures involved in the main plant equipment. The traditional models of risk-sharing (involving supply-chain or logistics) may no longer hold, and the developers may be party to some of it. At the same time, the ongoing financial constraints and worsening profitability could make way for another round of consolidation among onshore wind OEMs.

05

Key Regional Markets

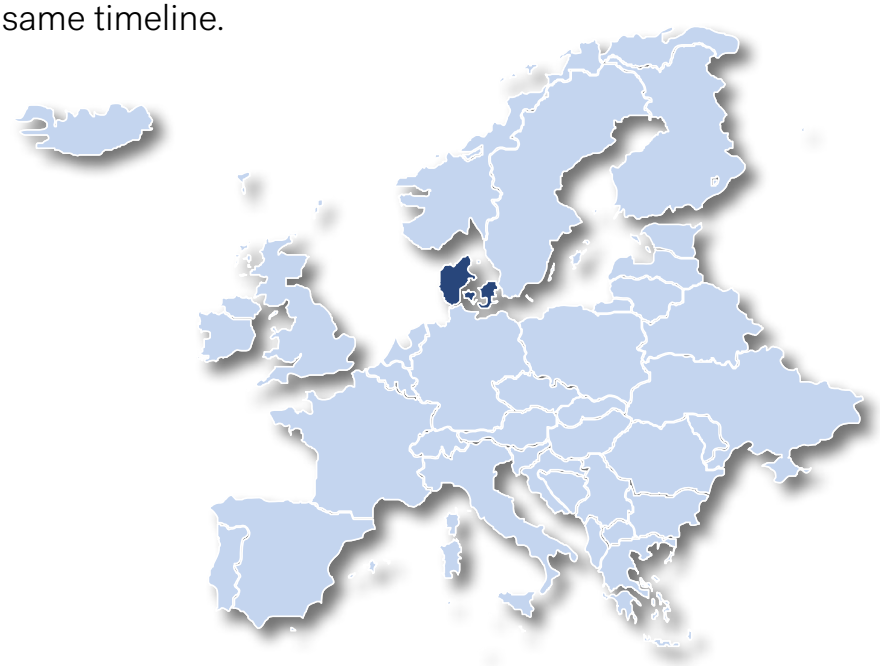
Key Regional Markets - Europe



Denmark

Denmark has traditionally been a strong market for wind energy, having an almost 40-year track record of developing wind turbines. Together with solar power, wind energy (both onshore and offshore) constitutes almost 50% of the electricity generated in Denmark. While this places Denmark in the Top 10 position among European countries in terms of onshore wind installed capacity in 2021, it is likely to lose this position to other faster growing onshore wind markets next year.

Denmark, in line with EU 2050 net zero target, has set milestones under the Danish Climate Act of 2020. The country seeks to reduce the GHG emission by 70% from 1990 level by 2030, while increasing the renewable energy share to 100% in electricity generation and to 55% in overall consumption. Additionally, Denmark is set to phase out fossil fuel by shutting down all coal plants by 2030 and end the sale of petrol and diesel cars within the same timeline.



GDP (Current Prices) USD (2021)	395.71bn
GDP Growth Forecast (constant prices) (2022-2026)	1.88%
Currency	Danish Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	10.3GW
Onshore Wind Share in Renewables (2021)	46%
Renewable Energy Target	2030 target of reducing GHG emission by 70% from 1990 level along with renewable energy share to be 100% in electrivity generation and 55% in overall consumption

GDP Source: IMF WEO, S&P and IRENA

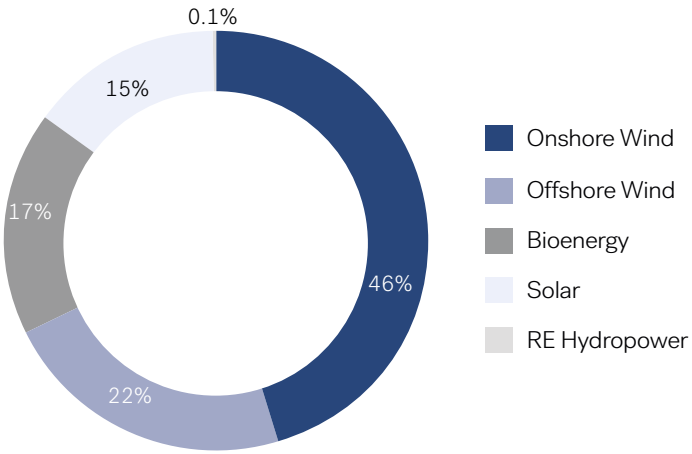
4.7GW Onshore Wind Capacity

- ✓ **Repowering of wind farms remain a major market opportunity**
- ✓ **Development of subsidy-free projects is gaining momentum**
- × Onshore wind deployment is expected to take a hit as policy makers shift focus on offshore wind and solar PV
- × Relatively volatile policy stun towards onshore wind
- × Geographic constraints and public opposition towards onshore windfarms

Denmark

Renewable Energy Mix

Current Renewable Energy Mix 2021

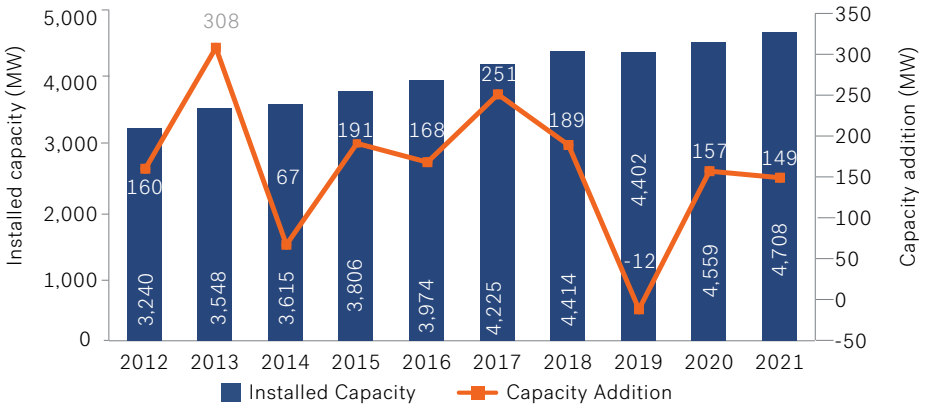


Source: IRENA Renewable Capacity Statistics April 2022

As of 2021, the total renewable energy installed capacity in Denmark reached 10.4GW, of which onshore wind accounted for the highest share (46%). But the share of onshore wind is likely to decline further, as policy makers shift focus to offshore wind and solar PV. The combined share of solar PV and offshore wind in Denmark's renewable energy installed capacity has grown from 29% in 2016 to 37% in 2021.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Onshore wind installed capacity in Denmark has largely remained flat in the past decade, never crossing the 500MW annual capacity addition mark. Geographic constraints and public opposition have imposed a ceiling on the growth potential of onshore wind, with policy makers reallocating resources to the development of the offshore wind energy market. Onshore wind installed capacity in Denmark reached 4.7GW by the end of 2021, adding 149MW during the year, in line with the level reached in 2020 (157MW). This is also in line with the 10-year average annual capacity addition of 163MW since 2012. In contrast, offshore wind installed capacity expanded by 605MW in 2021, the highest annual capacity addition in the 10 years to 2021.

Demand Drivers

A mix of policy push and geopolitical events have served to renew focus on renewable energy, particularly onshore wind and solar PV. In April 2022, the Danish government announced its plans to quadruple generation of onshore wind and solar energy by 2030 in order to meet its sustainability targets and also reduce reliance on Russian gas. This implies adding more than 700MW of solar and onshore wind capacity annually, significantly higher than the average 285MW added in the last five years.

The Danish government has released a policy paper "Denmark can do more II" in April 2022 to outline the measures needed to accelerate the transition to a more sustainable energy system by 2030. It envisages a subsidy-free route to expanding the installed capacity of solar and onshore wind power. Case administration is likely to be expedited, in consultation with municipalities, to remove bureaucratic bottlenecks and ensure shorter path to operational starts.

In May 2021, the European Commission approved a EUR400 million support package proposed by Danish authorities to support the production of sustainable energy from onshore and offshore wind, tidal power, hydroelectric power and solar PV. The aid will be disbursed through competitive auction process between 2021 and 2024, through a Contract for Difference (CfD) mechanism. However, the renewable energy industry is seen to be pivoting away from subsidies, as evident from the lack of participation in the technology neutral auction held in October 2021. Seen in the context of nascent steps in the renewable PPA market, as seen from Better Energy's bundled PPA for solar energy in the beginning of 2022, the potential for the next phase of sustained growth for renewables remains high.

Market Opportunity

Repowering remains a major market opportunity given that Denmark operates the oldest wind turbine fleet globally. As of 2019, ~53% of the installed onshore wind capacity in Denmark was of 15 years or more vintage. Repowering accounted for 86% of the onshore wind capacity addition in 2019. Vestas has been generating steady business in this segment with the latest order from Eurowind Energy A/S, being in June 2022, for repowering 40MW of legacy wind turbines in the Nørre Økse Sø wind farm in Northern Denmark. Persistent issues related to land availability and local residents' opposition to wind farms have resulted in marginal capacity expansion of onshore wind. Repowering represents a viable opportunity to expand capacity without exacerbating the prevailing challenges.

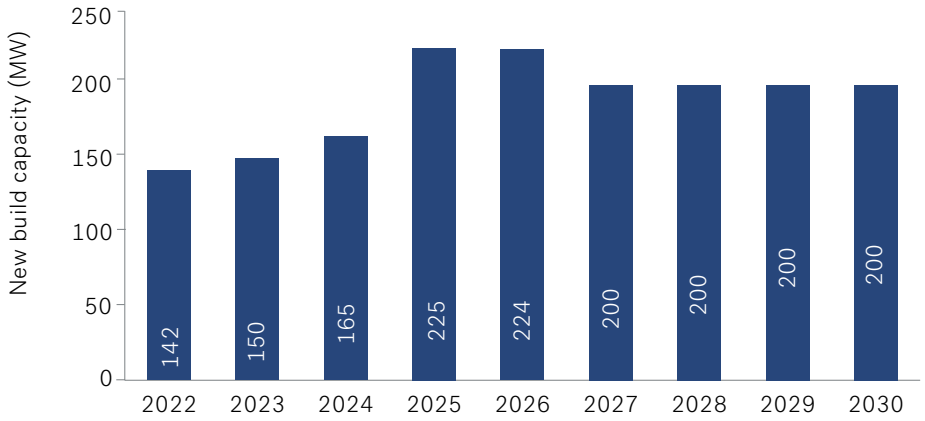
The development of subsidy-free projects is gaining momentum in Denmark, inasmuch as the latest technology neutral renewable auction in October 2021 drew no response from bidders, who were wary of basing their business plans on subsidy support. The advent of subsidy-free projects in Denmark can be traced back to 2019, when a 16.8MW wind farm at the northern port of Hirtshals became operational. The resilience of the onshore wind industry in Denmark is also highlighted through M&A transactions taking place. In March 2022, Eurowind Energy A/S acquired a 325MW portfolio of onshore wind assets from Vattenfall followed by Encavis' acquisition of the 11.5MW wind farm Svoldrup.

Another segment that is seeing some traction in the country is the Hybrid projects involving solar and wind energy. In 2021, Viking Wind installed a hybrid off-grid turbine project in Middelfar with integrated battery storage, which has the capacity to provide 20 to 25 Danish households with 100% renewable energy through the year. While, in 2022 Eurowind Energy announced its plan to build wind-solar hybrid at five onshore energy centres, which can host 1GW capacity cumulatively.

Given the seasonality of the energy generated by onshore as well as offshore wind farms, battery-based energy storage holds significant potential of being a major market segment. The Danish wind market has witnessed some traction in this regard, including setting up of an integrated battery energy storage system at Samso island. Innovative technologies such as the GridScale storage system, which stores electrothermal energy in large tanks filled with crushed stone, offer new avenues of development for the wind energy industry.

Outlook

Denmark's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

As per BNEF, the onshore wind industry in Denmark is expected to witness a marginal acceleration in capacity addition until 2025, peaking at 225MW annual capacity addition before stabilising at an average of 200MW per year from 2027 onwards.

Public opposition to onshore wind, on account of noise pollution and its impact on public health, constrained availability of land and negative impact on scenic beauty of places where wind farms are located are some factors that have contributed to the industry's tepid growth in recent times. To address growing public opposition, the Danish government introduced the Energy Agreement in 2018, which committed to a strategic reduction in the number of onshore wind turbines by almost 50% to 1,850 by 2030 from 4,300 recorded in 2018. Additionally, if the plan doesn't follow through, the new projects are to be suspended until the targeted number of the turbines is achieved. This represents a major regulatory roadblock to the incumbent administration's stated goal of increasing power generation from onshore wind and solar PV technologies.

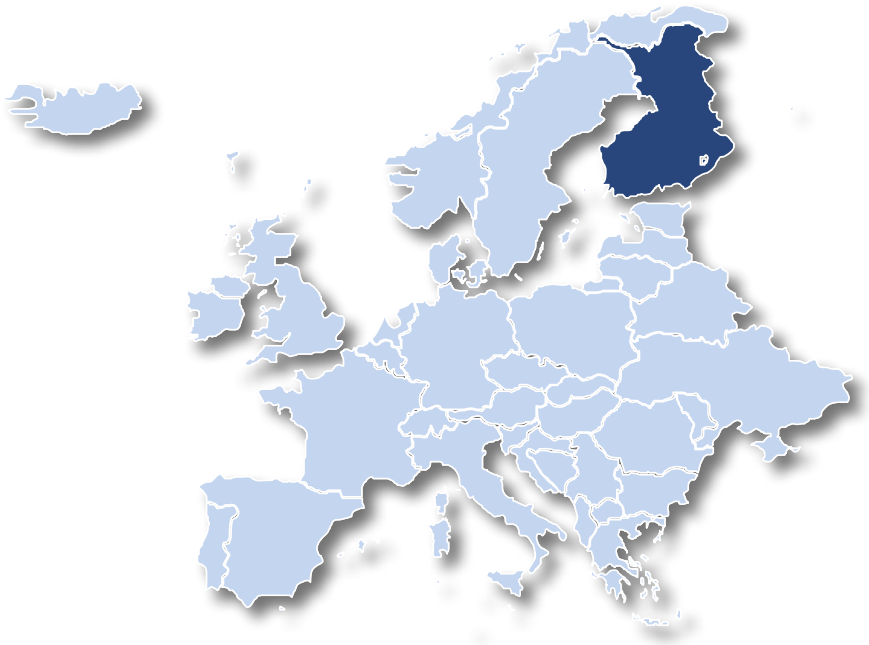
Recent measures to involve municipalities in the approval process can potentially help alleviate the issue of local opposition. Besides, the prevalence of a flexible power system, high degree of interconnection and a robust of ecosystem of turbine OEMs like Vestas bodes well for the continued development of the onshore wind industry.

Finland

Finland has been at the forefront of energy transition policy in Europe having set a target to achieve net-zero by 2035, 15 years earlier than the EU's timeline. The country's National Climate Change policy, adopted since 2015, provides the interim targets to support the rapid transition including 55% reduction in GHG by 2030 and 80% reduction by 2050 from 1990 level. Additionally, various measures were put in place to accelerate the phasing out of fossil fuels in sectors such as transport and power generation, while boosting the share of renewable in overall consumption beyond 45% recorded in 2020.

GDP (Current Prices) USD (2020)	271.62bn
GDP Growth Forecast (constant prices) (2021-2025)	1.87%
Currency	Euro
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2021)	9.6GW
Onshore Wind Share in Renewables (2021)	33%
Renewable Energy Target	Emission-free power generation industry by 2030 and carbon-neutral position by 2035

GDP Source: IMF WEO, S&P and IRENA



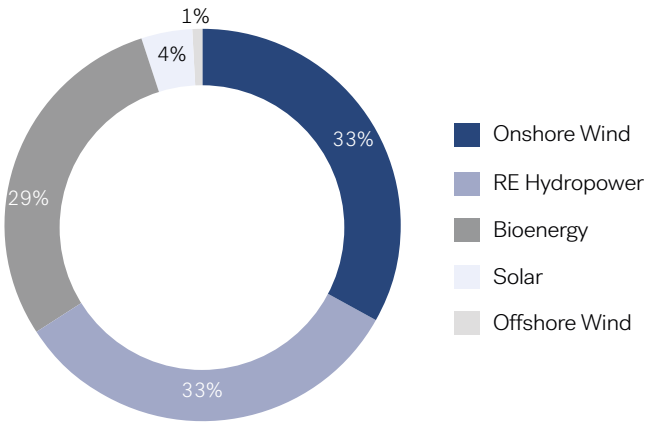
3.2GW Onshore Wind Capacity

- ✓ **Ambitious renewable target of achieving net zero by 2035, 15 years earlier than the EU's timeline**
- ✓ **Long-term development of the grid through Grid Development Plan 2022-2031**
- ✗ Public opposition to onshore wind on account of concerns around environmental impact
- ✗ Limited availability of land with favourable wind conditions to site new farms

Finland

Renewable Energy Mix

Current Renewable Energy Mix 2021

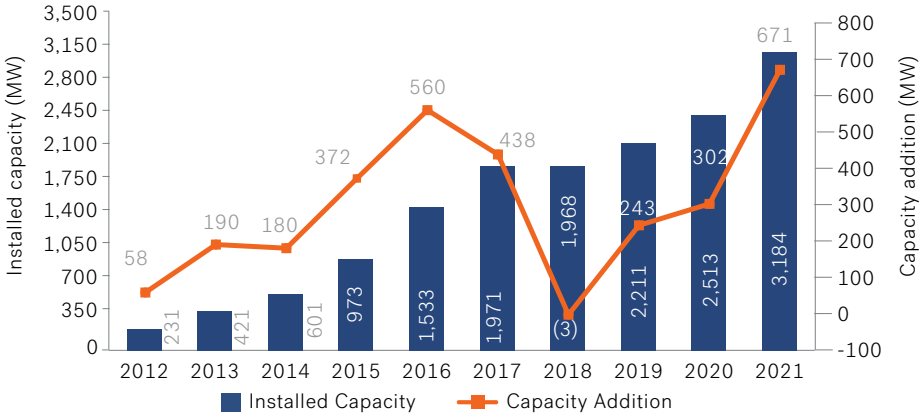


Source: IRENA Renewable Capacity Statistics April 2022

Wind energy, including onshore and offshore, represents the largest source of renewable energy, with a combined share of 34% in Finland's renewable energy mix. Onshore wind has the largest installed base of 3.18GW among renewable energy sources in Finland as of 2021, followed closely by renewable hydropower. Despite its pre-eminence in the domestic renewable energy market, Finland's onshore wind installed base trails its Nordic peers. However, it is undeniable that the sector has achieved sustained growth in the past decade, from a share of 3% of the total renewable energy mix in 2011 to 33% in 2021.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Annual capacity addition for onshore wind in Finland has been volatile, peaking at 560MW in 2016, followed by a sharp drop in the next 2 years. This trend coincided with the withdrawal in renewable energy subsidies after 2017, without an alternate system of competitive auctions being set up. In late 2018, an auction for 1.4TWh of annual renewable electricity generation was held with the entire capacity being directed towards wind energy. This helped onshore wind stage a comeback with annual capacity additions accelerating year on year to reach a record high of 671MW in 2021.

Demand Drivers

Fiscal support has been a key element that contributed to the reversal of fortunes of the Finnish wind energy industry. In 2020, the government allotted subsidies to the tune of EUR335 million to wind producers, to be provided during the first 12 years of the project since the turbines became operational. However, the subsidy scheme regulates the period of project commencement as an eligibility criteria, which is during 2011-2017 only. Tax benefits are also provided to the host municipalities of the onshore wind park, which has helped mobilise local support for wind farms. The property tax rates are applied on the wind power plants with minimum capacity of 10MVA, subject to the age reduction i.e. tax value decreases by 2.5% annually until the minimum tax value of 40% is reached. The wind turbines located in the wind farm are eligible for these tax rates, while the turbines that are not located in the farm are subject to the general property tax rate under the host municipality.

Planned upgrades to the electrical grid network will help cater to a changing electricity generation system. Finnish electricity system operator Fingrid has set up the Grid Development Plan 2022-2031, which is expected to provide the long term development enabling the grid system to meet the requirements of predominantly renewables based power generation. The investment value of around EUR2 billion spanning over 8 years, will also seek to broaden and upgrade the cross-border and main domestic transmission network to enable more renewables capacity to be connected to the grid.

Corporate PPAs have been a major demand driver for the wind energy industry. A record 431MW of power was sold through PPA in Finland in 2020 with 2021 slated to overtake that milestone. Major offtakers such as Solvay, Alpiq, Google and Equinix have signed long term PPAs with wind developers in 2022. In the absence of subsidies since 2018, corporate PPAs, having a duration of 10-15 years, have emerged as an effective funding tool for wind developers. Supportive spot prices and escalation of power prices in continental Europe have contributed to the development of the PPA market, prompting increased participation from utilities.

Market Opportunity

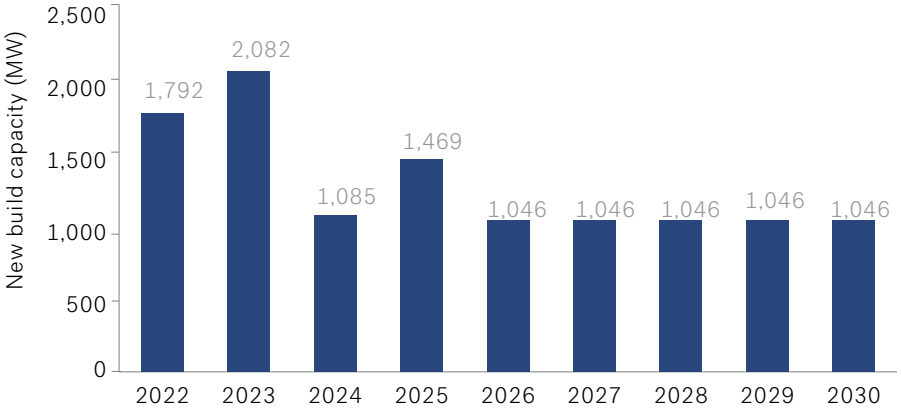
Finland has massive wind power potential with an estimated 21.3GW of wind power projects under various stages of development. While all will not come online, it is estimated that ~7GW of projects have a land use plan or a land use plan with a building permit. The robust project pipeline has helped sustain momentum in capacity addition with 784MW of capacity being installed in the first six months of 2022. This is ~17% higher than the capacity added through the full year of 2021. As per the Finnish Wind Energy Association, 4.25GW of onshore wind projects were under construction in February 2022. With policymakers aiming at 30TWh of wind generation by 2030, the share of wind in the country's electricity consumption is expected to increase sharply from 7% in 2019 to 30% by 2030.

Finland has set international benchmarks for transition to subsidy-free power following the withdrawal of subsidies in 2021. It is estimated that cumulatively 1GW of subsidy-free wind farms are either in the pipeline or commissioned recently in the country as 14 PPAs were signed between 2015 and mid-2021. There is considerable investor interest in subsidy-free wind projects as evident from OX2's EUR650m deal to construct and divest a 455MW subsidy-free wind farm in Finland to a consortium of four Finnish energy companies.

Technological innovations in energy storage in Finland hold promise for the sustained development of the wind and other renewable energy technologies. Neoen was credited with building the largest battery energy storage system (BESS) in the Nordics when it announced in 2019 the construction of the 30MW/30MWh Yllikkälä Power Reserve One project to support the growing capacity of wind farms. More recently, Finnish researchers have been credited with developing the world's first commercial large-scale sand-based thermal energy storage system. Finnish startup Polar Night Energy collaborated with Vatajankoski, a Western Finland-based energy utility, to develop a low-cost way of storing renewable energy for months.

Outlook

Finland's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The onshore wind market in Finland is expected to see elevated activity in the coming years as projects currently under development come online. BNEF projects annual capacity addition for onshore wind to exceed 1GW till 2030, peaking at ~2.1GW in 2023. Finnish Wind Power Association (FWPA) estimates that Finland would have achieved ~5GWW of cumulative installed capacity of onshore wind by the end of 2022. It also expects EUR6 billion to be invested in the Finnish wind power industry between 2022 and 2025, equivalent to the cumulative fixed investment made in Finnish industrial sector in 2021.

Despite the positive outlook, Finnish onshore wind industry has a few challenges to overcome. Public opposition to onshore wind on account of concerns around environmental impact persist despite efforts to educate and shape public perception. Like other smaller European countries, there is limited availability of land with favourable wind conditions to site new farms. Despite investment plans by Fingrid, the existing grid infrastructure is expected to encounter challenges as wind power generation picks pace, contributing to greater generation intermittency. Lastly, the shift in focus towards offshore wind is likely to divert resources, in terms of fiscal incentives and other benefits, away from onshore wind.

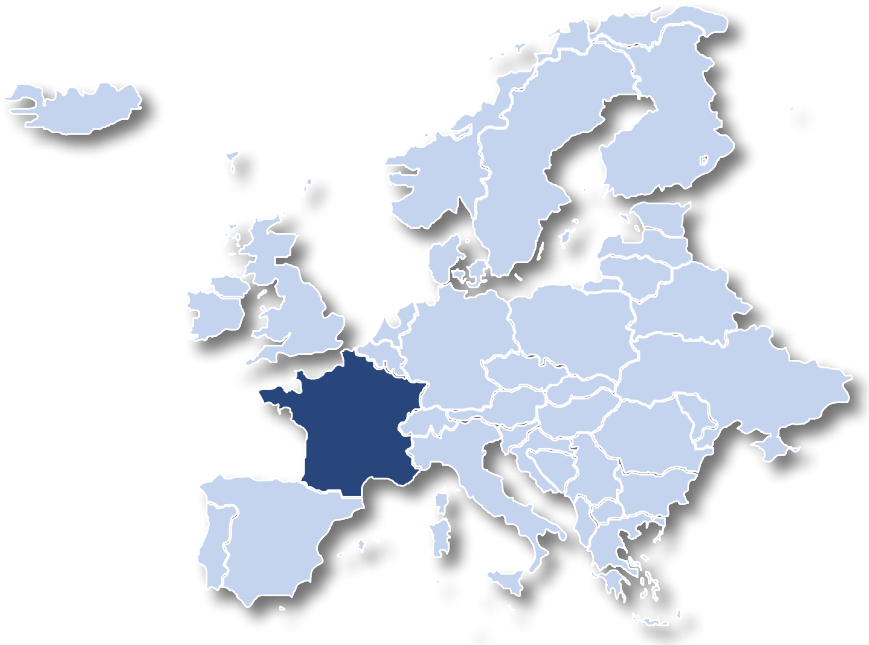
Overall, onshore wind energy in Finland has one of the brightest prospects of development among Nordic countries. Declining wind prices have ensured sustained demand as well as policy support for expanding its share in electricity consumption. With the share of wind energy in electricity projected to increase by more than 4x by 2030, the sustained expansion of the onshore wind industry in Finland is a given.

France

France's energy mix has been undergoing a transition in the past few years, to reduce its over-reliance on nuclear energy by increasing the share of renewable energy as part of the country's sustainability targets. In 2021, France was ranked third in Europe, after Germany and Spain, in terms of cumulative installed capacity of onshore wind. Onshore wind is one of the key renewable energy technologies that French policymakers are basing their decarbonising plans on, accounting for 32% share of the country's renewable energy mix in 2021. The share of onshore wind in France's renewable energy mix has grown steadily over the past decade, from 19% in 2011 to 31% in 2021.

GDP (Current Prices) USD (2021)	2,935.49bn
GDP Growth Forecast (constant prices) (2022-2026)	1.74%
Currency	Euro
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2021)	59.5GW
Onshore Wind Share in Renewables (2021)	31%
Renewable Energy Target	Achieve carbon neutrality by 2050 and 100GW of solar PV capacity by the same year

GDP Source: IMF WEO, S&P and IRENA



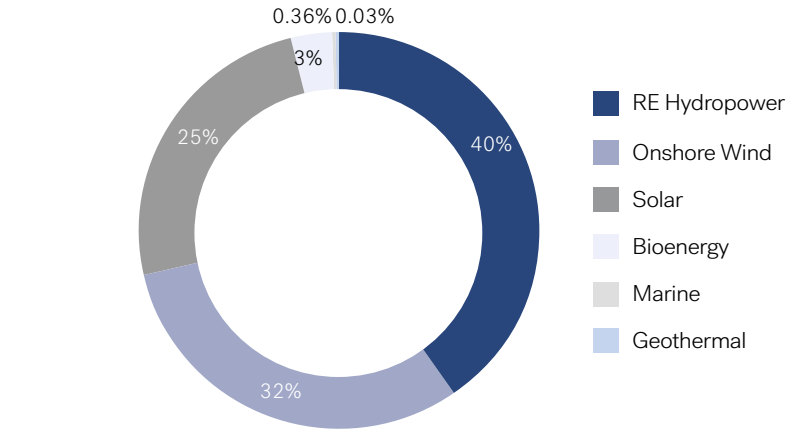
18.7GW Onshore Wind Capacity

- ✓ **Public opinion regarding onshore wind is overwhelmingly positive**
- ✓ **Policy support through multi-year energy plan (PPE)**
- ✗ Policy focus is getting shifted to develop the offshore wind industry
- ✗ Regulatory roadblock in terms of approval time being substantially higher than other major markets in Europe

France

Renewable Energy Mix

Current Renewable Energy Mix 2021

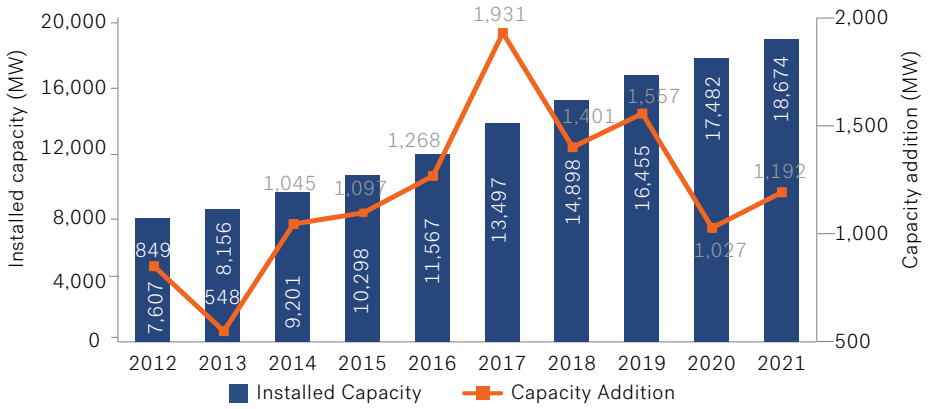


Source: IRENA Renewable Capacity Statistics April 2022

Policy formulation has played a key role in shaping the evolution of the onshore wind energy industry in France. While the 2050 net zero target sets the overarching direction of adoption of renewable energy sources, the national law on Climate and Energy introduced in 2019, sets a target to phase out coal by closing the last four plants in 2022. It a mix by 2035. To achieve the above and ensure a smooth transition to a more 'green' energy mix, policy makers have set out a target to almost double the cumulative installed capacity of onshore wind to 36GW by 2050.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Between 2014 and 2021, France has registered a steady annual capacity addition for onshore wind which has averaged 1.3GW during this period. Capacity addition peaked at 1.9GW in 2017 on the back of supportive regulatory framework and funding support to the tune of EUR1 billion. Disruptions caused by COVID-19 led to a sharp decline in capacity addition to ~1GW in 2020 before staging a recovery last year (~1.2GW), although still below the seven-year average of 1.3GW.

In 2020, the French government introduced the 'France Relance Recovery Plan' to support affected industries. Out of a total budgetary outlay of EUR100 billion, EUR30 billion were dedicated to sustainable recovery objectives to speed up the transition. However, it is widely acknowledged that France is lagging on its renewable energy targets with the current share of 20% in electricity production being half of the target of 40% by 2030. Within wind energy, policy support is expected to shift to offshore wind from onshore through this decade with 40GW of offshore wind capacity expected to come online.

Demand Drivers

Competitive auctions have helped trigger a downward trend in wind energy prices, helping the technology achieve a level of competitiveness vis-à-vis other energy sources. In the latest auction in 2022, 510MW of onshore wind capacity was awarded at an average price of EUR59/MWh, down from EUR62.9/MWh in 2020. The price differential with other major energy sources such as nuclear (EUR110-120/MWh for new nuclear power) has been a major factor in driving adoption of wind power.

Policy support has also been crucial to ensuring sustained development of the onshore wind market. The multi-year energy plan (PPE) envisages a cumulative installed capacity of 33.2-34.7GW of onshore wind by 2028. This implies an average annual capacity addition of 2.1-2.3GW in the next seven years, which will entail an increase of ~60-75% over current levels. Unlike many other European countries, public opinion regarding onshore wind remains overwhelmingly positive with almost 80% approval among residents who live in close proximity (10 km) to a wind farm. This is crucial to ensure sustained expansion of the onshore wind industry as public support is a key element in the regulatory approval process for any new wind farm.

Authorities have also attempted to simplify the process of regulatory approval through a host of measures such as reducing the need for lighting and signalling on turbines, improving the recycling of wind turbines, streamlining the consenting process and prioritising the impact on local communities and citizens to avoid any legal hurdles down the line.

Market Opportunity

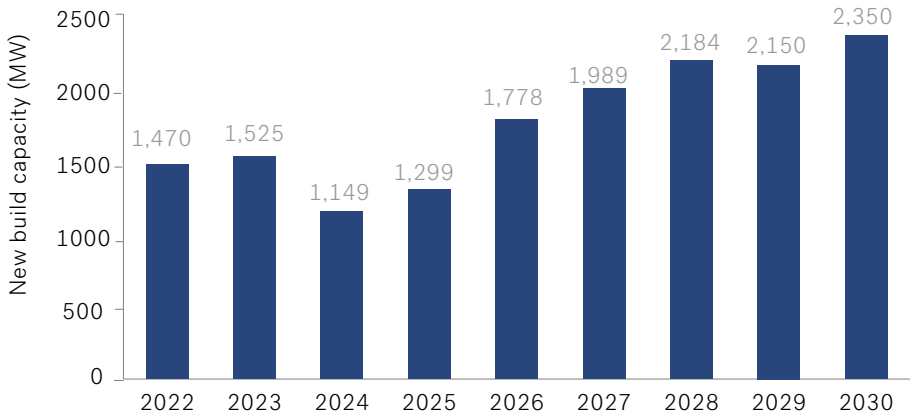
Having trailed behind its European peers on sustainability target for the better part of the previous decade, France is stepping up financial support to the renewable energy industry to spur capacity growth and accelerate the transition. In July 2021, the European Commission (EC) approved the French aid scheme with provisional budget of EUR30.5 billion, which provides the grants to renewable operators, including onshore wind, awarded via competitive tenders for a cumulative new renewable capacity of 34GW that would be organised between 2021 and 2026.

While the PPA market in France in still at a nascent stage, transactions in the public and private sector indicate growing traction for this market segment. In mid-2021, a PPA was signed between ENGIE and the Departmental Council of Meurthe-et-Moselle to set up a wind farm to fulfil the demand for clean energy from a catchment of almost 70,000 people. In Q4 2021, RWE entered the French wind market by signing a PPA with Statkraft, involving RWE's first plant in the country. Similarly, Boralex, a Canadian renewable energy company, has secured three PPA's in France, with the latest being a 5-year contract with IBM France in April 2021.

Repowering of legacy wind turbines represents another significant growth potential as the unit power of wind turbines in France in 2020 was among the lowest in Europe – 2.7MW vis-à-vis 3.3MW average). It is estimated that 3,565 wind farms will reach the end of their operational life by 2025, entailing an investment of EUR18 billion for repowering them. In Q4 2021, a German wind turbine manufacturer, Vensys got the order to repower 24MW wind farm of RES SAS.

Outlook

France's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Despite visible progress, France had had mixed success in its energy transition efforts with several major policy initiatives and targets being pushed back. The plan to reduce the share of nuclear energy from 70% to 50% by 2025 has been extended to 2035 to ensure energy security in the face of escalating gas prices. The country has the ignominy of failing all its renewable energy targets since 2010 and was conspicuous in being the only EU country to fail meeting its target of 23% renewable energy in 2020.

BNEF forecasts patchy growth in annual capacity addition of onshore wind, peaking at 2.35GW in 2030, but still well below the level required to meet the target of 2030.

There are significant challenges to the sustained expansion of the onshore wind industry in France. The biggest is the stated policy focus to develop the offshore wind industry which has been almost non-existent till the end of 2021 with 2MW installed capacity (IRENA). With 40GW of offshore wind capacity targeted by 20250, the bulk of government resources is likely to be diverted towards that technology to the detriment of onshore wind. The politicisation of onshore window along political lines is also likely to wean away some of the public support for the sector. Regulations represent another major challenge, with the approval time being substantially higher than that in other major markets like Germany. Restrictive orders like the one issued by French Ministry of Defence in mid-2021, wherein wind turbines must be installed at minimum distance of 70km from military radar, instead of 30km allowed previously, are further slowing growth.

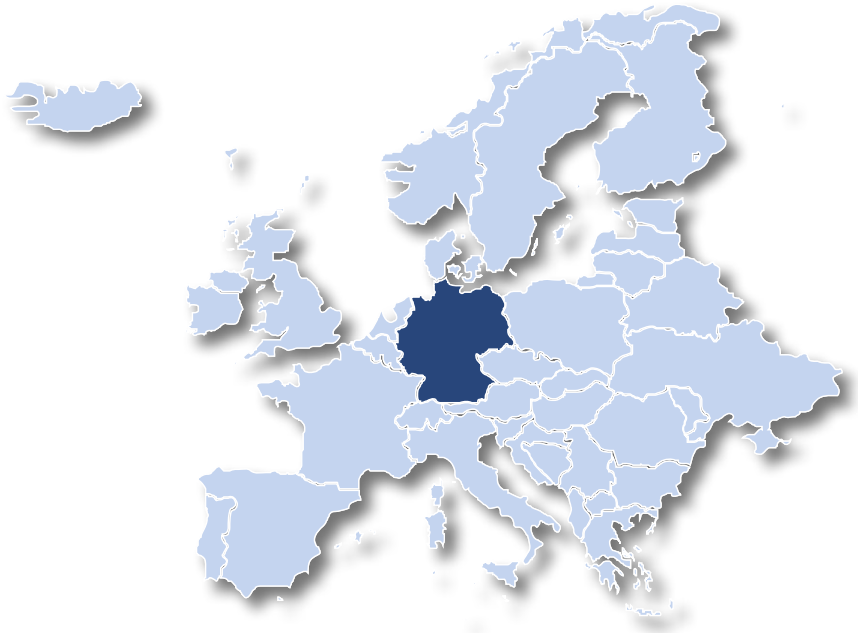
While it is obvious that renewable energy is likely to play a pivotal role in France's quest to achieve Net Zero by 2050, IEA has recommended a marked increase in investment levels for the country to have a realistic chance of successfully attaining its sustainability goals. The trends in capacity addition in the near term is likely to offer a view of the overall progression of the onshore wind industry in France.

Germany

Germany has had a leadership position in onshore wind power. It is gradually taking the steps to recover the lost ground, as energy transition becomes the highest the priority in public policy (hastened by the European energy crisis). From a policy perspective, onshore wind has an important role in the renewable energy objectives which is why legislative amendments were done to ease the constraints in the project development. More are in the offing to expand the project pipeline.

GDP (Current Prices) USD (2021)	4,225.92bn
GDP Growth Forecast (constant prices) (2022-2026)	1.78%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	138.2GW
Onshore Wind Share in Renewables (2021)	41%
Renewable Energy Target	80% renewable generation by 2030 and 100% by 2035

GDP Source: IMF WEO, S&P and IRENA



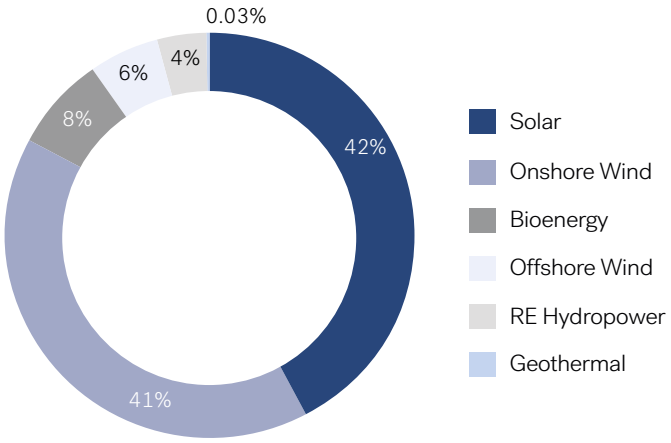
56.0GW Onshore Wind Capacity

- ✓ **Policy support through enactment of new legislation**
- ✓ **Increased investment in hybrid projects involving battery storage alongside the onshore wind farms**
- × Land distribution for upcoming projects is highly skewed, with southern states being awarded less than 3% of the projects in March 2022 auction
- × Higher capital cost compared to other European countries due to limited land availability

Germany

Renewable Energy Mix

Current Renewable Energy Mix 2021

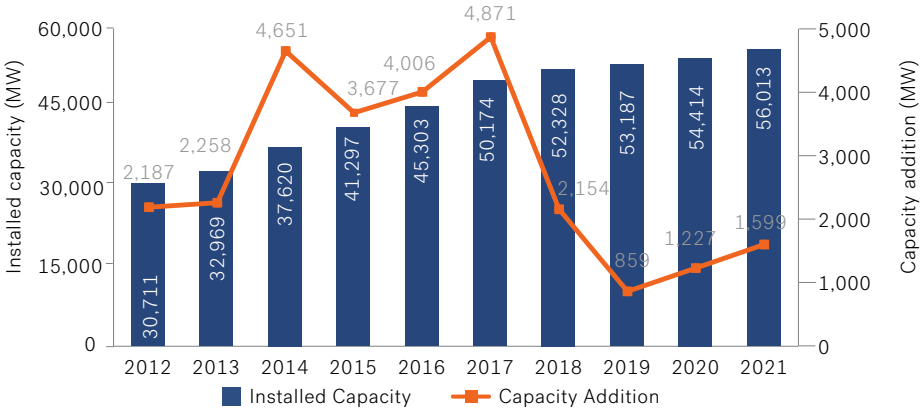


Source: IRENA Renewable Capacity Statistics April 2022

Onshore wind power's relative contribution in the renewable energy mix ranks second after solar power. The competition is likely to stay higher considering the rapid offtake in solar from both grid-connected and off-grid mediums. Yet, onshore wind power projects are progressively expected to fill in the gap from closure of coal and nuclear power plants.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

The trend in onshore wind capacity base shows a wide variance in the rate of growth. There is a marked contrast between the average 4GW incremental annual capacity during 2014-2017, and the below-1GW level by end-2019. The 2017-2019 was a phase when the prospective projects dried up due to challenges in project development, especially in terms of permitting delays. The results were also seen in terms of abysmal responses in the auctions. Since then, the industry has turned around.

Demand Drivers

Germany has set out ambitious energy transition objectives – involving a phaseout of conventional energy resources (fast-tracked by the gas crunch due to Russia-Ukraine conflict) to be replaced with renewable energy. The aim is to source 80% of total power requirement from renewable energy resources by 2030. This goal is to be met through capacity of about 115GW worth of onshore wind power generation. .

As of July 2022, the German government enacted a legislation aimed at expanding onshore wind capacity addition to over 12GW annually by 2025, and 10GW thereafter. To enable the project pipeline in meeting such objectives, the legislation provides for improvements in onshore wind permitting. This development came as a boost to the country's onshore wind market that has otherwise been stagnating lately due to constraints arising from land, approvals and costs.

The concerns of project sites and permitting for instance could find a redressal with the enactment of new legislation. About 2% of the available land area must be allocated for onshore wind power projects. German states that have so far been unable to allocate 2% of their territory for onshore wind, could now (with the new legislation) exchange up to 50% of their designated sites with an overachieving state. Such sites will have to be bought within the framework of state contracts. For developers this could possibly enable a better project development schedule.

Further, various states are gradually considering amendment to the norms related to minimum distance of the onshore wind projects from residential areas. While this is not mandatory for those which allocate the designated land area of the projects, various provincial authorities are considering measures to help the case of expediting the project planning. There are additional simplifications in procedures available to enable repowering of wind power projects in existing sites.

The streamlining of procedures becomes important when developers no longer have feed-in tariff support and instead must secure projects on a competitive basis. The resulting market orientation helped propel power purchase agreements. Statkraft for instance has been catering to the industrial consumer requirements through the PPA route since the expiry of FiT. At the same time, competitive bidding has emerged as the major route of project allocations thus driving investor interest.

Market Opportunity

As per WindEurope's report, by end-2021 Germany had investment worth EUR3.1 billion towards the new onshore wind power projects. This corresponded to 2.1GW.

The country's onshore wind project pipeline is progressively set by the auction-based tenders. As of March 2022, about 1,330MW worth of capacity was awarded, at a weighted average bid price of EUR57.7/kWh. As per the regulator, the auction attracted 141 bids, indicating the investor interest in this market. It is also a contrast to the situation during 2017-2019 when multiple auctions went under-subscribed.

At Germany's average capital cost of EUR1.5 million per MW in onshore wind projects, the total capacity auctioned in March 2022 is close to EUR2 billion. The capital cost is relatively higher than other European countries due to the constraints in land availability. Another round of auction that was concluded in June 2022 yielded 931MW of onshore wind capacity allocation.

While new capacity development gets the investment interest, repowering finds a renewed focus. By 2025, about 16GW could be at the end of its commercially useful life. This presents a clear opportunity for the OEMs to tap into the refurbishment demand. Some of the notable examples include Vestas (42MW order in December 2021 for Wöhrden repowering project) and Nordex (72MW order in April 2021 for the Reussenkroege wind farm).

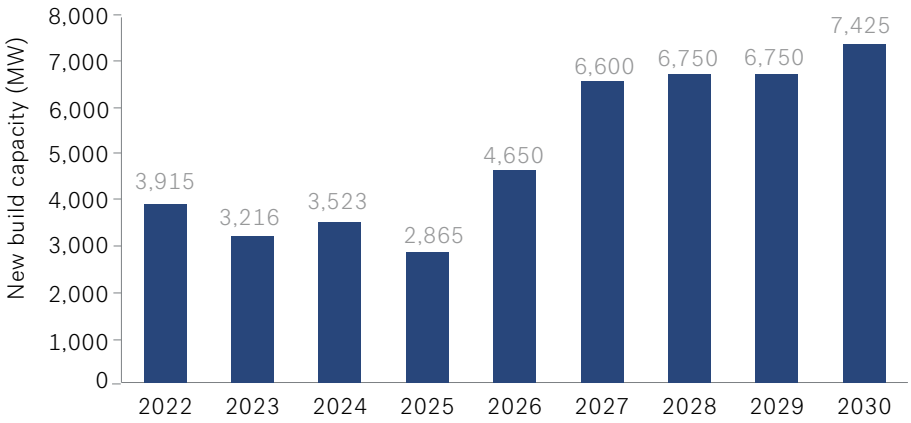
The offtake for energy from the onshore wind farms is high among industrial and commercial consumer segment. Lately, this is the trend that appears to be discernible, based on the PPAs signed by major developers/owners of the onshore wind farms. In April 2022, Statkraft signed PPA with cement manufacturer OPTERRA for a contracted 300GWh of power based on both onshore wind and solar. Similar PPAs were signed by Statkraft in other industry groups as well including telecom, automotive, and food among others. Notably, in most of the cases, the supply was contracted against onshore wind projects operating post-expiry of the tariff support facility.

The rising demands of energy transition is also driving investments towards hybrid projects, involving battery storage. The first such hybrid project was installed in July 2022, involving the developer Juwi AG and battery storage supplier Smart Power. While most of such hybrids are skewed towards the solar-based generation, the combination with onshore wind is being gradually taken up.

The German bulk power transmission network will need significant upgrades and expansion in capacity to accommodate the rising renewable energy-based generation. For the grid operator, the energy transition is further challenging because of the ongoing phaseout of coal and nuclear power generation – sources which generally act as the stable baseload in grid dispatch. As per a study commissioned by E.ON., the estimated investment requirement is about EUR110 billion by 2050.

Outlook

Germany's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The German onshore wind market's project pipeline could expand significantly due to the policy focus on the matter. The BNEF projections indicate an average annual capacity addition of 3GW between 2023 and 2025, after which it could rise to an average 6GW. If the currently planned policy initiatives are successful, an expanded pipeline could potentially double the latest projections.

The optimistic outlook for Germany's onshore wind stems from the important measures at simplifying the permitting process. By end-2021, as per WindEurope's estimates, over 4GW of new onshore wind capacity secured permits. This was 2.5 times the annual capacity permitted during 2017-2019. The new legislation could help release a higher capacity volume to augment the installed base. While all this is still under the works, it has helped signal investors towards the upcoming bullish phase.

The policy push for states allocating land for upcoming capacity, while helpful, could also result in a skew. The recent auction of March 2022 partly reflects such a picture. Most of the wind projects awarded in this auction are concentrated in the north and centre of Germany. In contrast, the southern states (Bavaria and Baden-Wurttemberg) had just four projects out of the 141 that got awarded. One way to mitigate this could be through initiatives undertaken by the respective states. For instance, the state of Bavaria plans to enable municipalities to relax the distance guidelines involved in wind project siting, so that there are more projects eligible.

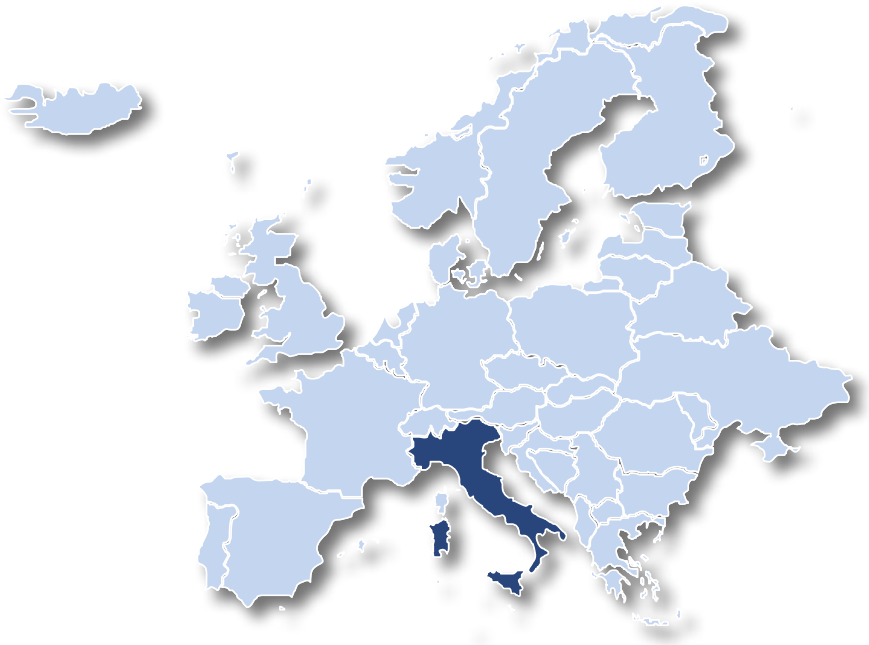
The urgency to enhance renewable energy share in energy mix is a positive sign. Yet, the energy transition is likely to be a complex one, in which the energy basket and the role of various energy resources must be worked out. Germany's dependence on gas for instance cannot be drastically reduced without alternate supplies in place. Onshore wind, along with other renewable energy resources will need to be supported by multiple systems including flexible options such as energy storage, regional interconnections in power supply as well as technology-led grid management for efficiency.

Italy

Italy is a key market for renewable energy in Europe, positioned fourth in the continent with ~57GW of renewable energy installed capacity. Italy's renewable energy mix has traditionally been skewed towards solar PV and renewable hydropower, which cumulatively accounted for 73% of the installed capacity in 2021. But onshore wind has been making steady inroads and its share of the installed capacity has risen from 16.9% in 2011 to 19.8% in 2021. As of 2021, Italy had the fifth largest installed capacity of onshore wind in Europe (not considering the UK), after Germany, Spain, France and Sweden.

GDP (Current Prices) USD (2020)	1,891.06bn
GDP Growth Forecast (constant prices) (2021-2025)	2.59%
Currency	Euro
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2021)	57.0GW
Onshore Wind Share in Renewables (2021)	20%
Renewable Energy Target	2030 target of reaching solar PV upto 52GW along with renewable energy share of 55% in electricity generation and 30% share in total energy consumption

GDP Source: IMF WEO, S&P and IRENA



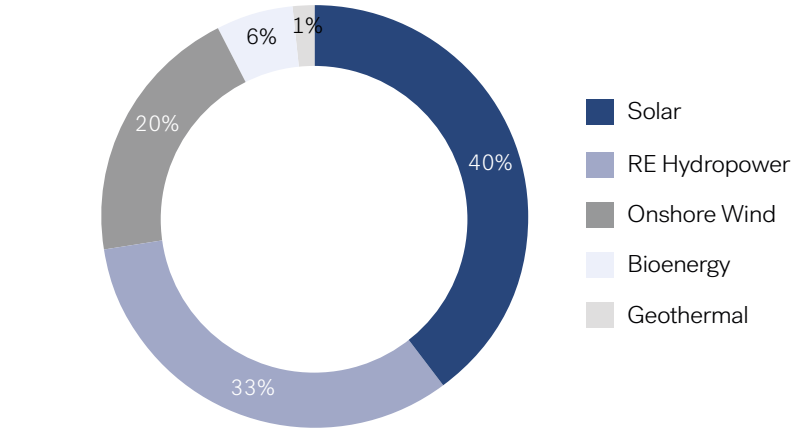
11.3GW Onshore Wind Capacity

- ✓ The National Recovery and Resilience Plan targets wind energy generation capacity of 19.3GW by 2030
- ✓ Budgetary support through the allocation of EUR68.6 billion under 'Green Revolution and Ecological Transition scheme'
- ✗ Slow project rollout due to complex approval process and delayed permit
- ✗ Lack of policy and local support creates bottlenecks in achieving the renewable energy target

Italy

Renewable Energy Mix

Current Renewable Energy Mix 2021

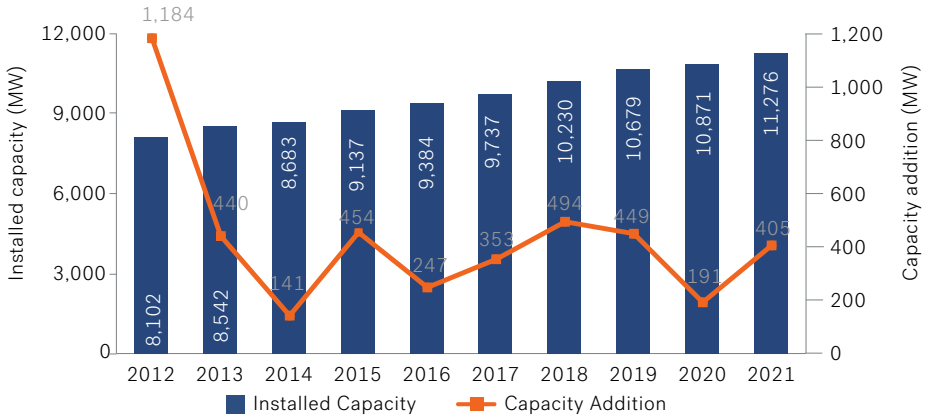


Source: IRENA Renewable Capacity Statistics April 2022

Aligned to EU's 2050 net zero target, Italy has set out its intermediate renewable energy goals such as increasing share of renewable energy to 55% in electricity generation and 30% in total energy consumption by 2030 as a part of National Integrated Energy and Climate Plan ("PNIEC"). In case of wind energy, the plan seeks to double the existing wind capacity as well as its share in electricity in the country.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Onshore wind capacity addition in Italy has been sluggish for the better part of the last decade. In the last nine years, annual capacity addition has averaged 353MW as per IRENA data, failing to breach the 500MW mark in any of the years. The last time annual capacity addition crossed the 1GW mark was way back in 2012, when it touched ~1.2GW.

The development of the onshore wind industry in Italy has been restricted to geographic pockets, particularly in Southern Italy, limiting the maximum growth potential of the technology. Since 2012, smaller sized wind energy plants, having capacity ranging between 20-200kW have been installed, which have had a muted impact on the overall installed capacity in the country. An onerous permitting mechanism has meant that developers favour smaller sized projects instead of utility-scale ones to hedge their planning risks.

Demand Drivers

The 'National Recovery and Resilience Plan' introduced in 2021 envisages a cumulative installed capacity of 19.3GW by 2030, to help achieve the target of 30% share of renewables in the country's energy mix by 2030. This would have implied adding 1GW of onshore wind capacity annually through to 2030, but the revised EU target of 40% share of renewables has meant that capacity addition needs to be higher. Budgetary support through the allocation of EUR68.6 billion under 'Green Revolution and Ecological Transition scheme' is expected to provide a fillip to the technology's expansion.

Soaring gas prices has led to wholesale electricity prices in Italy tripling in 2021. The widening price differential with renewable power like solar PV and onshore wind has meant that the latter is almost 3x cheaper, thereby fuelling the their demand by retail and institutional consumers alike. Competitive auctions had also helped in driving down wind power prices till 2020 when it reached EUR48.62/MWh in the first joint technology tender at the start of 2020. Prices have reversed direction since then in the face of waning competition and flagging demand in the subsequent auctions, but the contracts for difference (CfD) mechanism still represents a viable option to ensure cost competitiveness of wind power.

A convoluted and lengthy permitting process has represented a significant challenge to the development of wind farms in Italy. Regulatory measures to resolve this bottleneck are underway and can potentially lead to acceleration in project approval and capacity addition. In March 2022, the Council of Ministers authorized six wind projects with a combined capacity of 418MW and signalled an effort to streamline the approval process of large utility-scale renewable energy projects going forward to reduce reliance on gas imports. This was preceded by the approval for two more wind projects with an aggregate capacity of 65MW in February through a more streamlined permitting process.

Market Opportunity

Development of wind energy in Italy has been historically skewed towards the southern part of the country, resulting in 90% of wind farms being located in the region. Italian wind association ANEV estimates that 2GW of incremental capacity can be installed by exploring the feasibility of regions, particularly the power consuming centres in central and northern Italy, which have hitherto remained out of consideration.

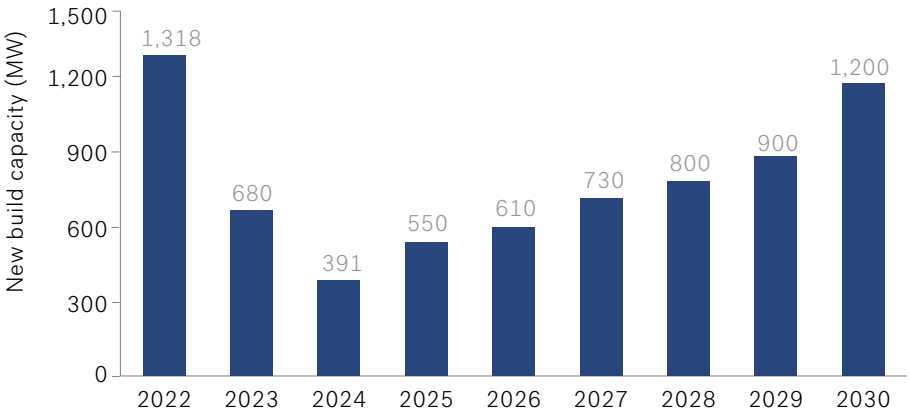
The corporate PPA market remains at a nascent stage in Italy. But there are early signs of initiatives to harness the potential from this segment as seen from two major long-term wind PPAs which were signed in 2021. One was a 10 year PPA signed between ERG Power generation (subsidiary of ERG) and Telenergia (subsidy Italian company Telecom Italia (TIM)) to supply 3.4TWh of green energy from the wind farm portfolio majorly situated in region of Basilicata during 2022-2031. The second major PPA was signed by RWE for producing green electricity for Sofidel from a 13.6MW wind project in Sicily. This contract started in early-April 2021 and will run until end of 2030.

Italian energy developers are also stepping up efforts towards sustainable energy generation. By end of 2021, Edison SpA announced its plan to invest around EUR3 billion to develop additional 3GW of wind and solar energy and boost its overall capacity to 5GW by the end of the decade. Italian renewables major Enel has advanced its net zero target from 2040 to 2030 and committed to an installed capacity target of 154GW within that timeframe. This entails an investment of EUR170 billion till 2030.

Repowering of legacy wind turbines represents another significant opportunity, pegged at 8.5GW of potential incremental capacity by 2030, as per a study conducted by ANEV/Studio Elemens. Given prevailing constraints around land availability and restrictive planning guidelines, the trend is expected to pick up seen from recent market transactions. In H2 2021, Vestas got a 42MW order to repower the Monreale Partinico wind park, located in Sicily, while in H1 2022, ERG SpA was awarded 20-year tariff for 143MW to repower three wind projects located in Sicily, Mineo-Militello and Vizzini, with overall investment of EUR150 million.

Outlook

Italy's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

BNEF projects annual capacity addition for onshore wind in Italy to peak at 1.3GW in 2022 as more utility scale projects are approved via a government led streamlined process. Annual capacity addition is expected to accelerate from 2025 onwards, reaching 1.2GW by 2030, well short of the onshore wind installed capacity target that the Italian government has set for itself.

There are several significant obstacles in the planned development of the onshore wind energy industry in Italy. A complex and lengthy permitting process has raised the planning risks for wind energy developers that is reflected in the lukewarm response to the technology neutral renewable auctions in the last two years. In the latest auction in 2022, only 975MW of utility-scale capacity, of which 392MW was onshore wind, could be awarded despite having 3.3GW of capacity on offer. Wind projects is Italy need an average period of five years to get permission vis-à-vis the EU's Renewable Energy Directive of 2 years for greenfield wind farms. The structural bottlenecks in the permitting process have led to tepid competition in auctions resulting in auction prices moving up since 2020 reversing the earlier trend of declining prices.

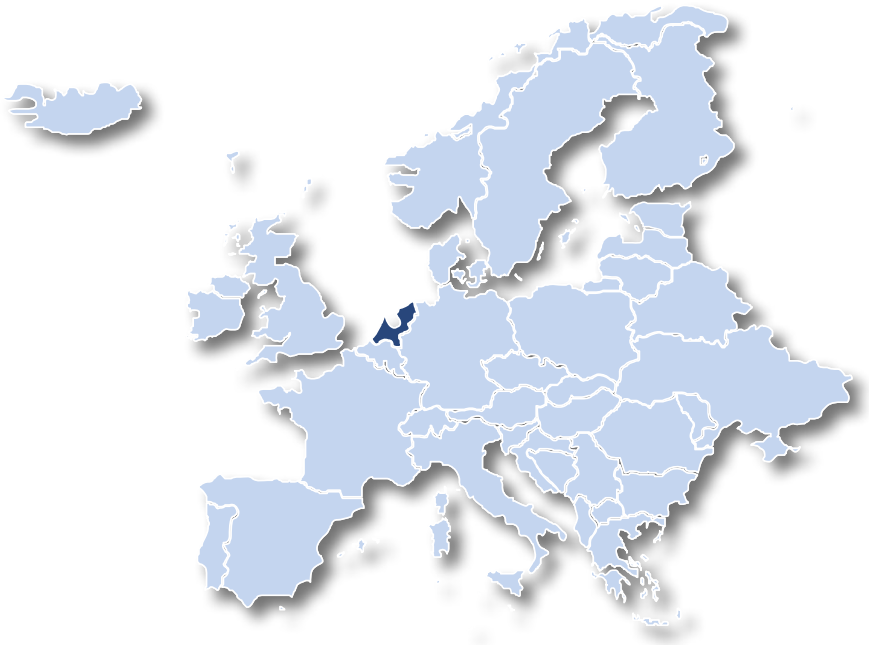
It is obvious that Italy will need a higher share of onshore wind in its overall energy mix if it were to come realistically close to achieving its stated goal of 55% share of renewables in its energy mix. But critical issues like streamlined permitting process, greater local support and more policy commitments to shift away from natural gas and other fossil fuels.

The Netherlands

Netherlands has ambitious targets in emission reduction and renewable energy integration. The country was among the earliest adopters of onshore wind power generation in Europe and has had an ecosystem in this regard. Over time, onshore wind is no longer the most important renewable energy resource for the country. Yet, a vast potential remains untapped, whether in terms of the pipeline of projects that could be freed up from procedural delays or by achieving rapid scaling up through repowering of existing wind farm assets nearing the end of commercially useful life.

GDP (Current Prices) USD (2021)	1,018.68bn
GDP Growth Forecast (constant prices) (2022-2026)	1.96%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	23.0GW
Onshore Wind Share in Renewables (2021)	23%
Renewable Energy Target	Reduce carbon footprint by 95% by 2050 from 1990 level

GDP Source: IMF WEO, S&P and IRENA



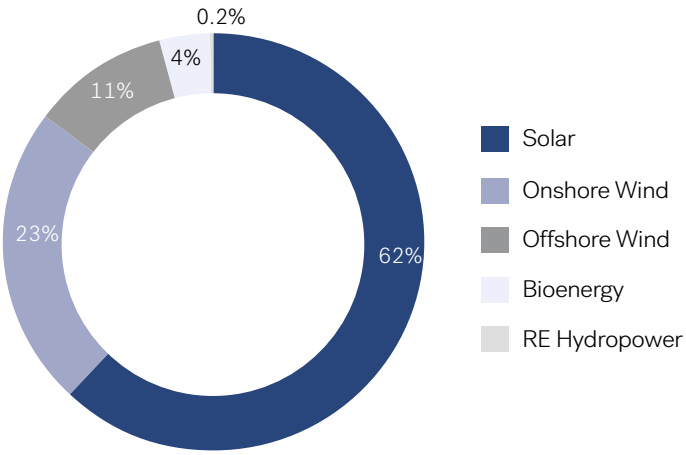
5.3GW Onshore Wind Capacity

- ✓ The National Climate and Energy Plan sets an aspiring target of achieving 60% renewable energy generation by 2030
- ✓ Availability of sizeable government and institutional funds supporting policy objectives
- ✗ Stagnant project pipeline in the onshore wind segment with increased investor focus toward offshore wind market
- ✗ Public opposition to onshore wind on account of visual pollution to fishermen and other environmental impacts

The Netherlands

Renewable Energy Mix

Current Renewable Energy Mix 2021

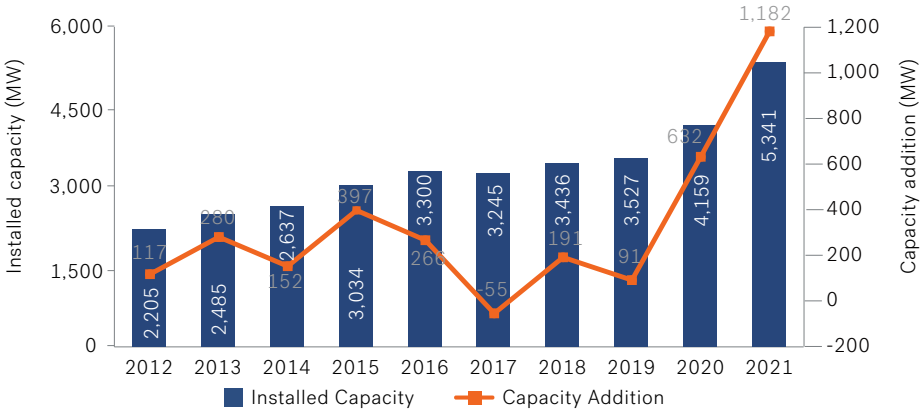


Source: IRENA Renewable Capacity Statistics April 2022

While the steps for renewable energy integration have been deliberate, Netherlands has a huge challenge in diversifying its overall energy mix. It remains reliant on conventional energy for a major part. It is in this backdrop that various renewable energy technologies have a space. Wind energy, of which onshore still has a relatively larger part than offshore, was traditionally an important part of Netherlands' renewable energy pool. Over the years, solar power displaced all other resources to play the most important role.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Netherlands has been among the pioneers in exploiting land-based wind energy resources. The progress however has not been consistent. The trend shows that after a near-stagnant rate of capacity addition till 2019, there was a jump in 2020 and 2021. The reason for this could vary across factors such as the funding made available under the SDE++ since 2017 that helped boost the pipeline, the advent of the subsidy-free projects in Europe since end-2018 (in which several of Netherlands' projects took off) and the policy push towards renewable energy in terms of auctions and funding. As per the Netherlands Statistical Agency, by end-2021, the onshore wind power capacity was led by 2,403 installations (up from 2,144 in previous year).

Demand Drivers

Netherlands' policy targets towards decarbonization and climate mitigation in the economy help set the direction for all the renewable energy resources. The country aims to achieve net carbon neutrality status by 2050 – involving among other things, a 100% renewable energy-based power generation by 2050. In the interim stages, this would entail phasing out various segments of conventional energy (such as coal-based power by 2029 and nuclear power by 2033). The National Climate and Energy Plan sets a 60% share target of renewable energy generation by 2030.

There is a budgetary outlay set aside for the energy transition objectives, that includes various renewable energy technologies and others that help reduce emissions. In March 2022, the government scaled up the budget to EUR13 billion. While the total funding pot is subject to competing technologies, it is important to highlight that onshore wind farms have availed the funding in past – in 2021 (as of July 2021), EUR99 million went to finance 13 onshore wind projects aggregating to 107MW.

The access to institutional funding such as EIB acts as an important facilitation for the projects to support policy objectives. Netherlands' stake in EIB helps access competitive long-term financing for the entities engaged in the renewable energy and related projects. In September 2021 for instance, EIB signed a EUR500 million loan agreement with Ørsted A/S for capital expenditure requirements. EIB notably has had a track record in financing wind power projects across Europe and an easier access helps the market by that extent.

Market Opportunity

As part of policy framework, the Dutch government plans to set aside a sizeable funding to facilitate the energy transition in the economy. In January, it announced setting up of a EUR35 billion to this effect. The focus is on the energy-intensive industries such as in Chemicals and Steel among others. While the fund allocation will find highly competitive options (offshore wind or solar PV), the scope will still be available for the onshore wind power projects to achieve the steep renewable energy targets.

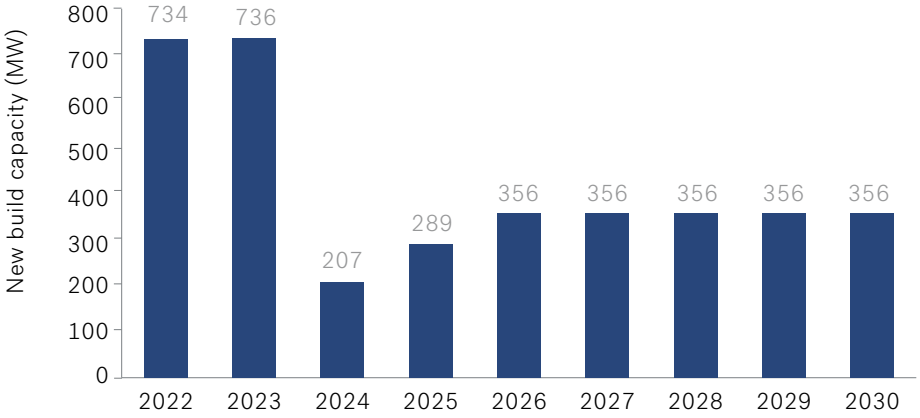
While policy measures move apace, the industries are taking steps to diversify energy sourcing options. The onshore wind farms are thus in consideration for power purchase agreements. In December 2021, the US-based food products major Cargill and the Swedish energy company/ utility Vattenfall signed PPAs for the 90MW Windpark Hanze onshore wind power project in the Netherlands. By 2023 when it gets commissioned, it could potentially meet Cargill Netherlands' 90% of grid-based power consumption. This was Cargill's first such renewable power purchase in Europe and the largest in its global operations. The PPA route has also been adopted by the utilities – In June 2020 the Dutch utility Eneco had signed PPA with SwifterwinT's for the latter's onshore wind power project due for repowering by 2023.

The country's legacy in onshore wind capacity development helps support a sizeable market opportunity in the ageing wind farm assets – whether in terms of decommissioning or repowering. Some of the leading OEMs are thus tapping into this demand segment. In December 2021, GE Renewable Energy announced signing a 156MW repowering contract, as part of Netherlands' Windplan Groen project. Under the same project ambit Vestas secure another such contract in the same period. Windplan Groen, comprising 90 wind turbines worth around 500MW, is a collaboration between residents and entrepreneurs.

With a progressively rising renewable energy integration in total grid-connected supply, energy storage is gradually emerging in critical role. By end-2021, financial closure was achieved in the project GIGA Buffalo – the largest battery-based storage project in the country so far. It has a 25MW capacity, to be connected with several wind farms and is contracted by energy trading entity Eneco on a rental basis. The project is thus also important for the business model of storage-as-a-service. The scope remains largely untapped. As per policy authorities, Netherlands' planned dependence on renewable energy would also require an energy storage capacity ranging 29GW-54GW to support flexibility requirements.

Outlook

The Netherlands' Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The capacity addition outlook is a weak one, reflecting a stagnant project pipeline. As per BNEF estimates, major capacity addition growth is expected by the end of 2023, after which barely 200-350MW worth of annual growth is projected. This could also be an indication of the onshore wind market getting edged out of the competition against the offshore wind segment where investor interest and policy focus is high.

The government's budgetary allocation for financing projects to mitigate emissions is important. Yet, it does not help target the objectives effectively because of the technology-neutral stance. In 2021 for instance, the predominant share of funding went to carbon capture and sequestration technologies, even as onshore wind projects were effectively more feasible for the decarbonization and renewable energy targets. The policy position so far remains unchanged and this could potentially impact the growth of the prospective onshore wind power projects.

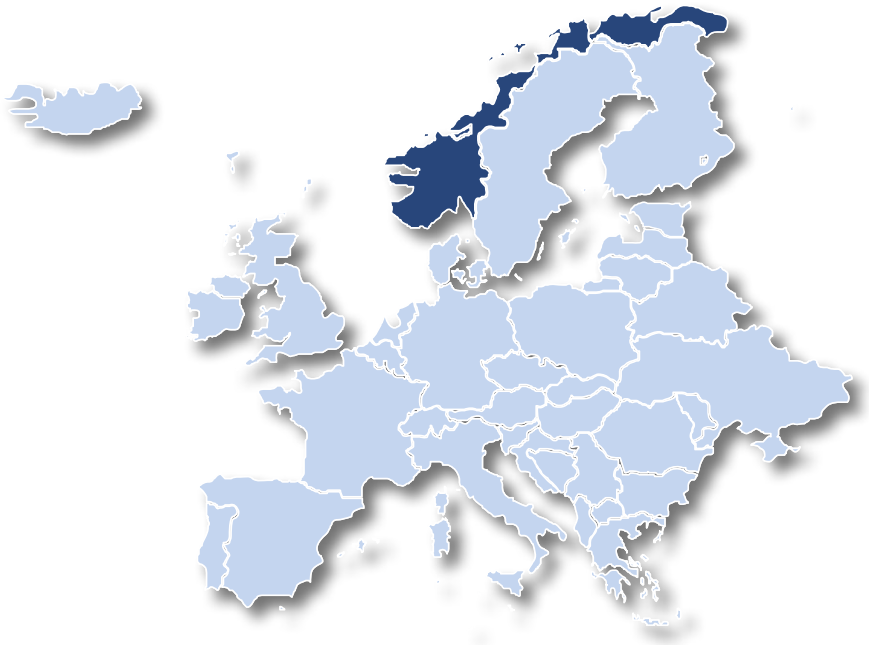
Despite potential, the onshore wind power projects face an uphill task in implementation, due to delays or cancellations. Local protests play an important role. As of April 2022, there were 74 projects impacted by the local opposition. Apparently, a predominant majority of the population is against having projects in the vicinity of their stay. The result is that local authorities took the safe route of cancelling such projects altogether and choose alternate resources (such as rooftop solar). It will be important for the government to resolve such a logjam before it imperils the business.

Norway

Norway's renewable energy base is predominantly skewed towards renewable hydropower which accounted for the 87% of the country's renewable energy installed base in 2021. Among other renewable energy technologies, onshore wind is the largest accounting for 12% of the overall installed base of ~40GW (2021). The onshore wind industry in Norway had stalled in the last three years due to regulatory restrictions on new wind farms as a result of public opposition on the grounds of environmental damage. This has pushed Norway to 10th position in terms of cumulative installed capacity in Europe despite having one of the highest potentials for onshore wind in the continent. But the industry has recently received a fillip through the reversal of the earlier ban on wind farms in April 2022 with capacity additions likely to accelerate henceforth.

GDP (Current Prices) USD (2021)	482.44 bn
GDP Growth Forecast (constant prices) (2022-2026)	2.33%
Currency	Norwegian Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	39.8GW
Onshore Wind Share in Renewables (2021)	12%
Renewable Energy Target	Achieve carbon neutrality by 2050

GDP Source: IMF WEO, S&P and IRENA



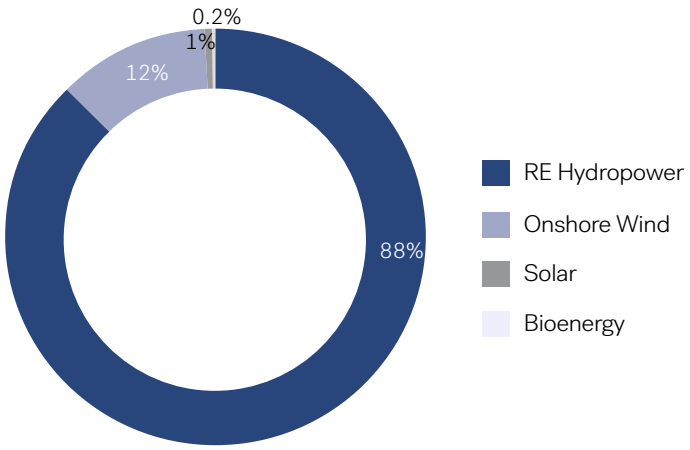
4.6GW Onshore Wind Capacity

- ✓ High wind potential and favorable weather conditions mitigate power generation risks
- ✓ Norwegian government's decision to reverse the earlier ban on approval for new wind farms to act as the biggest growth catalyst for the onshore wind industry
- × Public opposition to wind projects on the grounds of environmental damage
- × New regulations to garner local support to add complexity of the project approval process
- × Increased focus on offshore wind is shifting attention away from onshore wind

Norway

Renewable Energy Mix

Current Renewable Energy Mix 2021

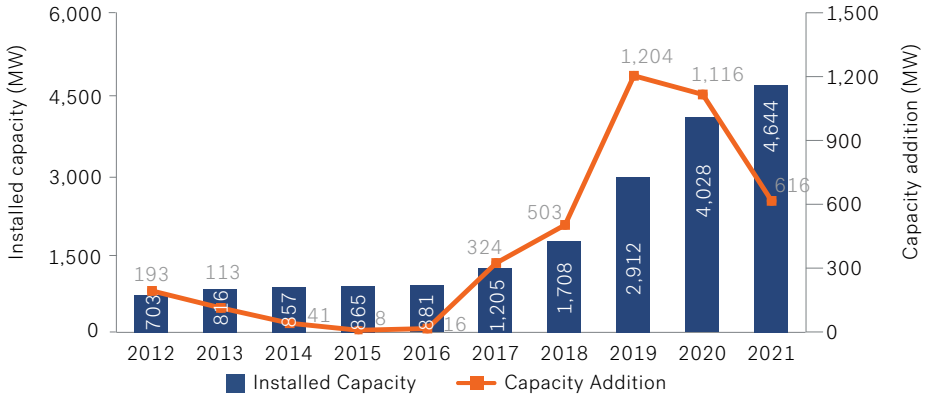


Source: IRENA Renewable Capacity Statistics April 2022

With an aim to be a low carbon society by 2050, Norway has laid out interim targets to be achieved under the Climate Change Act. The government has committed to a target of at least 50% up to a maximum of 55% reduction in emission levels in 2030 compared to 1990 levels. The associated energy transition is likely to require higher contribution of onshore wind in electricity production and consumption, marking a shift away from an over-reliance on renewable hydropower. But policy support remains patchy as no targets have been laid out for onshore wind, unlike offshore wind which has a stated capacity target of 30GW by 2040.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Capacity addition for onshore wind in Norway has been a two-paced one in the last decade. Annual capacity addition started picking up from 2017 and peaked at 1.2GW in 2019 helping Norway more than triple its cumulative installed base to 2.9GW by 2019. But growing public opposition to wind farms, spurred by concerns around environmental impact and sound pollution, led to the decision to halt new project approvals in April 2019. This subsequently led to annual capacity addition progressively slowing to 1.1GW and 616MW in 2020 and 2021 respectively. With the regulatory impasse set to be resolved, Norway seems poised to overtake Denmark in terms of cumulative installed capacity for onshore wind in 2022.

Demand Drivers

The Norwegian government's decision to reverse the earlier ban on approval for new wind farms in April 2022 is seen as the biggest growth catalyst for the onshore wind industry. The decision to revert to onshore wind comes in the backdrop of dwindling energy surplus as oil production continues to decline and power consumption increases. The licensing process of new wind farms is contingent on new regulations that require approval from host municipalities, in an attempt to garner local support and fend off any regulatory challenges during the development phase, thus mitigating planning risks for developers and investors.

It is also likely that power production will lag electricity demand as electrification of transport gathers momentum and battery electric vehicles (BEVs) account for 50% of the country's passenger vehicle fleet by 2030. It is estimated that electricity consumption will increase by ~57% from 140 TWh to 220 TWh by 2050. While renewable hydropower accounts for ~88% of electricity generation, its unit price (53 ± 6 EUR/MWh) is considerably higher than renewable alternatives such as solar PV (20 ± 3 EUR/MWh) and onshore/offshore wind (32 ± 4 EUR/MWh). It is estimated that wind power helped Norwegian consumers reduce their electricity bill by 2,000 - 4,500 NOK in 2021. The prevailing price differential with renewable hydropower is likely to help drive adoption of onshore wind going forward.

Norway has seen sustained development of the corporate PPA market since 2016 when major offtakers such as Norsk Hydro, Google, Alcoa Norway signed long term agreements with wind power producers. The downward trend in wind power prices has helped project developers in obtaining project financing support thus creating a case for more merchant exposure. Recent transactions such as Telenor's 10-year PPA with Hydro Energi AS and Axpo Nordic's agreement with Green Investment Bank (GIG) to supply wind power to Eramet Norway highlight the depth of the corporate PPA market in Norway. Strong interconnectivity and shared grid structure in the Nordic region has helped in the expansion of the corporate PPA market.

Market Opportunity

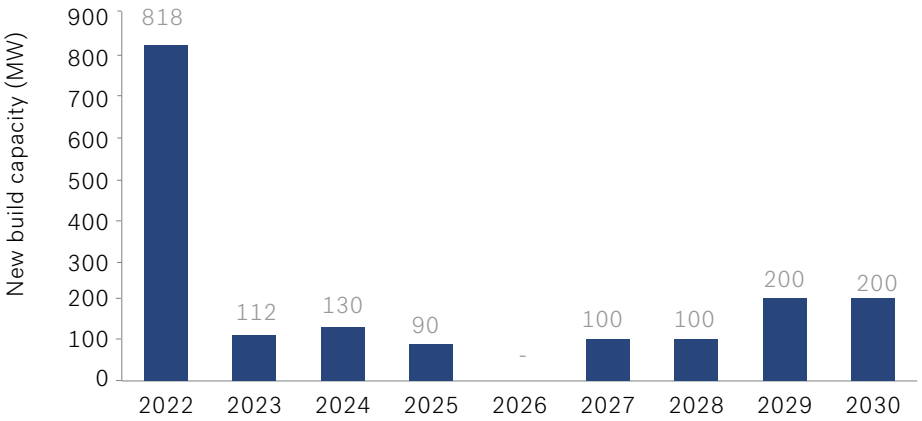
Norway has high wind potential, which mitigates any generation risks for power producers. In fact, supportive weather conditions pose downside risks as seen in early 2022. Stormy weather in the Nordic region in January resulted in a record power output of 21.3GW. The spike in output led to a collapse in wholesale power prices from an average of EUR96.29/MWh to below EUR50/MWh. While this enhances the competitiveness of wind power vis-à-vis other power sources, a drastic fall can undermine the financial viability of projects.

Electrification of transport in Norway offers significant opportunities for the development of renewable energy other than hydropower. Norwegian policymakers have set a target of 100% EVs in new passenger vehicle sales by 2025, from the current level of 60%. The shift from fossil fuels to electricity is likely to trigger a sharp uptick in demand for electrical power, which can potentially be met through higher wind power generation. While the focus has largely shifted to offshore wind, there are several significant onshore wind projects in the project pipeline. Two major onshore wind projects are expected to come online in the next couple of years, adding around 1.9GW of the cumulative wind capacity. Øyfjellet Wind Park, situated in central Norway, is expected to add 400MW capacity to the installed base while the remaining 1.5GW is expected to be added by the Hordavind wind farm generating 5.4TWh of capacity.

Th resilience and long-term potential of the Norwegian onshore wind market has been evident from sustained transaction activities, both at an asset level as well as corporate M&A during recent times. The Nordic Investment Bank (NIB) deployed funding of NOK600 million to five of six wind farms of Fosen Vind. Macquarie's Green Investment Group acquired the 47MW Tysvær Wind Farm from Spanish Power. In March 2021, Stadtwerke München (SWM) and TrønderEnergi AS ("TrønderEnergi") acquired a 60% stake cumulatively in Roan Wind Farm, the second largest wind farm in Norway. Increased investment in grid expansion and upgradation, coupled with increased interconnectivity within the Nordic countries is likely to attract increased attention from investors looking to capitalise on the power exporting potential of the region.

Outlook

Norway's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook
Note: Data not available for 2026

According to BNEF, the annual onshore wind installations in Norway are expected to grow at a marginal pace from 2023 onwards. Annual capacity addition is expected to expand to 818MW in 2022, and then decline sharply to a 100-200MW range annually till 2030. However, this scenario is likely to improve on the back of the withdrawal of licensing permission to wind farms in April 2022.

While the resumption of licensing of onshore wind farms in Norway is a major positive for the onshore wind industry, the new rules framed to address the concerns of local communities is likely to add to the complexity of the project approval process. The proposed Production Tax, which went into effect in July 2022, will have implications on the profitability of wind projects. However, the decision to share the proceeds of the tax with local municipalities is likely to address the biggest concern of public acceptance that developers are faced with. In 2019, a survey indicated that 78 out of 101 municipalities are opposed to wind farms. Growing focus on alternate technologies like offshore wind is also likely to stymie the future development of the onshore wind industry in Norway. The target to install 30GW of offshore wind capacity by 2040 will require significant regulatory and fiscal support, diverting attention away from onshore wind.

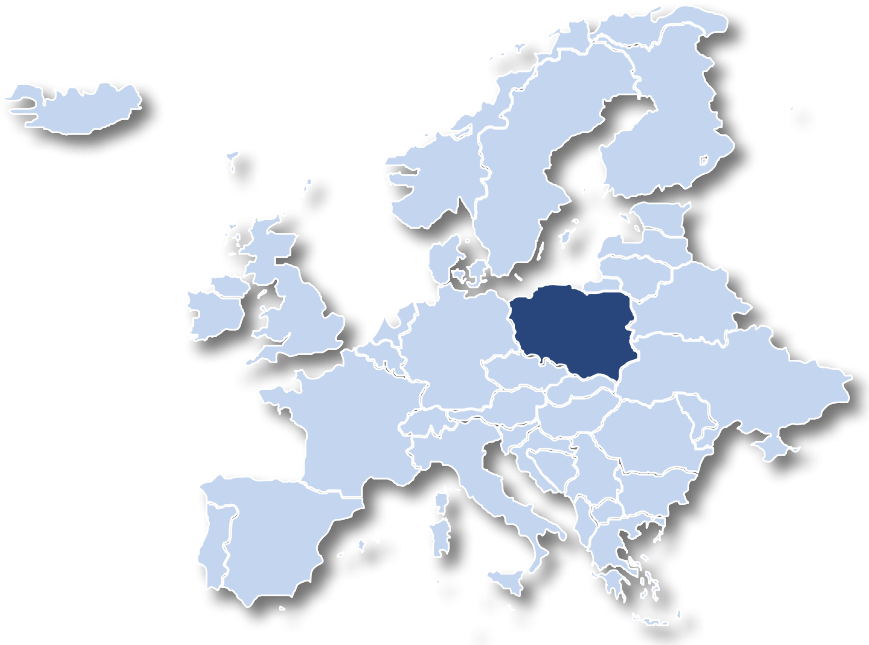
Overall, the onshore wind industry is expected to witness sustained growth in the coming years, as power consumption increases and the transition to a renewable-based energy system gathers pace. Limited availability of land and competing renewable energy technologies are likely to impede a higher a growth trajectory, but falling wind power prices are likely to offset their impact through sustained demand.

Poland

Poland's renewable energy base has shown strong growth, owing to robust capacity addition by solar PV followed by onshore wind. In 2021, ~3.15GW of renewable capacity was added in the country, almost 10x time the 319MW capacity added in 2018. The turnaround in performance in the last three years has been achieved on the back of infrastructure developments complemented by a supportive policy regime. To achieve energy efficiency, the Polish government, through Energy Policy of Poland - 2040 (PEP) has set milestones to be achieved by 2030 such as, limiting power generation share of coal to 56% while improving renewable energy's share to 23%. The country also seeks to reduce the GHG emission by 30% from 1990 level during the same time frame.

GDP (Current Prices) USD (2021)	674.127 bn
GDP Growth Forecast (constant prices) (2022-2026)	3.25%
Currency	PLN
Country Credit Rating (S&P)	A-
Renewable Energy capacity (2021)	15.4GW
Onshore Wind Share in Renewables (2021)	45%
Renewable Energy Target	2030 target of limiting share of coal in power generation to 56% while imrpoving share of renewable energy to 23% along with reducing GHG emmission by 30% from 1990 level.

GDP Source: IMF WEO, S&P and IRENA



7.0GW Onshore Wind Capacity

✓ **Robust capacity growth in recent years on the back of infrastructural developments complemented by a supportive policy regime**

✓ **More streamlined licensing process with regulatory approval shifting to local governments**

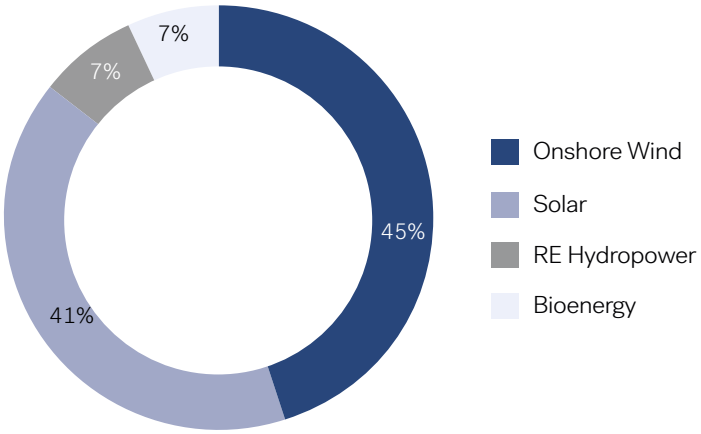
✗ Coal-fired energy generation rebounded to ~80% of overall electricity generation in 2021 due to increased energy demand

✗ Exemption of excise duty on coal and gas used in residential heating slowed down the transition towards cleaner energy

Poland

Renewable Energy Mix

Current Renewable Energy Mix 2021

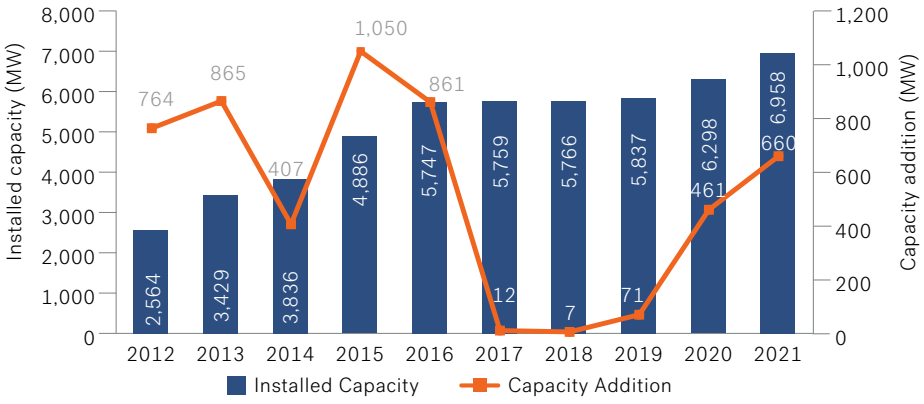


Source: IRENA Renewable Capacity Statistics April 2022

Although onshore wind remains the largest source of renewable energy in Poland, accounting for ~45% of the total installed capacity of 15.4GW as of 2021, solar PV has played an outsized role in new capacity addition. Of the 3.15GW capacity added in 2021, solar PV accounted for 2.3GW or ~73% of capacity installed. While offshore wind has a marginal presence in the country's renewable energy mix, there are plans to develop 9-11GW of offshore wind capacity between now and 20240 as per the latest energy policy. Overall, Poland has the seventh largest installed capacity of onshore wind in Europe as of 2021 with a cumulative installed capacity of 6.96GW.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Onshore wind addition in Poland had collapsed in 2017 following the imposition of the "10H" rule, which forbade the construction of wind farms where there are buildings within a distance of ten times the height of the turbine. The next three years witnessed less than 100MW capacity being added cumulatively as the prevailing legislation rendered 99.7% of Polish land ineligible for wind farms. 2020 has marked a reversal in fortunes for the Polish onshore wind industry following auctions held in 2018-19. Capacity from these auctions started coming online in 2020 and an estimated 3GW onshore wind capacity is expected to be added by 2022. Poland is reported to have installed 7.48GW capacity by June 2022, keeping the country on track to achieve the auction's capacity addition goals.

Demand Drivers

The Polish government's decision to reverse the earlier "10H" rule in July 2022, seen as the biggest stumbling block to setting up wind farms in the country, is likely to catalyse a surge in onshore wind projects. With regulatory approval shifting to local governments, the licensing process is expected to become more streamlined. It is estimated that the current minimum distance of 500 metres is likely to increase the availability of land for wind farms by 25x and increase the wind potential of the country to over 40GW from 10GW earlier. Consensus analyst estimates indicate a requirement of at least 17GW of onshore wind installed capacity to meet the GHG40% target that EU had set out previously, an increase of at least 10GW over this decade.

Skyrocketing power prices have shifted focus on the growing need for renewable energy, and particularly onshore wind, which has been shackled by restrictive regulation till recently. Power prices in Poland, where the energy system is primarily skewed towards fossil fuel (coal, lignite) which accounts for around 70-80% of generation, have been at record highs in recent times, exacerbated by the Russia-Ukraine conflict. The Polish Wind Energy Association estimates that wholesale electricity prices would have been twice as high, had it not been for the impact of wind power. Spot electricity price of wind power has averaged PLN398/MWh in 2021, considerably lower than the average wholesale electricity price of PLN823/MWh reached in December 2021.

The renewable auction system continues to be a key policy instrument in the toolkit for renewables development. As per IEA estimates, renewable auctions held between 2016 and 2021 helped award 6.1GW capacity to solar PV and 5.1GW capacity to onshore wind. In the latest auctions held during December 2021, onshore wind accounted for 460MW capacity awarded while solar PV emerged as the largest recipient, being awarded 870MW of combined capacity. Notably, observing the response, the timeline for these renewable auctions has been extended from 2021 to 2027. This is likely to be a key channel to ensure large scale onshore wind capacity addition and facilitate the planned energy transition.

Market Opportunity

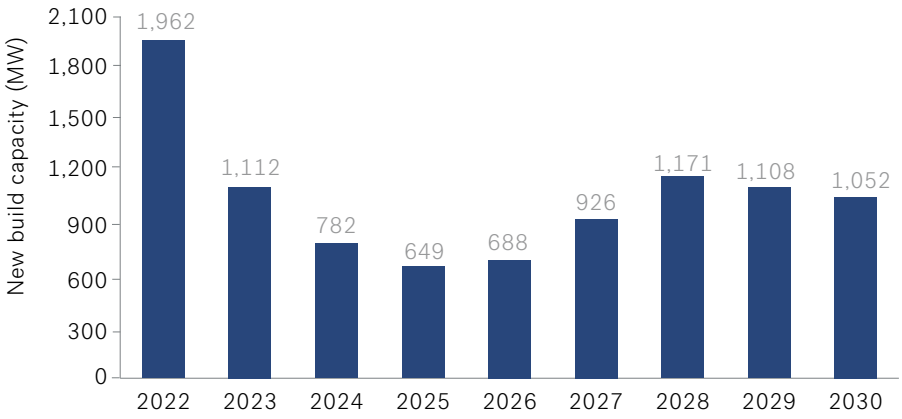
The onshore wind market is transitioning from prevailing contracts for difference (CfD) support mechanism to a subsidy-free, merchant supply model. This began in 2019 when Polish utility Polenergia announced the construction of the 38MW Szymankowo wind farm, making it the first subsidy-free onshore wind project in the country. While this project was also unique due to the absence of long-term PPA, corporate PPAs have played a key role in developing the onshore wind market away from state subsidies. The first wind PPA was signed between Mercedes Benz and VSB Energie in 2018. The corporate PPA market has expanded considerably since then with recent deals such as ENERTRAG-Orange Polska, Axpo-Green Investment Group and NSG Group-EDP Renewables being signed in 2022.

The long-term growth potential of the Polish onshore wind industry is also evident from the uptick in investment activity. In June 2022, the European Commission recently endorsed the EUR35.4 billion Polish National Recovery and Resilience Plan (NRRP), which envisages accelerating green and digital transition in the aftermath of COVID-19. Institutional investors such as Octopus Renewables, Ingka Group (owns majority of IKEA) and Iberdrola are also ramping up investments in Polish onshore wind, in an apparent endorsement of the resilience of the onshore wind industry.

The energy storage segment is poised to scale up rapidly in the aftermath of a comprehensive set of policy changes that aim to expand the use of energy storage facilities, define licensing requirements and eliminate tariff obligations which were double charging energy storage systems. Poland's state-owned utility PGE plans to install 800MW of energy storage by 2030, including the largest project in Europe (200MW). The growth in energy storage capacity is expected to support the development of the onshore wind by balancing the impact of intermittent generation, thereby playing a crucial role in balancing a grid that will need to adjust to intermittent generation.

Outlook

Poland's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The BNEF forecasts of annual onshore wind installations in Poland preceded the announcement of the easing of restrictions on wind farms. Hence the capacity addition projections that indicate a declining trend till 2025 might no longer be applicable. The Polish Wind Energy Association as well as policymakers indicate a target of cumulative installed capacity of 17-20GW by 2030. This would require annual capacity addition to average more than 1GW through this decade. About 500MW onshore wind capacity was already installed by June 2022, taking the cumulative installed capacity in the country to 7.48GW, keeping it on track to achieve the target in 2022.

There are several challenges to the sustained development of the onshore wind energy industry in Poland, primary among which is the continued dependence on fossil fuels, particularly coal. Coal-fired generation rebounded to ~80% of overall electricity generation in 2021, reversing several years of declining trend as Polish industry staged a comeback in the aftermath of COVID-19 and energy demand picked up. Exemption of excise duty for coal and gas used in residential heating slows down the transition to more sustainable energy sources. The Polish government is also considering nuclear energy as an option to bridge the impending energy gap that is likely to be created by the substitution of coal-based power. This is likely to stymie the growth of the renewables sector as resources are spread across multiple energy generation technologies. Increasing competition from solar PV and offshore wind is also expected to result in the deceleration of the onshore wind sector.

Despite these challenges, the outlook for onshore wind remains strong, primarily on account of the increasingly attractive price dynamics vis-à-vis fossil fuel generation, growing need to expand generation capacity in the wake of closure of coal-based capacity and a release in pent-up demand following the upliftment of restrictive regulations.

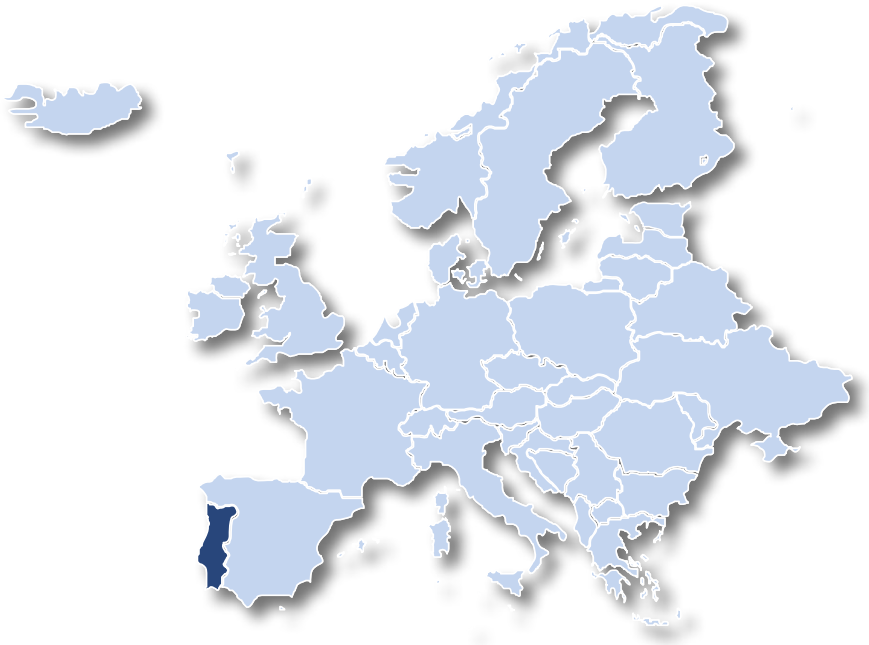
Portugal

Portugal has successfully become one of the major renewable enablers in Europe with the country sourcing 60% of its electricity from renewable sources as of 2022. Onshore wind combined with hydropower account for 83% of the total renewable base in the country.

Portugal's government has advanced the country's clean energy target. The country aims to achieve 80% of its gross electricity consumption from renewable sources by 2026 instead of 2030, with an anticipated increase by c.2x in installed capacity up to 28.8GW, compared to 15.1GW in 2022. Onshore wind is responsible for 26% of Portugal's electricity consumption, the third-highest in Europe after Denmark and Ireland. Notably, adhering to the phase out of the conventional resources Portugal closed the last coal-fired power plant in November, 2021. This increases the country's dependence on renewable energy in absence of proven oil and gas resources.

GDP (Current Prices) USD (2021)	250.053 bn
GDP Growth Forecast (constant prices) (2022-2026)	2.51%
Currency	Euro
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2021)	15.1GW
Onshore Wind Share in Renewables (2021)	35%
Renewable Energy Target	Improving share of renewable energy in power generation to 80% till 2026, while reducing GHG emission by 45%-55% by 2030.

GDP Source: IMF WEO, S&P and IRENA



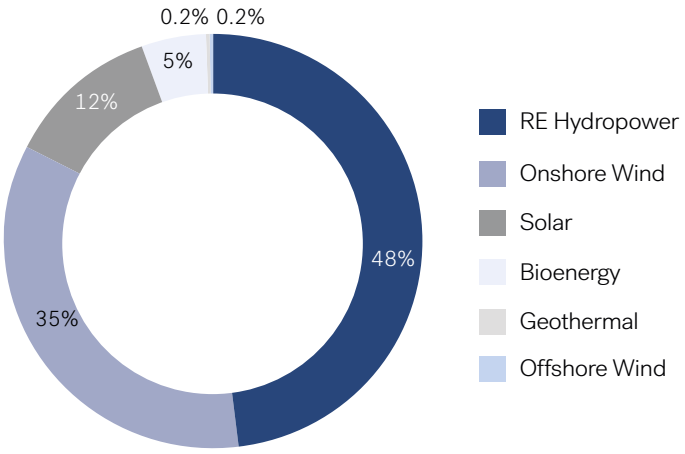
5.2GW Onshore Wind Capacity

- ✓ **Ambitious renewable target to source 80% of electricity consumption from renewables by 2026**
- ✓ **Green Tax implemented in 2015 establishes a new value for the maximum tax depreciation of wind and solar technologies**
- × Untapped sites are constrained by environmental or land planning issues and lack of grid infrastructure
- × Solar PV and offshore wind having competitive edge over onshore wind as the preferred renewable option for the current government

Portugal

Renewable Energy Mix

Current Renewable Energy Mix 2021

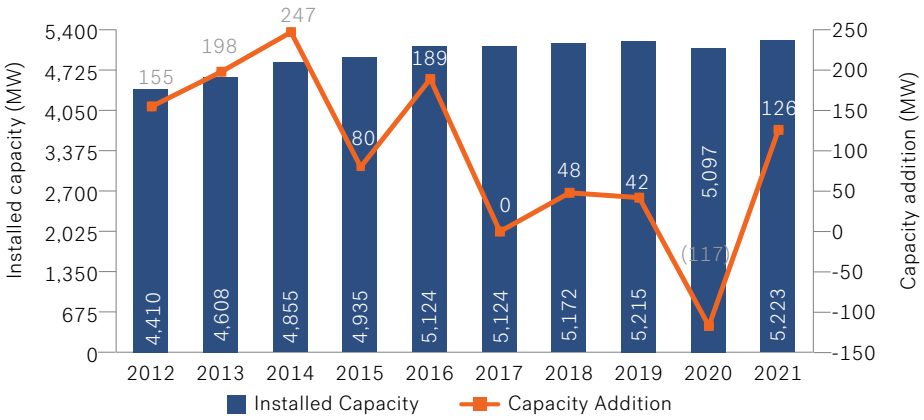


Source: IRENA Renewable Capacity Statistics April 2022

Over the years, the share of onshore wind energy in Portugal's renewable mix has declined from 40% in 2011 to 35% in 2021 primarily in favour of solar energy. Additionally, since last couple of years, offshore wind energy has seen accelerated boost to its base. Though the potential of onshore wind energy in Portugal is quite high, more than half of it is already in use. The sites which are still untapped, are constrained by environmental or land planning issues and lack of grid infrastructure.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

The annual capacity additions in Portugal peaked in 2014 following the stable increase over the previous years. Since then, the annual capacity additions have had downward movement except a smaller recovery in 2016, which could be due to a drop in electricity consumption in a recessionary economic condition. Eventually in 2020 the pandemic led disruption resulted in lowest additions in eight years.

Nevertheless, Portuguese government opted for resilience measures during 2020, to support different sectors including renewable energy in the path of economic recovery. The energy efficiency plan in the context of Economic and Social Stabilisation Program was launched during H2 2020 with budget of EUR4.5 million. Owing to these efforts the onshore wind annual capacity additions showed signs of recovery in 2021 and the total capacity reached 5.2GW.

Demand Drivers

Ambitious decarbonization goals and supportive policy framework bode well for the onshore wind industry. It received the required support through a series of initiatives introduced during 2001-2012. However, in wake of financial crisis, new legislation suspended all new power generation allocation procedures indefinitely, which limited the growth in the renewable sector. The scrapping of FiT for large-scale power projects commissioned after November 2012 and increased emphasis on repowering the existing projects discouraged the new wind project development in Portugal. Thus, the sector could not get rid of the slowdown imparted since then.

Green Tax implemented in 2015 establishes a new value for the maximum tax depreciation of wind and solar technologies. The proposal of reducing 50% of the Municipal Real Estate tax (IMI) for renewable energy power-producing buildings was accepted in 2015. This was a significant step in reducing the cost of power projects and acted as a major driver to increase investor interest into the wind sector.

While current government's regulatory regimes are focused towards easing down the obstacles of small-scale generation plants suitable for self-consumption of renewable energy and the tendering system is aimed at utility-scale solar PV and offshore wind sectors, onshore wind has clearly taken a backseat. However, the future deployment of this technology will be driven by the 2026 binding renewable target as solar PV and offshore wind won't be able to suffice requirement.

Market Opportunity

Portugal is a country with free trade, no customs barriers, free movement of goods and other key economic advantages. These factors are likely to play an important role in driving the investor interest in this sector. Moreover, the efforts taken by Portuguese government towards renewable sector has received the support of international institutions. The European commission (EC) endorsed Portugal's EUR16.6 billion recovery and resilience plan in June 2021. Of the total investment, parted in EUR13.9 billion in grants and EUR2.7 billion in loan, 38% will be utilized for the climate change objectives such as improving energy efficiency of the country by deepening the penetration of the renewable energy resources such as onshore wind.

The strengthening presence of multinational energy developers could be seen in Portuguese renewable sector. The companies are collaborating to bridge the gap of project financing for renewable deployment. In Q1 2022, an alliance was formed between European Investment bank ("EIB") and Ben Oldman to finance the deployment of solar and onshore wind projects with 430MW capacity in the Iberian Peninsula. A budget of EUR100 million has been earmarked for the purpose with additional EUR100 million to be raised through bonds. Also, in 2021 EIB and BPI decided to provide financial aid of EUR112 million to EDP Renováveis to construct two onshore wind farms with a total capacity of 125MW.

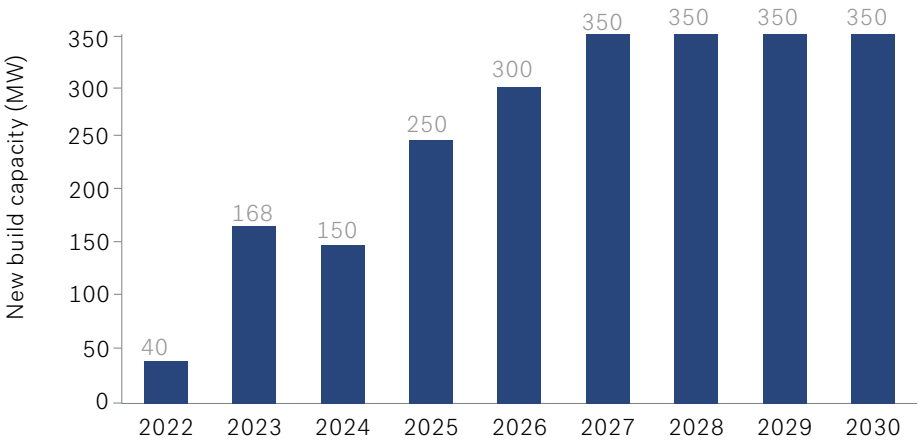
Though the onshore wind projects have had limited expansion opportunity in the country, the recent spur in solar-wind hybrid projects might bring in investment opportunities with multinational players boosting the competitiveness of the segment. Notably, in 2022, EDP Renovaveis announced its plan to develop wind-solar hybrid projects of 1.3GW in the existing parks in Iberia by 2025. Another example would be of Endesa Generación, which was awarded the connection rights to develop renewable energy hybrid park in March 2022 with solar - 365MWp and wind - 264MWp and BESS - 169MW.

Another key area to look at is the wind turbine services market as Portugal is regarded as one of the key markets in the European Union. According to industry estimate European wind services market is expected to grow by USD2.21 billion from 2020 to 2025. 40% of this market growth is expected to be originated from France, Italy, Turkey, Sweden, Poland, Denmark, and Portugal.

In the absence of government subsidy scheme, the prevalence of power purchase agreements (PPA) in the Portuguese renewable market has attracted participation in onshore wind sector, with corporate PPAs facilitating the financing. However, in recent times the solar and offshore wind sector are experiencing more traction in the PPA market compared to onshore segment.

Outlook

Portugal's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The BNEF forecast on annual onshore wind installations in Portugal indicates a market growth at marginal pace during 2022-2027, post which the stability is expected to take place till 2030, indicating the possible overall market expansion in Portugal.

Despite the affirmative forecasts, the prevailing complications for onshore wind farms on account of their ecological footprint continues to be a major obstacle in the way of expansion. Thus, communal opposition amidst net zero target is adding to the complexities in granting environmental licenses to large onshore wind farms. Adding to it is the issue of grid bottleneck. Grid capacity for connection of power projects has become scarce and the government is promoting access to the grid through competitive tenders for new renewable energy capacity.

On brighter note, recently enacted Decree-Law No. 30-A/2022 of 18th April, 2022 which will remain in force for two years, simplifies certain steps of the licensing procedure to step up production. Further, Decree-Law No. 15/2022 which came into force from 15th January 2022, has consolidated different electricity sector frameworks that were previously scattered across several different pieces of legislation, such as overpowering, additional energy, repowering and distributed generation/self-consumption, and renewable energy communities. The law has alleviated complexities by setting out the legal framework applicable to the activities of generation, storage, transmission, distribution, and supply of electricity.

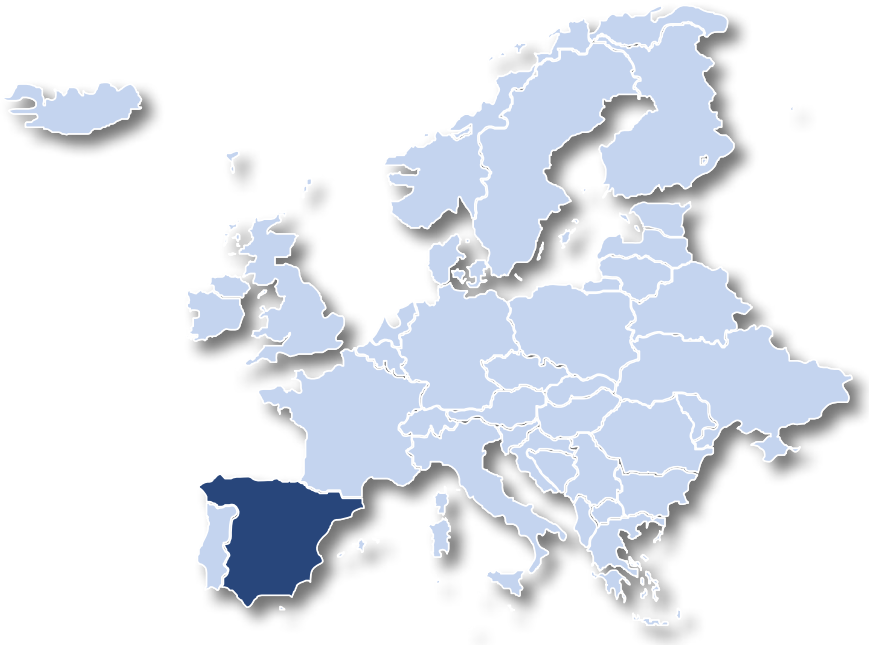
Overall, the unstable policy framework towards the onshore wind sector in the wake of stronger performance by other renewables has adversely affected its expansion in Portugal. Yet, the empathy towards the sector by taking care of some of the challenges through regulatory reforms could help to maintain the technology's significant role in Portuguese renewable energy base.

Spain

Spain's renewable energy market, and that of the onshore wind, appears to have turned the corner since last few years. With reforms for market-led capacity auctions, there is a steady project pipeline, and the investments are gradually on an upswing. It also helps that the country already has a sufficiently high base to build upon – onshore wind capacity ranks at second highest in Europe (after Germany). Furthermore, the investments for new onshore wind farms during 2021 stood highest among European countries.

GDP (Current Prices) USD (2021)	1,426.22bn
GDP Growth Forecast (constant prices) (2022-2026)	2.99%
Currency	Euro
Country Credit Rating (S&P)	A
Renewable Energy capacity (2021)	61.5GW
Onshore Wind Share in Renewables (2021)	45%
Renewable Energy Target	2030 target of GHG emission reduction by 23% along with renewable target of having 42% in energy end use and 74% in electricity generation

GDP Source: IMF WEO, S&P and IRENA



27.5GW Onshore Wind Capacity

✓ **Steady project pipeline driven by market-led capacity auctions**

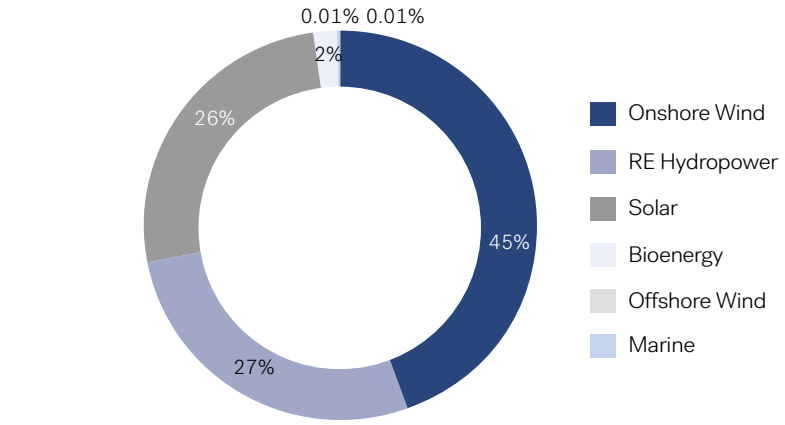
✓ **Maximum investment commitment in onshore wind power in 2021 among all European countries, amounting to EUR3.2 billion**

✗ Unstable regulatory framework such as the "gas tax" – a type of windfall gains tax

Spain

Renewable Energy Mix

Current Renewable Energy Mix 2021

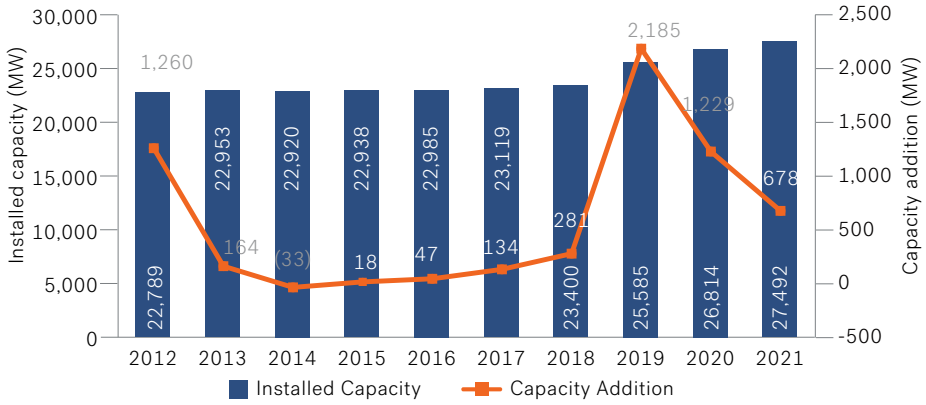


Source: IRENA Renewable Capacity Statistics April 2022
Note: The above data on wind includes 5MW of offshore capacity (out of total wind generation capacity of 27.5GW)

As per the country's wind power association, by end-2021, wind energy held about 23% share in the total energy generation. With a negligible share of offshore segment (5MW out of the total 27.5GW of total wind-based power generation capacity), all the wind energy is based on onshore plants. So far, the growth in onshore wind capacity has ensured that the segment continues to have an edge against the competing options. Progressively, this might be harder to maintain though.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Despite a sluggish growth trend, the Spanish onshore wind capacity base is Europe's second largest after Germany. The trend shows a near-stagnant growth path for most of the period between 2013 and 2021. The breakout in the trend is seen in 2019 and 2020 – a fallout of the reform measures since 2017 when projects were allocated through competitive bidding. The spike in 2019 is explained by the commissioning schedules of the auctioned projects of 2017/2018. In fact, the same capacity growth should have ideally continued through 2020, but for the outbreak of the pandemic that stalled project development and impacted the project pipeline.

Due to the lag between capacity allocations and development, the trend is likely to show similar pattern of spikes around end-2022 and mid-2023 as the recently bid projects gradually come online. This however could have significant riders due to the persistent challenges in circumventing the permitting delays and frequent regulatory changes.

Demand Drivers

Spain's policy direction on renewable energy involves a targeted installed capacity of 160GW and a 74% share in total electricity generation, both by 2030. About 50GW of the planned capacity could be based on wind power. The targets also include a staggered implementation of phasing out conventional power generation capacity, based on coal (by 2025), oil (by 2030) and nuclear power (by 2035) – all as part of the overarching decarbonization objectives. The progress in terms of the targets has been encouraging, considering that the country achieved the targets of 2020 (in terms of share of renewable energy in total consumption).

The energy crisis imposed on the European region due to Russia-Ukraine conflict, has also accelerated the ongoing efforts on renewable energy, both for wind and solar. It also helps that the country is presently better off than others, in terms of its relatively lower dependence on Russian natural gas supply (due to diversified LNG sources from North Africa). Both factors reinforce the case for the onshore wind market investments as there are expectations of applications being fast-tracked to achieve the maximum in the limited time frame.

As part of the reforms, the policy and regulatory framework was re-aligned, to have a market-led route of capacity growth. This involves a structure where the authorities stipulate the required renewable energy capacity to be procured, which is then put up for competitive bidding. This has been an important step in stabilising the market. Among other things, the advent of a stable and predictable revenue stream through auctioned projects has also helped the financing of the projects (non-recourse project financing) with high leverage ratios ranging 80%-90%.

Market Opportunity

Among the European countries, Spain had the maximum investment commitment in onshore wind power in 2021, amounting to EUR3.2 billion (WindEurope, April 2022). This is the highest since 2009. A focused policy effort towards the auction-based allocation of capacities and a clear visibility of such opportunity made the difference for the country, which in recent past was languishing for want of investments (post withdrawal of feed-in tariff support and subsidies).

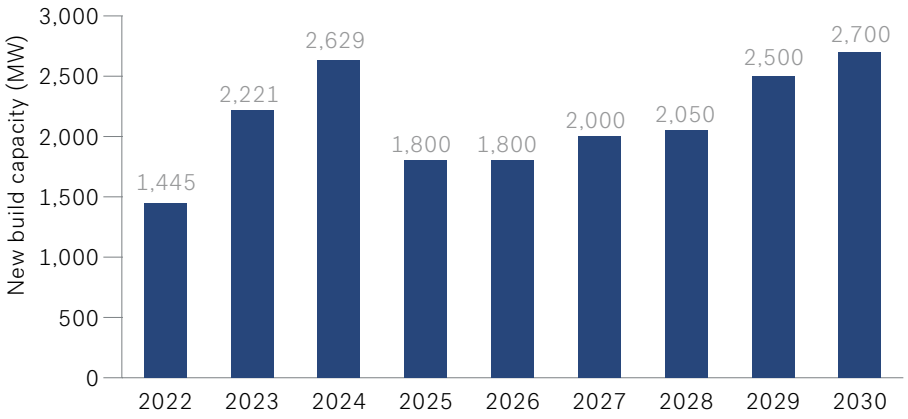
The revival of auctions in 2021, after a hiatus since 2017, has been helpful in improving the investment prospect. While these are technology-neutral auctions, the response was encouraging from the onshore wind segment developers. For instance, in one of the auctions during October 2021, onshore wind-based projects cornered 2.25GW of capacity allocation, out of the total 3.1GW awarded in the auctions. It was a first for the country's auctions where solar power did not cover all the capacity on offer. The next auction (fourth in the series) covering 3.3GW of capacity, will be held in November 2022, with an expected 1.5GW earmarked for wind.

The European Investment Bank's (EIB) green loans – referring to financing projects for sustainability and environmental impact, contribute towards the impetus for private investments in the Spanish market. In July 2022, the Spain-based renewable energy company Iberdrola and EIB signed for the latter's EUR550 million green loan involving a project portfolio worth 1,800MW across wind farms and solar plants. The total actual investment for the wind farms could amount to over EUR1.1 billion. Such multilateral funding is also instrumental in facilitating the progress on renewable energy targets, both for the region and the country.

With active policy push for decarbonization, the transmission infrastructure is being augmented to meet the upcoming requirements. The government-approved 2021-2026 Electricity Transmission Grid Planning entails EUR6.96 billion worth of investments for a future network that can accommodate two-thirds share of renewable energy in the total grid power supply. Notably, 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.

Outlook

Spain's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

BNEF projections indicate an average of 2GW capacity addition annually till 2030. The project pipeline has been a strong one, largely due to the momentum generated by the successive auctions. As per the industry association, about 600 wind power projects are under evaluation of policy/regulatory authorities. A fair share of the growth impetus could come from policy measures. For instance, in the aftermath of the energy crisis due to the Russia-Ukraine armed conflict, the Spanish government promised to expedite the approvals for wind power projects of up to 75MW capacity.

Also important is the policy objective towards decarbonization and sustainability that has apparently helped bring in multilateral funding through the European Investment Bank (EIB). In November 2021, EIB extended the first financing operation in Spain that was linked to emission reduction and climate action. A EUR250 million financing agreement was finalized with Endesa for solar and wind farm projects in Spain.

The Spanish power market meanwhile is expected to reflect the evolving dynamics of energy demand and supply. By end-2021, the country registered Europe's largest PPA-based contracted volume. Yet, with the evolving energy crisis and the spike in prices, the focus appears to be on shorter-term PPAs (less than 10 years) and for baseload contracts. The expectation is that the emerging PPA market could be led by a set of utilities through large renewable-based investment funds. Also, corporate buyers could play a bigger role in the scheme of things.

Among other things, the industry's growth prospects will be contingent on a stable regulatory framework. This has been somewhat an area of concern for the investors, at least based on the recent past events. In the time around September 2021, the government had decided to impose a 'gas tax' – a type of windfall gains tax on the wind farms that apparently earned a premium due to the high wholesale market prices (due to spike in gas-based power price). It was subsequently retracted, by exempting the projects which had PPAs or any other financial hedging. Yet, it left an impression on investors about the regulatory risk that future projects could face.

Progressively, efficiency and economies of scale will be key for the onshore wind capacity growth. This is because of the gradual saturation in the resource-rich locations, while solar power emerges as the nearest competitor in the successive auctions. While the industry associations have asked for separate auctions, Spain is likely to pursue technology-neutral bidding as done so far. There is a possibility that the future onshore wind power projects could find it difficult to out-bid the utility-scale solar photovoltaic plants and might need to incorporate varied technology and other innovations for the competitive edge.

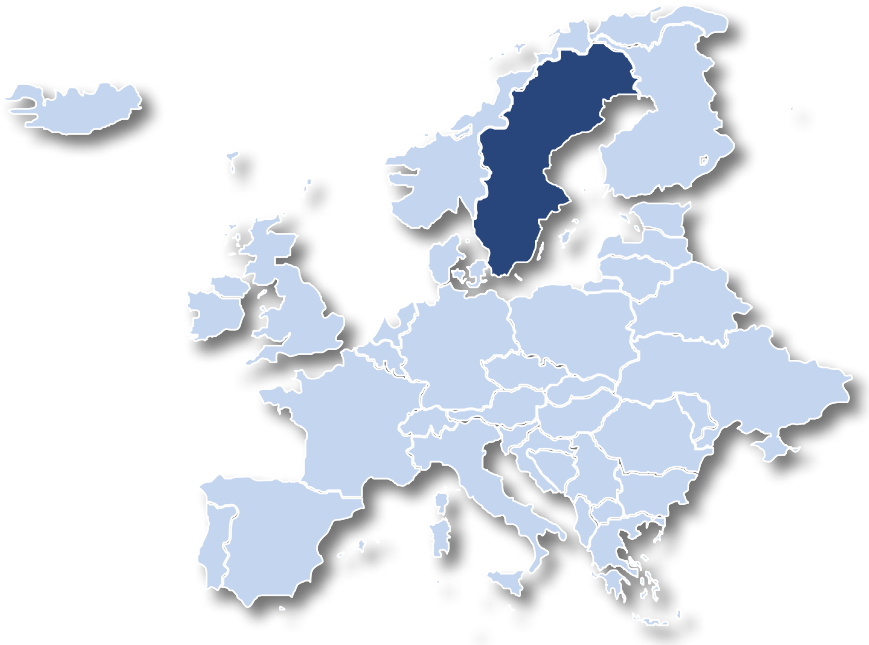
Sweden

Sweden is a leading decarbonization player in the world with most effective ways implied by the government to wean off the conventional energy resources. Although, hydropower is the dominant renewable energy in the country, Sweden has emerged as major wind market in Europe, with total wind capacity of 12GW achieved by end of 2021. On domestic level, onshore wind has become second major renewable energy source, growing at CAGR of 17% during 2011-21.

Sweden has set the most ambitious goal of net zero economy to be reached by 2045, which is five years earlier than EU goal. Additionally, the country has set interim targets, such as the emissions of transport sector be reduced by at least 70% by 2030 from 2010 level, while by 2040, power sector will be completely decarbonized.

GDP (Current Prices) USD (2020)	627.44bn
GDP Growth Forecast (constant prices) (2021-2025)	2.41%
Currency	Swedish Krona
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	34.5GW
Onshore Wind Share in Renewables (2021)	34%
Renewable Energy Target	Net Zero Economy by 2045 and by 2040 complete decarbonization of power sector

GDP Source: IMF WEO, S&P and IRENA



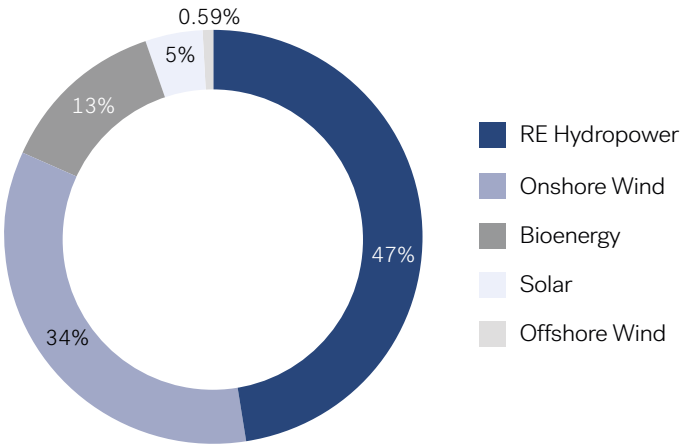
11.9GW Onshore Wind Capacity

- ✓ Onshore wind is the primary contributor among non-hydro renewable sources to meet ambitious net zero goal
- ✓ Growing competitiveness in the wind PPA market leading to reach the economic price
- ✗ Tedious permitting process for wind projects, resulting in derailing of the projects
- ✗ Opposition against onshore wind farms on communal and political front

Sweden

Renewable Energy Mix

Current Renewable Energy Mix 2021

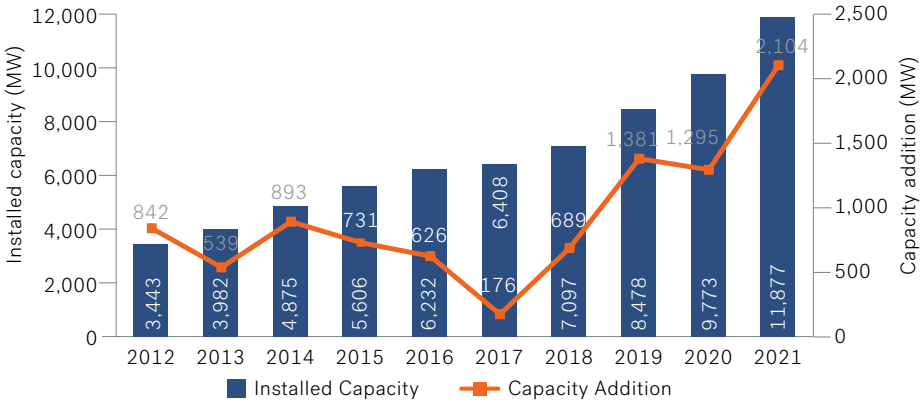


Source: IRENA Renewable Capacity Statistics April 2022

The share of onshore wind in the country's renewable mix has improved at steady rate over the last decade. In 2011, the onshore wind energy accounted for 11% of the renewable energy mix of Sweden, which improved to 34% in 2021. Onshore wind is followed by bioenergy and solar power, while offshore wind is still at a very nascent stage, accounting for just 1% of the renewable energy mix.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

During 2012-2017, annual onshore wind capacity additions in the country saw expansion as well as contraction, with lowest additions recorded in 2017. However, since then the capacity additions in Sweden increased steeply.

Following the upward trend, the capacity additions in Sweden underwent a small dip due to pandemic outbreak. However, the fall was contained by governmental efforts to sustain the renewable sector through contingency measures introduced to stabilize the economy. The investment in the carbon neutral solutions widened on the backdrop of expectations of achieving improved ecological as well as economic status of the country. Accordingly, the total onshore wind capacity reached 11.9GW in 2021, with annual additions reaching the peak in the same year.

Demand Drivers

The target to achieve 100% renewable-based electricity system by 2040 is the major demand driver of the Swedish wind market. To achieve the target, the country has plans to scale up its wind power capacity to 100TWh by 2040 — of which 80TWh would come from onshore wind. This aim has boosted the activity in the wind sector which has offset the negative impact of elimination of the subsidies. With such high spirit, the wind sector in Sweden is estimated to expand by 70% by 2024 compared to the level achieved in 2021.

The Swedish government in collaboration with Norwegian government introduced electricity certificate scheme in 2012 with an aim to increase the green electricity production. The scheme involved reallocation of the income earned through the certificates into the generation of green electricity. However, the technological advances achieved in recent times recorded better and faster generation of green electricity, indicating the deeming effect of the certification. Thus, both the countries involved have decided to sign off the scheme by 2035, 10 years early than planned.

The use of onshore wind-based power has seen growth in Sweden owing to favourable price dynamics. The improving penetration smoothed by technological and infrastructural developments in the country is proving to be beneficial for renewable energy sector overall. The supportive environment has underlined that the wind sector can now be built without subsidy support.

The growing clean energy demand has encouraged market participation over the years, leading to adoption of PPAs in Swedish wind energy sector. The tech players such as Microsoft and Google have entered into the long term PPAs in the country, in collaboration with international energy developers such as NTR PLC and GE Renewable Energy. The growing competitiveness has enabled the companies to reach the economic price (an average price of EUR29/MWh as of Q3 2020) in the Swedish wind market, thereby raising the market attractiveness.

Market Opportunity

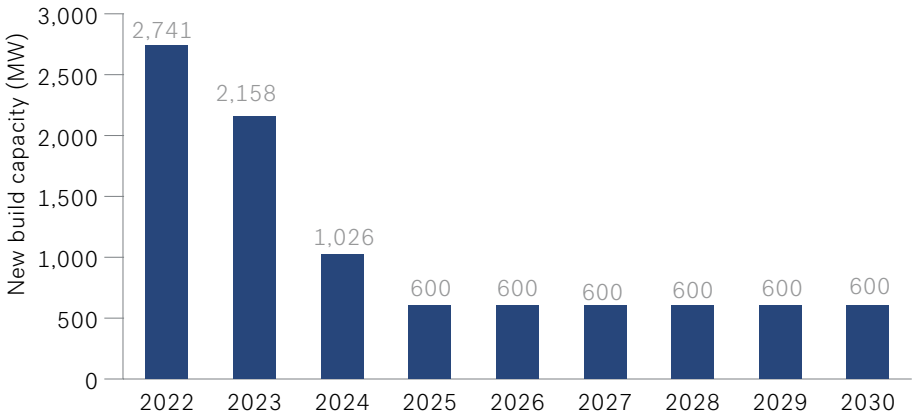
Sweden is the major energy exporter for its European peers such as Denmark, Finland and Lithuania.. In this regard, expansion of the wind sector is an added advantage as it facilitates lower carbon footprint, while enabling exports of clean electricity. The competitive cost achieved in the fossil free electricity market is also creating margins for electrification in Sweden.

The country is increasingly developing into a tech hub, attributing to the growing presence of several data centre and IT companies, attracted by the availability of cheaper electricity and the predominance of renewable energy sources. The large corporates such as Google, IKEA have signed several PPAs in Sweden to improve the renewable energy grasp. In December 2021, Microsoft entered a long term PPA with NTR for wind energy in Sweden, which includes electricity supply from an 86MW wind farm project along with future output of the Norra Vedbo wind project due in 2022. The farm situated in southern Sweden, will be powered by 20 turbines of 4.3MW.

The whole Sweden is emerging as wind investment hotspot, while the northern region accounts for lion's share in this regard, with leading power companies such as Vattenfall, OX2 as well as multinational conglomerate such as GE establishing and expanding their presence. The region has seen larger onshore wind projects being developed, including 353MW Blakliden Fäbodberget wind farm owned by Vattenfall along with Vestas and AIP Management came online during H1 2022, comprising 84 turbines and ability to deliver fossil-free electricity to 22k homes. Another major project inaugurated in June 2022 is RWE Renewables operated Nysäter wind farm, which is considered as one the largest wind farms in Europe. The farm spreads across 400km with total capacity of 475MW operated under 114 wind turbines.

Outlook

Sweden's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The 2040 roadmap set by Swedish Wind Energy Association expects 5,300 wind turbines to be built up in the country with installed capacity reaching 18.5GW by 2030, while by 2040, the wind turbines' stock is expected to reach 5,000 with installed capacity reaching 33.3GW. The lesser number of turbines point to the rapid technology development, which increases the generation of each turbine.

The BNEF projections of annual onshore wind installations in Sweden, on the other hand, shows tempering trend. Significant annual addition of c.2.5GW is projected until 2023, followed by a sharp decline in 2024 to c.1GW. Post 2024 annual onshore wind installation is projected to have a downward movement and maintain an estimated average figure of 600MW annually until 2030.

Despite strengthening presence of wind energy in the country, some bottlenecks continue to prevail. One of the major challenges is the tedious permitting process for wind projects, resulting in derailing of the projects. In the process, 'municipality' veto', which is municipalities' right to object to the construction of wind farms, given in the middle or the by the end of the process becomes the major roadblock. However, in 2021 the new assessment rules were initiated to improve the whole procedure. The major upgrade suggested was 'municipality veto' to be processed in the early stages of the investment which will be beneficial for the businesses as well as community involved.

The wind sector also faces the challenges on communal and political front as well. The big wind projects are facing opposition from the local communities based on adverse impact the wind turbines will have on bird species while the scenic beauty also being hurt in the meantime. The arguments sprouting in the areas under consideration for the wind farms especially in central Sweden suggest the build-up of the wind farms near the urbanized area rather than rural areas. The similar opposition is being experienced in parliament where the concerns regarding national security are aroused as the international participation in wind sector spurred. These oppositions are expected to work in favour of offshore wind segment as wind turbines set far from residential areas will be widely accepted by the community as it will meet the clean energy demand without hurting the scenic beauty of Sweden.

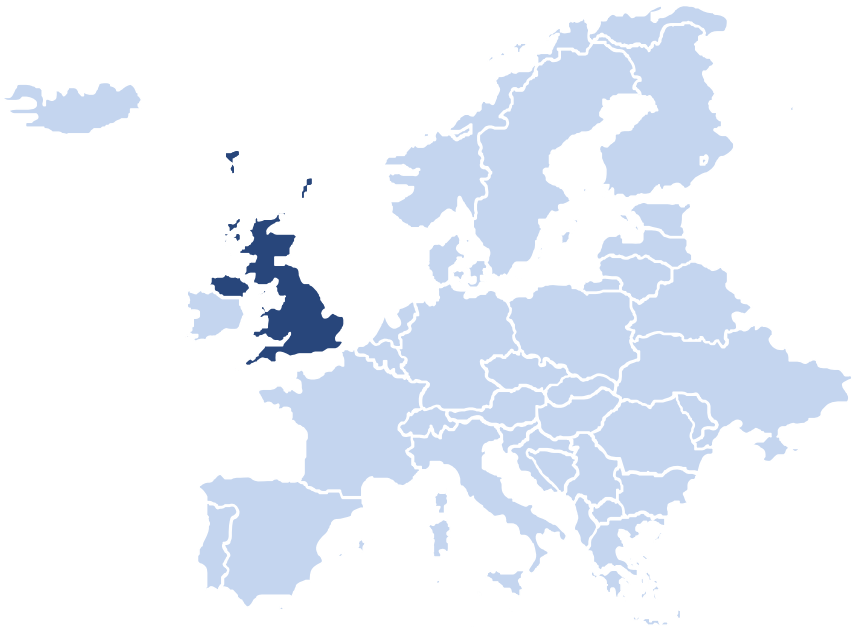
Overall, Sweden moving speedily towards the net zero target. The supportive government and resourcefulness of the country have paid off in terms of exponential growth achieved in onshore wind sector. However, the obstacles in the path persist which need to be looked up. Nevertheless, the milestones achieved by the country are motivating for its peers in Europe as well as globally.

United Kingdom

UK has evolved as one of the major wind markets in the Europe with total wind capacity reaching 27GW in 2021. The British government seeks to deepen the penetration of the wind energy in the country to eventually phase out the unconventional energy resources completely, which fits with its 2050 net zero target. The interim targets such as decarbonize electricity system by 2035 through widening the spread of solar and wind energy still holds. Accordingly, the country has expanded its offshore wind target to 50GW by 2030 in its energy security strategy, while it is yet to set an ambitious target for onshore wind.

GDP (Current Prices) USD (2020)	2,758.87bn
GDP Growth Forecast (constant prices) (2021-2025)	3.22%
Currency	Pound Sterling
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2021)	50.3GW
Onshore Wind Share in Renewables (2021)	29%
Renewable Energy Target	Net-zero emissions by 2050

GDP Source: IMF WEO, S&P and IRENA



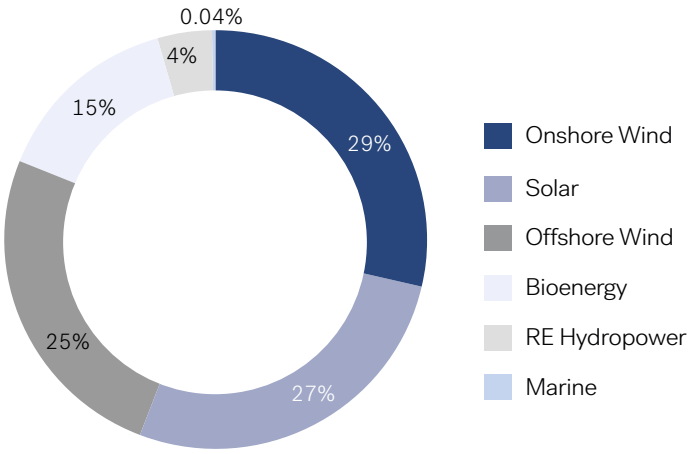
14.4GW Onshore Wind Capacity

- ✓ **Onshore wind is the cheapest option available for new power generation**
- ✓ **Government lifted ban on onshore wind, allowing it to compete for government contracts**
- ✗ Political as well as communal opposition due to ecological footprint of onshore wind farms
- ✗ No onshore wind capacity target in the government's latest energy security strategy

United Kingdom

Renewable Energy Mix

Current Renewable Energy Mix 2021

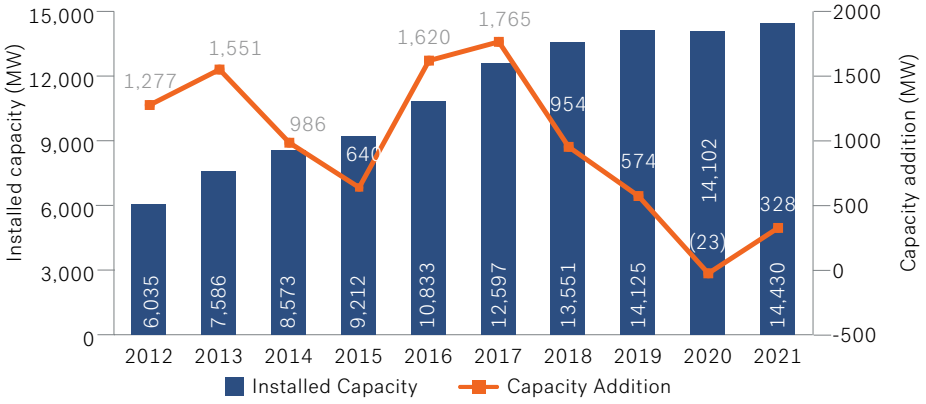


Source: IRENA Renewable Capacity Statistics April 2022

During the last decade the share of onshore wind energy in the UK's renewable energy mix has declined in favour of solar PV, while share of offshore wind energy has improved. In 2011, the share of onshore wind energy in the renewable mix was 37%, down from 42% in 2010, which shrunk to 31% in 2016. The government's decision to scrap the subsidy support available for onshore wind projects resulted in stagnated share of the energy at 31% till 2018 and continued decline thereafter, reaching 29% in 2021. Nevertheless, onshore wind energy still accounts for the highest share in the UK's renewable energy mix, and is expected to improve with lifted ban as well as improved efforts by the current government. The technology is still the cheapest option available for new power generation in the UK. Especially, on the backdrop of rising energy bills, it has significant contribution in the country's power sector.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

The onshore wind capacity addition in UK has grown, however, at tapering pace. Over the period of 10 years, starting from 2012, the annual onshore wind capacity additions in the country had fluctuating trend. After expanding in 2013, the annual additions reduced till 2015, followed by sharp increase in 2016 and 2017, with the latter recording the peak of annual additions.

Post 2017, the onshore wind capacity additions in the UK declined steeply, showcasing the adverse effect of abolished subsidy support. Though the subsidies were re-established in 2020, the pandemic outbreak-led restrictions resulting in shutdown of already established capacities added to the fall. Nevertheless in 2021, the positive movement in the capacity additions took place, summing up the total onshore wind capacity in the UK to 14.4GW.

Demand Drivers

The government ban on onshore wind which had placed the technology in doldrums since 2016, was finally lifted in 2020, allowing the projects to compete for the government contracts in 2021. This inclusion is expected to nourish the sector by stimulating investment into building up wind turbines onshore along with imparting price stability, thus, paving the way for strong expansion to take place in coming years.

By end of 2021, the British government announced biggest ever flagship renewable energy auction scheme with funding budget of GBP285 million a year. This fourth round of auction admitted onshore wind energy along with solar, first time since 2015. Even though, only GBP10 million of the total budget was allocated for the onshore wind and solar energy, the opportunity to compete for the subsidy drove the demand in these sectors. With expected electricity generation capacity allocation of 12GW in the fourth round, a capacity cap of 3.5GW was set for each of these two technologies in procurement exercise.

There have been instances of onshore wind turbines facing opposition by people surrounding the onshore farm mainly due to noise and their adverse effect on bird species. However, growing energy dominance of Russia fuelled by Ukraine war compelled UK to be more welcoming towards the onshore wind energy as it offers the most cost-effective choice for new electricity in the country. Additionally, on one good windy day the electricity production by wind farms can rise to the level of reducing electricity cost to the new low, protecting consumers against the soaring power prices. Though the national level support is yet to be deployed, community wind projects are spurring in the country, which involve grants and non-secured loans from local and winder community, supporting the planning and construction of the wind turbines. Currently, Scotland accounts for maximum onshore wind turbines generating 1,200MW – 9,000MW of the wind power, while UK in total has more than 11,000 wind turbines onshore and offshore, which produce nearly a quarter of the country's electricity as of 2021.

Market Opportunity

UK has opted to hold contracts-for-difference (CfD) auctions to allocate new clean energy generation capacity annually, starting from March 2023, rather than every two years. Inclusion of onshore wind in these auctions create an opportunity for the wind developers to receive funds immediately next year as government contracts provide price guarantee to prospective investors by taking a significant level of risk away from the investment. This new proposal has gained much appreciation from the renewable energy industry's trade associations.

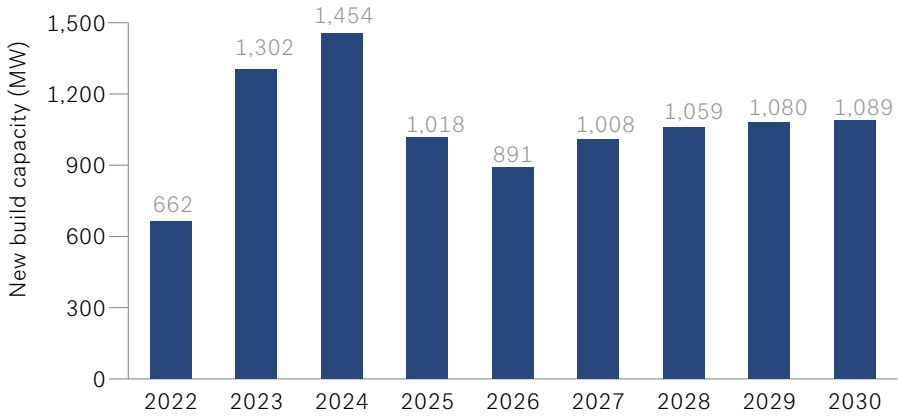
Although, subsidies are integral to future capacity deployment, corporate offtake of onshore wind energy is demonstrating a strong case for subsidy-free onshore wind development without the need of public funding. UK's one of the largest unsubsidized wind farm by Amazon came online during Q4 2021. This 50MW wind farm is expected to deliver 168,000MWh of clean energy annually. Amazon plans to commission three more plants in the country by 2025, which will cumulatively provide 529MW of clean energy. This will power Amazon and AWS data centres, corporate offices, and fulfilment centres across the UK, supporting the country's 2030 renewable target.

Energy storage is another area which comes in handy to address the system instability caused by intermittent nature of onshore wind turbines. Therefore in an effort to eliminate output volatility, the British government has started relaxing the planning process of building and maintenance of battery storage units, which has highlighted the opportunity for the battery storage players to boost up the activity and bring the boom in market. One of such ambitious initiatives could be the government awarding around GBP6.7 million in the energy storage competition, as announced in February 2022. The aim of the competition is to optimise the renewable energy potential that will help lower the costs in the shift to a greener energy system.

Under the energy storage funding, the Catapult energy system's project got selected with finance value of GBP149,954. The University of Southampton is also part of this 'Renewable Copper project' which aims to develop a rechargeable Copper/Zinc (CuZn) battery technology to provide long duration (4-12 hour) electricity storage with lower carbon emissions and lower costs compared to other storage systems. This battery storage is expected to save around 60 tonnes CO2eq/MWh/year and could reduce the curtailment of wind power by up to 65%, and thus helping to maximise its renewable energy potential.

Outlook

UKs Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

According to the data provided by Renewable UK, the total onshore wind capacity in the pipeline of the projects that are operating, under construction, consented or being planned in the UK has grown to nearly 33GW, highlighting the affirmative market approach.

The BNEF forecasts of onshore wind energy installation in UK indicates an affirmative market outlook during 2022-2030. Over first couple of years, the installations are projected to have a rapid growth, leading to peak in 2024 for the period since 2018. Thereafter, a drop in installations till 2026 is expected to be followed by recovery, however a flatter one. Nevertheless, by end of the forecast period, the annual onshore wind installations in the country are expected to exceed the current level.

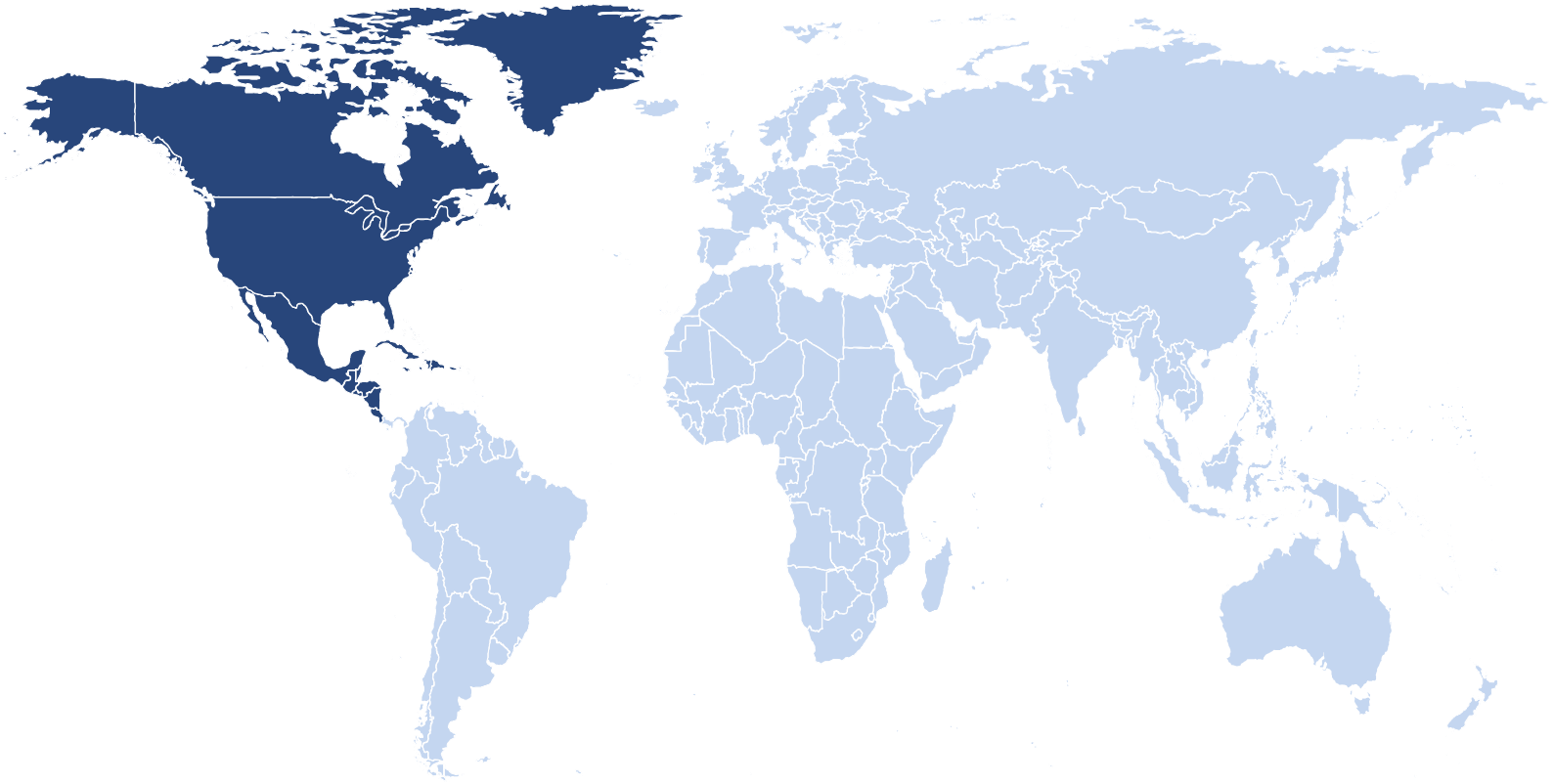
However, this might not be enough to reach the target set by the Climate Change Committee of 35GW of onshore wind capacity by 2035.There are some major stumbling blocks in the path of onshore wind energy capacity optimization in UK. The limited support of local communities posing ecological concerns, resulting in the government providing consent to lesser number of projects than should have ideally happened. However, the cheaper electricity made available by the onshore wind energy is winning the support of people in UK.

The political as well as communal opposition in the country has put the British government to the back foot. The opposition regarding the unpleasant presence of wind turbines is offsetting the government's efforts, discouraging further expansion. As a result, the government could not include the onshore wind capacity target of 30GW to be reached by 2030 in its latest energy security strategy.

Nevertheless, the British energy security strategy has included the measures to expand the sectors in terms of improving the national network infrastructure and extending support to new projects with local backing. Scotland is the destination for majority of the onshore wind projects, while activity in Wales is also expected to grow. The strategy also added the plan to support the repowering of existing onshore wind sites whenever needed and deploy technological advances.

UK, overall, has not been able to capitalize on its full onshore wind potential owing to the various challenges. The technological advances in wake of growing need for renewable energy are expected to support the country's decarbonization goal and onshore wind energy has potential to play pivotal role in the process. Few critical steps like relaxing planning control to fill a pipeline of future projects and substantial upgrade of the UK grid to accommodate the incremental capacities are essential in this regard.

Key Regional Markets - North America



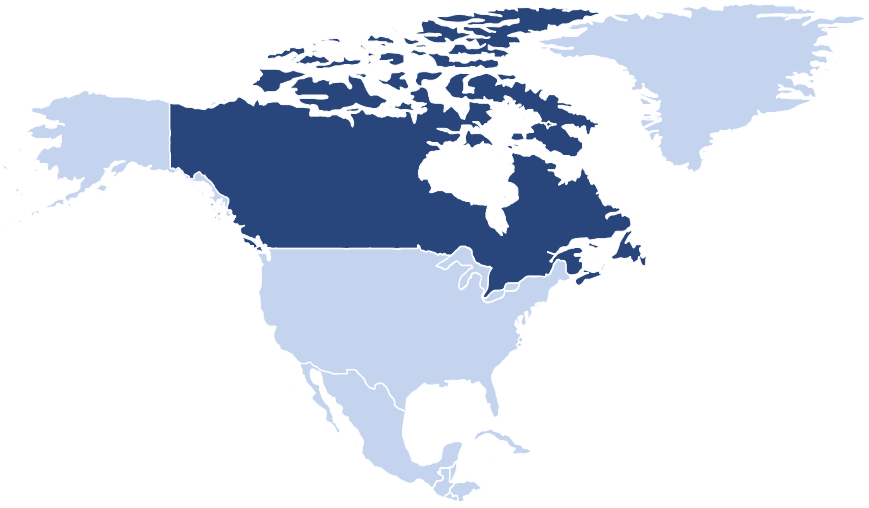
Canada

A policy-driven energy transition is underway in Canada, as the country seeks a net-zero carbon goal. As this gets implemented across sectors, onshore wind has an integral role among other renewable energy technologies.

The trend shows that the capacity addition has been largely stagnant so far. Yet, the market opportunities indicate a pipeline getting expanded gradually through power purchase agreements (PPA), carbon emission credits, and new technology configurations of hybrid power projects (wind plus storage). While federal policies are important, the provincial authorities appear to have the critical role – Alberta for instance has emerged as the frontrunner due to the favourable policies and power market institutions.

GDP (Current Prices) USD (2021)	1,990.76bn
GDP Growth Forecast (constant prices) (2022-2026)	2.35%
Currency	Canadian Dollar
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2021)	102.9GW
Onshore Wind Share in Renewables (2021)	14%
Renewable Energy Target	Decarbonization of electricity supply by 2035 and achieve net-zero emissions by 2050

GDP Source: IMF WEO, S&P and IRENA



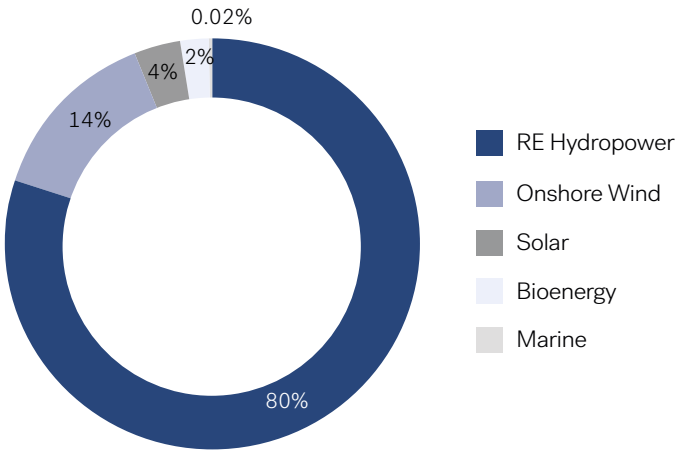
14.3GW Onshore Wind Capacity

- ✓ **Policy-driven energy transition underway both at federal & provincial level**
- ✓ **Project pipeline getting expanded gradually through power purchase agreements (PPA), carbon emission credits, and new technology configurations**
- ✗ Delay in environmental and related approvals is working as deterrents for potential developers
- ✗ Clean energy outlook is dominated by hydropower while onshore wind has a relatively insignificant role

Canada

Renewable Energy Mix

Current Renewable Energy Mix 2021

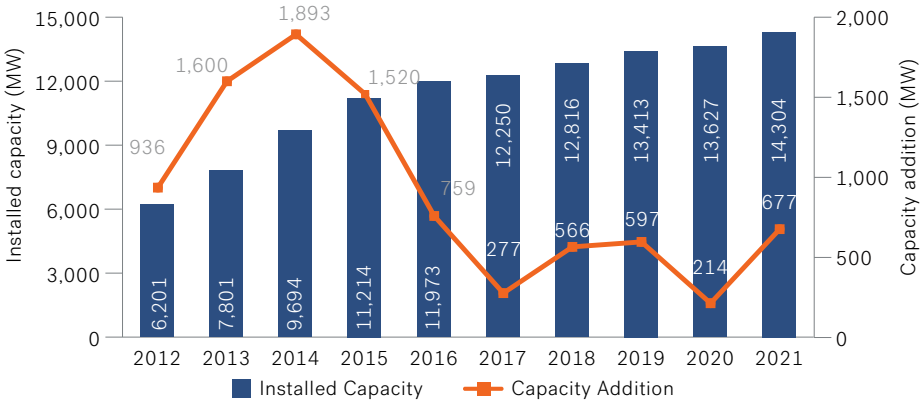


Source: IRENA Renewable Capacity Statistics April 2022

After hydropower generation, onshore wind's share is largest. In a long-term perspective, the favourable shift towards onshore wind is discerning, rising from 7% in 2012 to 14% by end-2021. A slow or stagnant capacity addition reflects in the trend as well, as relative shares stayed stagnant for several successive years. It is also true that the country's hydropower generation base continues to skew the balance, for its competitive advantage in costs as well as grid balancing capability (contrasting intermittent renewable).

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Canadian onshore wind capacity addition trend shows a stagnancy since 2015. Most of the new capacity in 2021 was from the Alberta province, besides others including Saskatchewan, Ontario and British Columbia. Weak pipeline, delays from procedural approvals and the competition from alternative sources are some of the factors. The lack of period bulk auctions for onshore wind has also not helped the cause of project pipeline.

Demand Drivers

Energy transition is recognized as an important public policy goal, for which separate budgetary allocation is provisioned. Such attention is helpful in getting the required momentum for the market, especially in terms of major support measures including funding, ease of regulatory norms and setting up of market-oriented processes. For instance, Canada's 2022 Federal Budget allocated CAD250 million over next four years for pre-development activities related to clean electricity projects of national significance. Another CAD600 million over seven years was set aside for renewable energy and grid modernization projects. New/emerging technologies found a mention in the Federal Budget. For instance, the Budget committed to an investment tax credit of up to 30% for battery storage solutions. This is timely and important for the ongoing shift in favour of renewable energy-based power generation.

As part of measures towards meeting the goals of renewable energy penetration by 2030, carbon offset scheme was launched recently by the Federal government. While currently this is limited to a select set of technologies, it can be expected to have a wider ambit in near future. The provincial authorities are at the same time implementing similar policy measures. In March 2022, the Alberta government proposed a new Electricity Grid Displacement Factor (EGDF) – determined as tonnes of CO_2 emission per MWh for projects that displace grid electricity with renewable-based electricity or reduce the consumption of grid-based power. Upon finalization, it will be applicable for all renewable offset projects, with offset start dates between January 1st and December 31st of 2023. Potentially, this could incentivize wind energy developers to fix their EGDF for the entire eight-year offset crediting period.

At the federal level, there are tax benefits available for industries spending on clean energy projects. For equipment purchased under the relevant income tax regulations' categories, certain capital costs are eligible for accelerate capital cost allowances. Furthermore, the regulations provide for the accelerated depreciation rates of the identified equipment.

The thrust on emission mitigation is finding gradual acceptance and adoption in the businesses across the industries. Many leading entities are investing or taking a stake in clean energy generation through carbon credits or through power procurement. In March 2022, Shopify and Royal Bank of Canada announced the signing of power purchase agreement with Rattlesnake Ridge Wind Power Project. Such purchase helps the companies offset a part of their total annual power purchase with a renewable energy-based source. In 2020, the company Shopify had used the carbon credits route to offset the net emission impact from its operations.

Market Opportunity

In August 2022, the provincial government of Nova Scotia awarded power procurement contracts to five onshore wind farms aggregating to 372MW. The projects, due for commissioning by 2025, are majority-owned by the local communities. The province's energy department held earlier that by 2030 it aims to source about 80% of its total energy requirement based on renewable energy resources. In July 2022, the federal government announced a budgetary allocation of CAD255 million for clean power sourcing options in the Nova Scotia province.

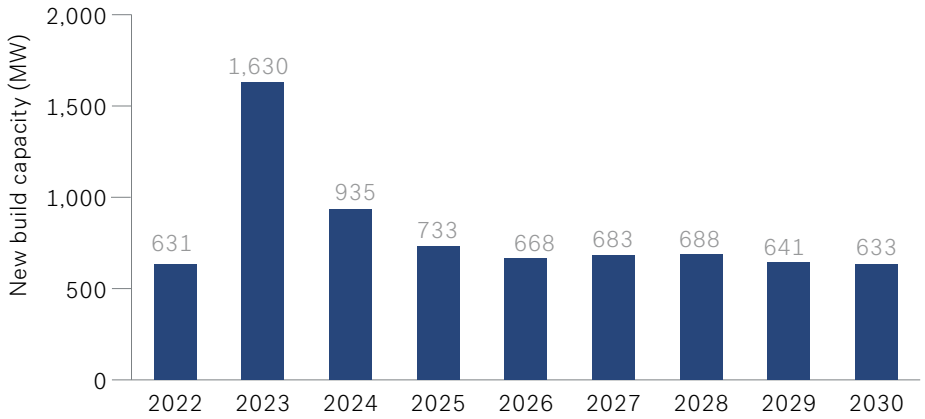
The Canadian province Alberta is in focus for most of the investments in renewable energy. By end-2021, the state had 358MW of onshore wind capacity addition. The project pipeline is expanding rapidly, with the recent major one being Enel Green Power' CAD250 million wind project. Other major investments in line include those of Capstone Infrastructure Corporation. Its CAD260 million Wildrose 2 project has had PPAs finalized with the Edmonton authorities as well as Pembina Pipeline Corporation. The same company has another wind farm project worth CAD85 million, due for commissioning by end-2022. There are other provinces taking up interest in onshore wind power projects. In April 2022, the Newfoundland government announced the lifting of ban on developing wind power projects, that was in place since 2007. With this approval, prospective investors can set up and export the generated power. The break from traditional regulation could help boost investor interest.

The investment interest is also high amongst the leading players of conventional energy sources. In April 2022, three major entities in Canada's energy business announced setting up of 1,200MW worth of wind energy capacity in the Québec province. Under this plan, each of the companies will develop about 400MW of capacity, while PPA will be secured by the utility Hydro- Québec. Total investment in the project is estimated at CAD3 billion.

The gradual rise in the renewable energy penetration is also bringing energy storage to the fore. Like other markets globally, there is a traction for the hybrid projects combined with battery storage. In 2020, Alberta had the first battery storage project commissioned at wind farm (TranAlta Renewables). Most of the upcoming battery projects are in conjunction with existing/installed generation projects including wind, solar and hydropower. Notably, the major aerospace and defence engineering and manufacturing company Lockheed Martin's proprietary flow-based battery technology has a pilot project situated at Alberta.

Outlook

Canada's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Canada's clean energy outlook is likely to be based on a multitude of options, of which onshore wind has a relatively insignificant role. The country's traditionally predominant hydropower generation capacity is expected to continue to hold similar share over the projected period till 2030. As a result, the projected onshore wind power capacity growth reflects one of a weak project pipeline. As per BNEF estimates, except for the 1.6GW expected new capacity in 2023, the rest of the period till 2030 is that of a declining trend.

The onerous requirements of environmental and related approvals that delay projects are deterrents for potential developers. The province Nova Scotia's largest wind farm stood delayed (as of March 2022) due to the protracted process of approvals. Other provinces too face a similar issue, multitude of approvals and permits cumulate in causing both project cost and schedule overruns. In a market-oriented scenario, such inordinate delays could impose huge costs on developers and thus potentially impact investments.

The emerging growth dynamics of the Canadian onshore wind market could be based on various factors including an improved project development pace, rapid growth in the battery storage capacities and the related hybrid projects, and a rise in the offtake of industrial demand through PPAs.

Mexico

Mexico's wind power sector can effectively support the policy goals of energy transition, due to the vast untapped potential and the private sector interest in this regard. The opportunities for developers also include potential cross-border projects, as one such recently commissioned wind farm project indicates. But to realize the potential, the policy and regulatory framework needs to be aligned. Mexico's recent reversal in policy direction about the private sector's role may have adversely impacted new investments.

GDP (Current Prices) USD (2021)	1,294.83bn
GDP Growth Forecast (constant prices) (2022-2026)	2.05%
Currency	Mexican peso
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2021)	29.4GW
Onshore Wind Share in Renewables (2021)	26%
Renewable Energy Target	35% share of renewable energy in total power generation by 2024

GDP Source: IMF WEO, S&P and IRENA

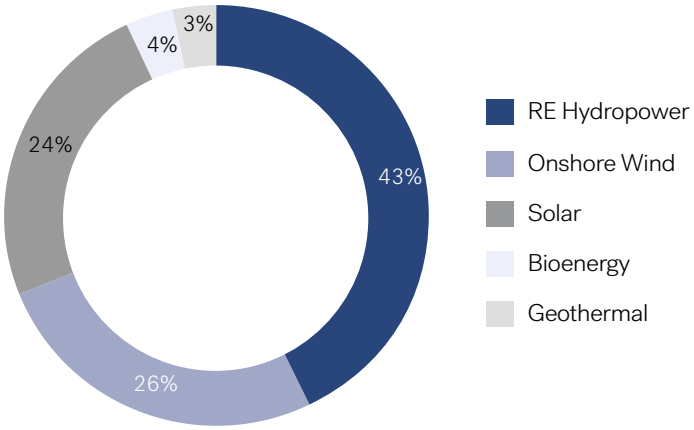
7.7GW Onshore Wind Capacity

- ✓ **Government signed deals worth 1.8GW with 17 US renewable energy companies for wind and solar energy projects in June 2022**
- ✓ **Robust project pipeline comprising 50 wind and solar power projects with a cumulative capacity of 7GW**
- ✗ Increased government involvement and public sector dominance in the energy sector
- ✗ Unfavourable market condition with Mexican regulators blocking European renewable energy developers

Mexico

Renewable Energy Mix

Current Renewable Energy Mix 2021

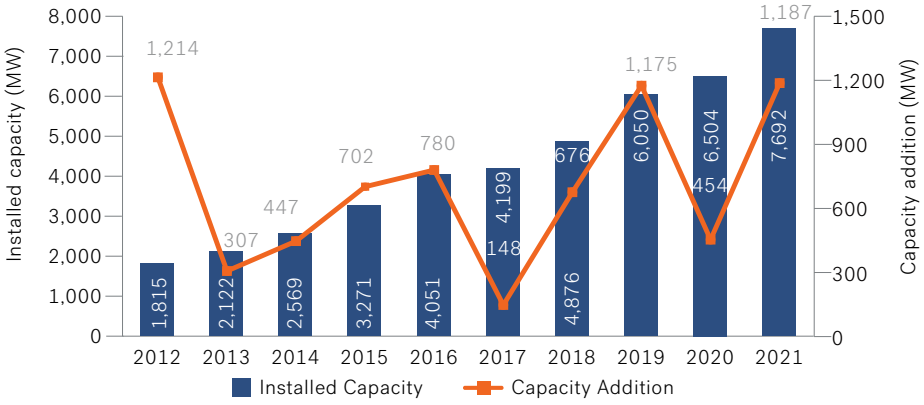


Source: IRENA Renewable Capacity Statistics April 2022

So far, onshore wind is the only wind power generation segment operational in Mexico. Offshore-based capacity is yet to be commissioned. As the long-term trend indicates, between 2012 and 2021 the share of wind power in renewable energy mix had more than doubled. While hydropower generation is still the predominant one, it has gradually ceded ground to wind and solar due to stagnant capacity. Yet, it has to noted that renewable energy is yet to gain any significant ground in Mexican energy consumption basket. Fossil fuel continues to play the most important role (about 70% share).

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Mexico's installed wind power generation capacity has had an inconsistent or unsteady growth pattern. In 2018, the capacity growth picked up after a drop, reflecting the projects awarded in the auctions during 2016. The second break in the trend during 2020 could be understood as the disruption from pandemic. The subsequent pickup was again a fallout of pipeline stuck at various developmental stages. Some of the major global wind energy developers, such as Enel are at advanced stages of their wind farm projects in Mexico and could be commissioning by end-2022 or early 2023.

Demand Drivers

The policy focus on renewable energy comes from the climate change legislation of 2012. As per the Act, the country commits to ensuring a 35% share of renewable energy in total power generation by 2024. By most accounts, this is a modest target. As of end-2021, the percentage of renewable energy in total power generation stood at 26.7%. The country's untapped solar PV potential (along with other renewable technologies) can support a far higher power generation requirement.

As per the US Department of Energy's National Renewable Energy Laboratory (NREL), Mexico's onshore wind power potential is worth 3,669GW. Some of the most resource-rich locations are in Southeast region where the estimated wind power potential is 744GW. Geographically, for developers such locations also present the scope for cross-border export to meet demand in Central American region. Among the other notable regions on offer in Mexico include the Baja California Sur. Among other systems, this region has a pumped hydropower system for the necessary storage backup in renewable energy dispatch to grid.

The capacity awarded in the auctions so far attest to the competitive costs that potential developers can realise. In the auction of 2017 (third in sequence) for instance led to a globally ranked cheapest price of USD17.7 per MWh. A sound market design, with commercially attractive wind generation sites helped set the context for such auctions. Most of the current momentum (though relatively diminished) in Mexican renewable energy sector could be attributed to the reform-led auction processes since early 2016. The cost advantage of such energy has also been helpful for the energy-intensive industries to engage in PPAs for Mexican wind power projects. In August 2020 for instance, the company Bayer had signed a 15-year PPA for Iberdrola's 105MW wind farm in Mexico.

Market Opportunity

In June 2022, the Office of the President of Mexico announced that the government had signed deals with 17 US renewable energy companies for solar and wind energy projects, aggregating 1,854MW. Quite a few of these projects could be planned for cross-border energy export, and transmission interconnections are being planned as well alongside. The announcement came in a backdrop of government seeking steps at addressing the investors' concerns about the market risks and exploring a resolution.

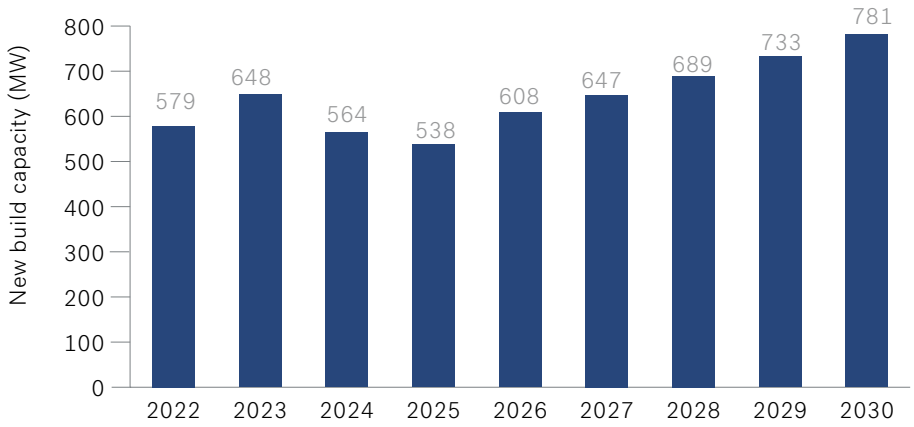
The first cross-border project already took off recently, setting a possible ground for replication ahead. In February 2022, the second phase (108MW) of Energia Sierra Juarez wind farm project went online. Based at Mexico's Baja California region, this project is the first cross-border renewable energy project between Mexico and the US. With commissioning of latest phase, the project is supplying 263MW to the Californian electricity market.

The Mexican wind energy market has a significant project pipeline. The untapped investment opportunity could be gauged from the number of private sector developers' applications pending approvals for the project permits. As of end-June 2022, over 50 wind and solar power projects, aggregating about 7GW in capacity, were in queue for the requisite permits from regulatory authority. While public investments are a factor, Mexico so far has been reliant predominantly on private investments for the renewable energy projects. This is unlikely to change directly, despite the prevalent challenges.

Meanwhile, the grid infrastructure has a significant scope of investment considering the rising demand on the network from varied renewable energy generation resources. As the transmission operator, the state-owned utility CFE's near-term plan (as of June 2021) involves 18 transmission projects with about 3,000 km of new transmission lines. The planned investment spending on transmission and distribution networks was estimated at USD2.3 billion for 2021-2025.

Outlook

Mexico's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Mexico has a strong project pipeline in wind farm projects, across various stages of planning, development and commissioning. As per the NREL's report (April 2022), there are about 860MW worth of projects that are in process of carrying out pre-commissioning tests. In the typical 'business as usual' scenario, such a capacity is most likely to be brought onstream. Another 1,705MW of tracked capacity comprises projects in various stages of securing permits, financing, transmission connectivity or starting development work. Another batch of projects, aggregating 2,686MW, constitute those in less advanced stages of the pre-development project work.

Despite the promise, the Mexican renewable energy market is going through an uncertain and sluggish growth phase due to the recent policy changes. Reversing past years of progressive energy sector reforms, the recently appointed government sought to make the public sector (the state-run utility CFE) dominant in the power market and make the energy regulatory authorities operate under the government. The proposed new rules would make CFE have at least 54% of the power market and would no longer have to dispatch the lowest cost of power first.

Recent instances of Mexican regulator blocking European renewable energy (both wind and solar) developers' permits makes the market appear unfavourable for the global majors and prospective investors. The Italian company Enel has three wind power projects which are awaiting regulator's approval for two years. The projects were initiated as part of auctions awarded by the past government. In current regime the regulatory permits were withheld without a define premise. Such a position comes in the backdrop of government's backtracking of reform measures of previous regime. With blocking of projects already under development, the concerns point to the larger issue of Mexican market's regulatory risk in contractual obligations. In another case and context, in June 2022 the regulator cancelled French company EDF Renewables' contract for the 252MW wind power project, on grounds of violation of community rules and norms.

Although the proposed legislative changes in electricity market are far from enactment and have been contested in the courts, investment momentum is adversely impacted. The longer the current phase of regulatory uncertainty prevails, the worse it will get for the Mexican renewable energy market. The steps towards energy transition so far have already shown the promise that the Mexican market holds if the conducive conditions hold.

United States

Globally, the US onshore wind market ranks second after China's in terms of the total installed capacity base. The trend shows a steady capacity addition, led largely by tax credits, corporate power procurement and the regulatory obligations for utilities' procurement. A mature power market further helps developers to capitalize on prices in the wholesale power market, beyond just the fixed contracts. The pace of growth however is increasingly coming under pressure from major infrastructural challenges in interconnection, as well as the competition from other renewable energy resources (mainly solar and offshore wind). The cost advantages still play in favour for the market, helped in large part by emerging hybrid energy storage options with wind/solar generation.

GDP (Current Prices) USD (2021)	22,997.50bn
GDP Growth Forecast (constant prices) (2022-2026)	2.16%
Currency	US Dollar
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2021)	325.4GW
Onshore Wind Share in Renewables (2021)	41%
Renewable Energy Target	100% clean energy goal by 2035 and net zero emission by 2050

GDP Source: IMF WEO, S&P and IRENA

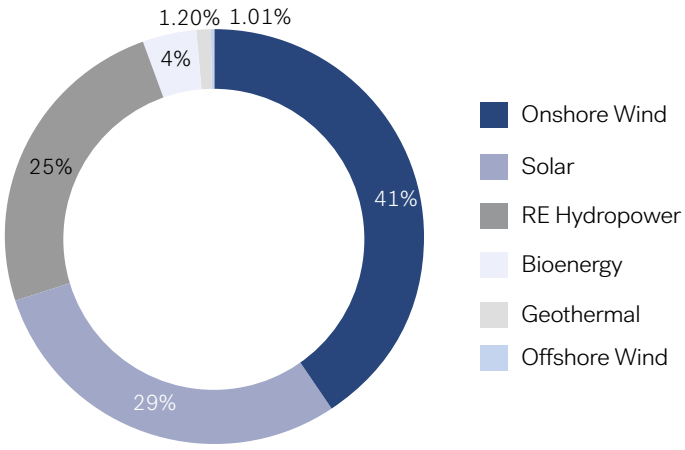
132.7GW Onshore Wind Capacity

- ✓ **Renewable portfolio standard (RPS) as a common measure across most of the US states**
- ✓ **Hybrid projects are assuming a mainstream position. This is supported by federal investment tax credit**
- ✗ Rising backlog in transmission connectivity, resulting in delayed commissioning of wind projects
- ✗ Most of the projects in pipeline are located at sites with lower wind speeds

United States

Renewable Energy Mix

Current Renewable Energy Mix 2021

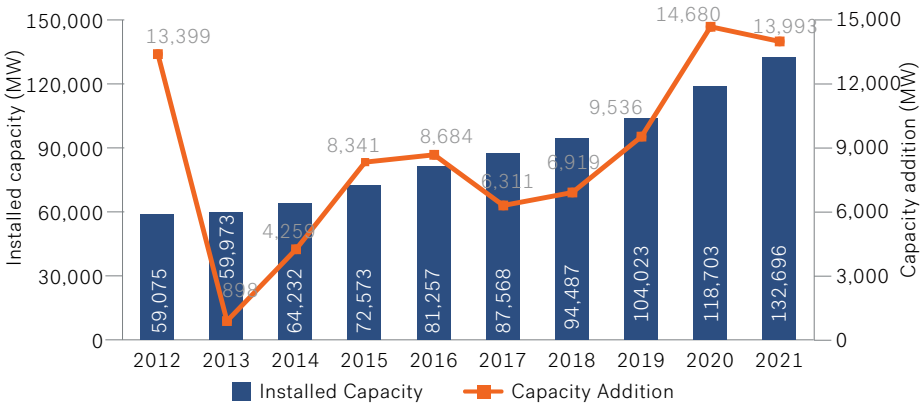


Source: IRENA Renewable Capacity Statistics April 2022

Onshore wind power has the maximum share of renewable energy portfolio in the US market. The trend shows the relative share has risen consistently since 2012, when it was 36%. This is likely to be maintained for some time as offshore wind segment is yet to take traction while solar power catches up. In terms of the total energy sale in the grid, wind power in the US has a 9.1% share. This however varies drastically at the state level. The state of Iowa, for instance, had 55% of total power generation due to wind energy.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

The onshore wind capacity addition has been on an upswing and progressively accounts for a major share (32%) of the overall new power generation capacity commissioned in the US. About 14GW of new capacity was installed in both 2020 and 2021. Marking a departure from trend, partial repowering is also emerging as a factor in the capacity addition. The US Department of Energy's report confirms 1.6GW of capacity brought onstream through partial repowering, driven by consideration of tax benefits, project lifecycle and the prices in the wholesale power markets.

By end-2021, the total installed capacity base was across 42 states of the US. However, the capacity is not uniformly distributed. Five states, namely Texas, Iowa, Oklahoma, Kansas and Illinois, together held about 56% share. The country's wind resource-rich locations are situated largely in Texas, the Midwest and the Central regions. In contrast, about 10 states (mostly Southeast region) have no wind power projects. The same variability is observed in share of wind energy in total generation – at the national level, wind power accounts for 8.4% of total American power generation from all sources. In the key states of wind power though, this is markedly high. Notable examples are Kansas (43%), Iowa (58%), Oklahoma (35%) and North Dakota (31%).

Demand Drivers

The tax credit available for wind power projects has been an important driver in the industry. It also helped that partially repowered wind power assets were included under the ambit of tax benefit during 2021. While the federal production tax credit (PTC) regime expired by 2021, the subsequent legislation under Inflation Reduction Act helped extend the tax credit facility by another 10 years. This has helped in project visibility. Furthermore, the new PTC regulations include credits for manufacturing and supply of wind power project components, thus providing a fillip for the domestic equipment manufacturing and supply chain.

Various states have tailor-made their respective policy and regulatory measures to promote renewable energy modes, including wind power. For many states such as California (the earliest one to promote wind power generation), specific measures helped them get a lead in investments. Yet, a common regulatory measure common across most of the states is the renewable portfolio standard (RPS) – that mandates the utilities or retailers to supply a stipulated share of power from qualified renewable energy resources. By end-2021, there were 31 states and the District of Columbia with RPS or Clean Energy Standards. Four states (Delaware, Oregon, North Carolina and Illinois) updated their policies or norms. Nebraska became the 20th US state to target 100% clean electricity by 2050. Notably, states which enacted legally binding RPS obligations are collectively responsible for over two-thirds of the total electricity sales (as of 2020).

Policy impetus has also helped wind power generation (as with other renewable energy sources) to gain a competitive position through economies of scale. Thus, it is progressively competitive to build a new wind or solar power plant instead of a new coal or gas-based one. As per Deloitte's report, about 77% - 91% of the total coal-based power generation in the US had operating costs higher than that of wind or solar power. Also important, is the fact that in states with high renewable energy penetration (California as the key example), hybrid renewable energy projects report levelized cost of energy competitive to that of a combined cycle generation.

Wind power developers stand to gain from the high wholesale power prices in the US market. As per the Energy Information Administration (EIA), the peaking demand during US summer period was led by the high gas and switching away from coal-based power plants. For wind power owners/developers, such a trend of rising prices has been a major propelling factor. While wind power projects typically secure long-term agreements (or PPAs), many of them also keep some capacity aside for the wholesale power market. A mature power market, such as that of the US, is thus among the key demand drivers working in tandem with other similar ones.

Market Opportunity

With the capacity installed by end-2021, the US wind power industry had total investment worth USD20 billion in the year. The entire market demand is met by just four manufacturers – GE, Vestas, Siemens-Gamesa Renewable Energy and Nordex. GE corners the maximum market share, at 47% of all of the US wind installations in 2021. The US wind power manufacturing capacity has consolidated, as challenges in pricing, profitability and supply-chain constraints forced idling or closures in many cases. Furthermore, even as the domestic capabilities are strong, the import dependence is high due to competitive pricing. In 2021, imports amounted to USD3.1 billion, sourcing primarily from Mexico, Spain and India.

Asset ownership in the market has been historically led by the independent power producers (IPP). About three-quarters of the new wind power assets in 2021 is attributed to IPPs, while the rest is due to the investor-owned utilities (IoU). The trend so far has been that the IPPs have been able to ensure faster project development than IoUs and have been better positioned at ensuring efficiencies and monetization of the available tax incentives.

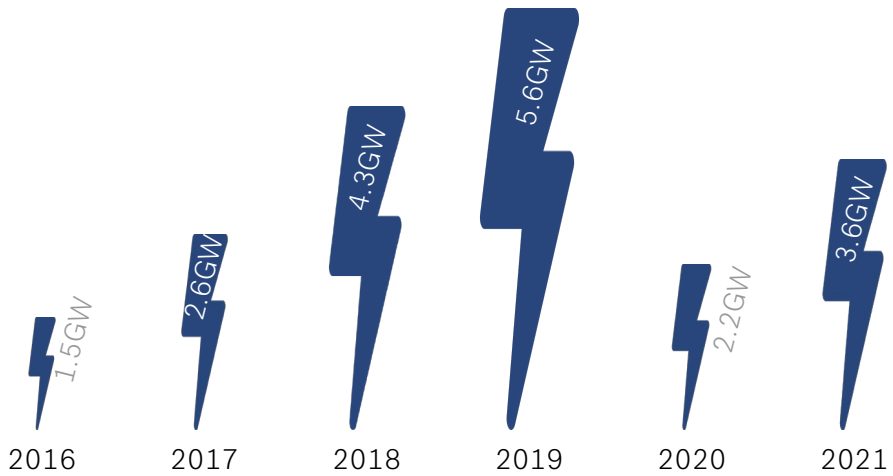
With rationalization in cost of battery-based storage systems, hybrid projects are assuming a mainstream position instead of being a niche one. This includes projects combined with storage as well as solar power. For instance, about 750MW of wind-solar-storage capacity was in queue for transmission interconnection by end-2021. Compared to 2020, this was a 133% rise. As per the US Department of Energy, there were 41 hybrid plants in operation by end-2021, amounting to 2.4GW. More than the requirement of grid dispatch, the addition of storage option helps developers fetch better prices on the power purchase agreements (PPA). As per Lawrence Berkeley National Laboratory's study, the addition of storage increased the PPA value by USD0.01/kWh.

As per industry sources such as the American Clean Power Association, the drive towards hybridisation is also fuelled by incentives such as the federal investment tax credit. A standalone energy storage project won't get the tax credit. But it becomes eligible for tax benefit, once paired with a generation (wind and solar) project. Other factors at play include the peak demand goals and network congestion. To meet the reliability targets (typical in California and Texas networks), energy storage systems are becoming the proxy option for transmission capacity. A four-hour Lithium battery-based storage is thus standard for most of the projects.

While the supply-side dynamics evolve, the demand side continues to be reinforced by industries and the related energy-intensive business enterprises. Corporate PPA continues to be an important demand for the US onshore wind power market, even with a relative decline in the capacity quantum over the years (reflecting competition from solar). The US-based technology majors are major demand drivers of the PPA capacity (both wind and solar). As per BNEF's study for the period till 2021, globally Amazon ranked as the top renewable energy buyer for the second time in a row. Its wind power procurement stood at 1,338MW.

PPA prices are on a rise, as highlighted in LevTen Energy's latest report. For the year 2021, wind-based corporate PPA prices rose 33.7% relative to previous year. Inflation and transmission bottlenecks are among the factors attributed for the price rise. This was higher than that of the solar-based PPAs for comparable period. It is also the case that the PPA market faces a higher demand than supply, which is also the reason why the prices have been on a rising trend since last two years.

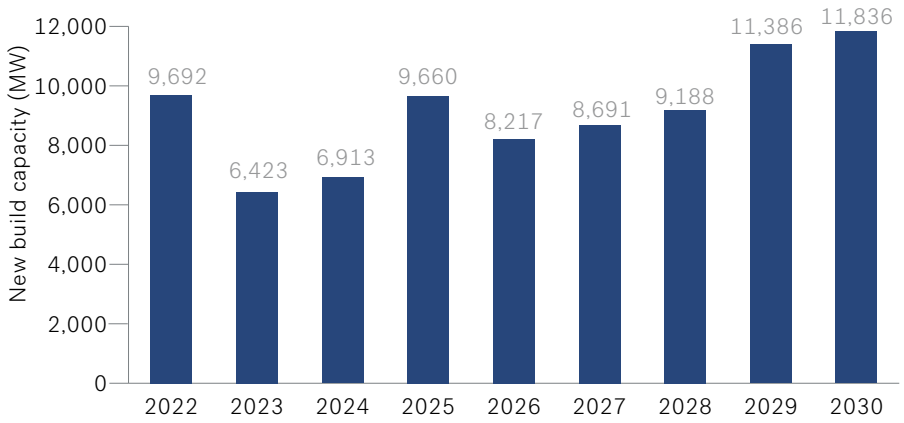
Corporate PPAs in the US based on Wind Power



Source: BNEF Corporate PPA Deal Tracker, March 2022

Outlook

US Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

The capacity projections indicate a dampening of the momentum in 2023 onwards. This could be due to multiple factors such as the competition from offshore wind power segment (incentives may skew the balance), solar power (both utility-scale and residential), price rise by OEMs and the timely transmission connectivity challenges. Yet, this could also be mitigated by the policy support through taxation, emerging technology options in storage (economizing the overall costs and returns) and the individual US states' initiatives in promoting the capacities.

Progressively, the onshore wind capacity will have to contend with lower wind speed locations to operate. As per the US Federal and industry data, the project pipeline (both under development and announced), the sites which are expected to have the build-out are those with lower speeds than the historical long-term average. For the capacities commissioned in 2021, the locations had wind speed of 8 metres/second (long-term average 100-metre wind speed). The response for such constraints will be on the predictable lines, comprising change in wind turbine configurations, such as in rotor diameters, total swept area dimension, hub height and the like.

The country faces a rising backlog in transmission connectivity. By relative scale, renewable energy-based generation faces the brunt of it (as compared to coal or gas-based plants). Addressing this bottleneck may just assume an urgency as delayed commissioning would also impact the project returns in a competitive market. As per the report of Lawrence Berkeley National Laboratory, the queue for projects awaiting the interconnection at the end of 2021 aggregated to 1TW – of which onshore wind power was 247GW. About 19GW worth of wind hybrids (combined with battery storage) were part of the queue. Furthermore, the waiting time is on the rise – from an average 2.1 years during 2000-2010, to about 3.7 years during 2011-2021.

Key Regional Markets - South America

Brazil

Brazil has emerged as the strongest market for renewable energy in the LATAM region with renewables accounting for 80% of power generation and 45% of primary energy demand. Notably, to accelerate the energy transition efforts, in 2021, Nationally Determined Contribution (NDC) of Brazil upgraded the timeline of the net zero goal from 2060 to 2050, with the addition of interim targets, such as 50% emission reduction by 2030 from 2005 level, with improved focus on non-hydro renewable resources such as wind and solar.

GDP (Current Prices) USD (2020)	1,448.55bn
GDP Growth Forecast (constant prices) (2021-2025)	2.21%
Currency	Brazilian Real
Country Credit Rating (S&P)	BB-
Renewable Energy capacity (2021)	159.9GW
Onshore Wind Share in Renewables (2021)	13%
Renewable Energy Target	35% reduction in GHG by 2025 from 2005 levels and to reach climate neutrality by 2050

GDP Source: IMF WEO, S&P and IRENA

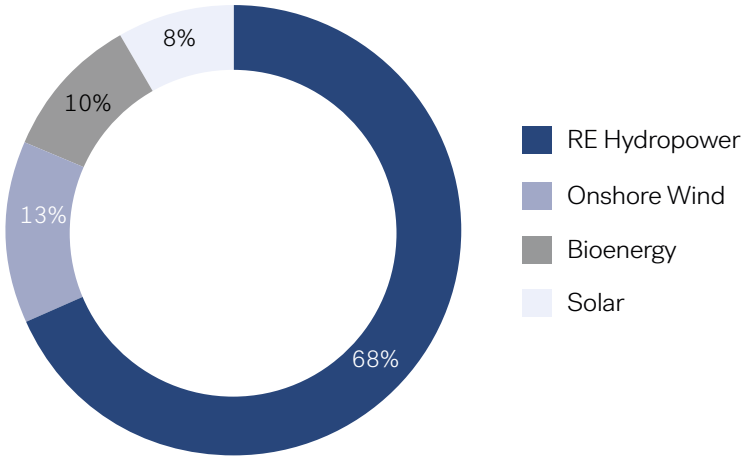
21.2GW Onshore Wind Capacity

- ✓ **Strong policy support for the development of onshore wind**
- ✓ **Onshore wind capacity addition registered 23% CAGR between 2014-2021, almost twice the global rate during the same period**
- ✓ **Robust project pipeline comprising 427 wind farms with a cumulative capacity of 15.4GW**
- ✗ High inflation, coupled with volatility in exchange rates have impacted project costs, resulting in bloated capex and diminished profitability

Brazil

Renewable Energy Mix

Current Renewable Energy Mix 2021

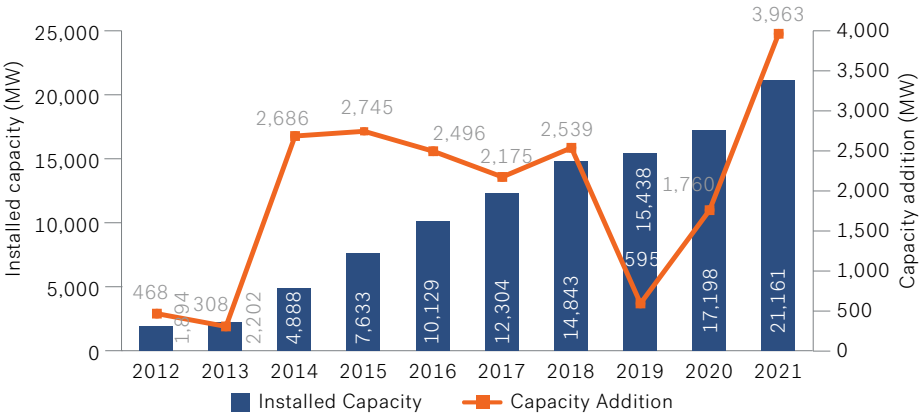


Source: IRENA Renewable Capacity Statistics April 2022

Brazil's energy mix has traditionally been skewed towards renewable hydropower, with the latter accounting for 55% of the country's electricity generation in 2021. But onshore wind has made rapid strides, almost doubling its share in the renewable energy mix from 7% in 2015 to 13% in 2021. It has established its leadership in the region as the biggest wind energy producer in LATAM. In 2021, ~9.9GW of renewable energy capacity was added in Brazil, of which onshore wind was the second biggest contributor after solar, accounting for ~40% of the capacity added. Solar and onshore wind cumulatively added 9.1GW installed capacity, 92% of the total capacity added in 2021, highlighting the growing importance of these technologies in Brazil's sustainability plans.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

Annual capacity addition for onshore wind in Brazil has been robust from the outset, averaging ~2.5GW between 2014 and 2018. This declined dramatically to almost a quarter of that value in 2019 because of cancelled auctions in late 2015 and 2017. Capacity additions have rebounded since then reaching a record 3.96GW in 2021. This has enabled Brazil to reach 21.2GW in cumulative installed capacity by 2021, which represents more than 70% of the cumulative installed capacity of onshore wind (29.8GW) in South America. Brazil has managed to add onshore wind capacity at a CAGR of 23% between 2014 and 2021, almost twice the global rate of 12% CAGR during the same time period. It is currently ranked 6th globally in terms of cumulative installed capacity of onshore wind, after China, USA, Germany, India and Spain.

Demand Drivers

The axis of growth for the onshore wind industry has pivoted towards the free market, away from regulated market auctions. This is apparent from the progressively lower allocation to onshore wind in the three auctions (A3 to A5) conducted in 2021 totalling 580MW. In contrast, the Brazilian Wind Energy Association, ABEEólica, estimates that 3GW onshore wind energy was contracted in the free market in 2021, representing the fourth consecutive year when the free market outperformed the regulated market. Corporate PPAs, which constitute the free market have been instrumental to growth of renewable power in Brazil and is estimated to have reached 10.7GW, constituting 41% of the total solar and wind capacity in Brazil.

Policy support for the development of onshore wind (and generally renewables) remain strong in Brazil. In January 2022, federal government support of up to BRL500 million was announced for solar PV and wind energy projects in every region of Brazil. The National Bank for Economic and Social Development (BNDES) has financed BRL3 billion worth of onshore wind projects developed by Engie under its FINAME II scheme, which promotes local sourcing for wind development. The federal government has also offered tax breaks for equipment and components used in wind farms. The IPI (Imposto sobre Produtos Industrializados), which is generally applied to factory output, imports and public sales, has been reduced to zero for wind farm equipment.

Demand for International Renewable Energy Certificates (I-REC) in Brazil has exploded in the last three years, growing from 4 million (2020) to 9.2 million (2021) and 13.2 million in YTD 2022 up to 10 May. In 2021, Brazil was the second largest market after China in terms of I-RECs issues with wind power accounting for half of the certificates. As carbon credit rules are tightened in developed markets, Brazilian commodity exporters like meat and sugarcane suppliers are likely to be impacted driving the rush towards I-RECs. This is also likely to boost addition of generation capacity as more Brazilian companies not only look to reduce their carbon footprint but also start viewing the sale of I-RECs as an extra revenue stream.

Market Opportunity

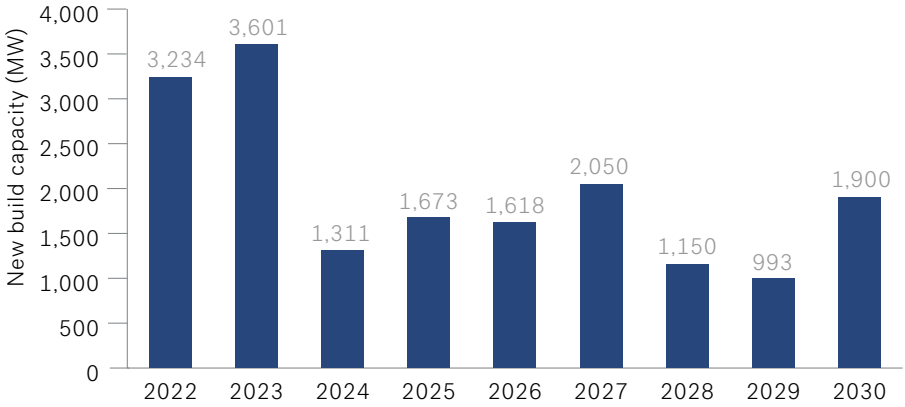
Favourable geographic conditions, especially in North-East Brazil which accounts for more than 88% of the country's wind power generation capacity, have been key to sustained expansion of wind energy technology. Wind capacity factor along Brazil's Atlantic shoreline averaged more than 40% in 2020, considerably higher than the global average of 35%. The growth potential of the region has attracted leading global renewable companies like Statkraft, Enel and Iberdrola to base major wind farm projects there in recent times.

The project pipeline for onshore wind in Brazil remains robust, indicating the likely hood of sustained capacity addition in coming years. As per energy regulator ANEEL, Brazil has 427 wind farms with a cumulative capacity of 15.4GW, in various stages of development. Of these, 178 wind projects, representing 6.6GW are under construction. As per projections from ABEEólica, Brazil is on track to have an installed capacity of 37GW for onshore wind by 2026. This implies a capacity addition of ~16GW in the next five years. With limited plans to expand renewable hydropower capacity, solar and wind are the two renewable technologies that form the cornerstone of Brazil's energy transition plans with projections of 35% growth in their production capacity by 2025.

Brazil's onshore wind energy industry has attracted sustained investments totalling USD32.36 billion between 2010 and 2021. In 2021, USD5.15 billion was invested in the sector, representing 44% of the overall investments made into the renewable energy sector in Brazil. Institutional support has played a key role in attracting investors. Besides domestic incumbent BNDES, the European Investment Bank (EIB) is expanding its investment programme in Brazil under its "Team Europe" initiative, with a strong focus on funding renewable energy projects. In March 2022, it announced a EUR200 million loan to Neoenergia, a Brazilian energy distributor for a project comprising 566.5MW of wind power and 149MW of solar PV.

Outlook

Brazil's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

There are varying estimates regarding the projected capacity addition of onshore wind in Brazil. BNEF represents the more conservative scenario projecting an addition of 17.5GW between 2022 and 2030. ABEEólica expects an approximately equivalent capacity to be added by 2026. Irrespective of the scenario, it is evident that onshore wind has a crucial role to play in Brazil's future energy mix, even as it starts taking preliminary steps towards offshore wind to diversify its renewable energy mix further. Wind represents the cheapest source of renewable power in Brazil and the price economics should ensure continued focus on its development even in the face of competition from solar PV and offshore wind.

High levels of inflation and correspondingly high interest rates, coupled with volatility in exchange rates have impacted project costs, resulting in bloated capex and diminished profitability. This has had an impact on foreign investments in the onshore wind industry in Brazil. Inadequate grid infrastructure creates bottlenecks to connecting the wind farms with the distribution grid leading to revenue losses. North-East Brazil, which offers the highest wind potential and is home to the largest concentration of wind farms, has poor physical infrastructure which makes project development a challenging task. Ongoing subsidies to coal-based power plants till 2040 under the Just Transition Law prolongs the runway for the complete withdrawal from fossil-fuel based energy, limiting growth for renewable technologies like wind and solar.

In the next five years, around 65 onshore wind farms are planned in Brazil with total investment amount to USD23 billion. Despite the prevailing challenges, onshore wind is likely to retain its pivotal role in the country's energy transition plans. Although the next decade should see increased attention and allocation of resources to solar PV and offshore wind, North-East Brazil's uniquely high wind potential will continue to draw investor attention to the onshore wind industry of the country.

Chile

Chile counts among the leading Latin American countries for its focus on renewable energy adoption. Its goal of decarbonization rests on wind and solar as the most important resources.

So, far, the entire wind power capacity growth in the country has been through development of onshore wind projects. With the untapped potential available, the wind power segment is far from saturation. Yet, it faces significant and an outsized competition from solar power in the overall renewable energy mix.

GDP (Current Prices) USD (2021)	316.86bn
GDP Growth Forecast (constant prices) (2022-2026)	1.67%
Currency	Chilean Peso
Country Credit Rating (S&P)	A
Renewable Energy capacity (2021)	14.9GW
Onshore Wind Share in Renewables (2021)	21%
Renewable Energy Target	70% share of renewables in energy matrix by 2030 and achieve carbon neutrality by 2050

GDP Source: IMF WEO, S&P and IRENA

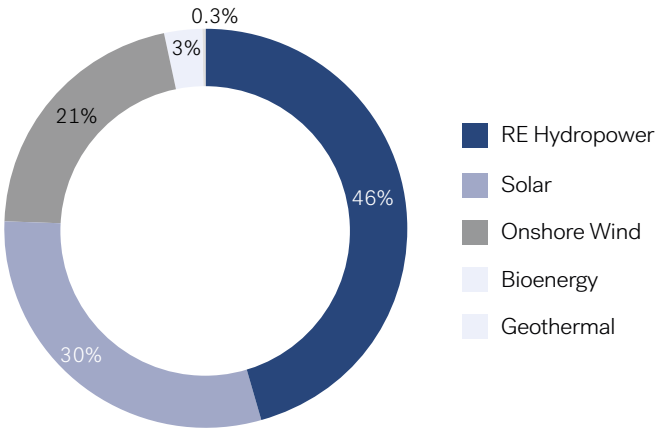
3.1GW Onshore Wind Capacity

- ✓ **High wind generation potential with significant amount of untapped wind generation resource**
- ✓ **Positive outlook with average 900MW of annual capacity addition is expected by 2027**
- ✗ Potential delay in decarbonization plan
- ✗ Competition from solar due to the vast untapped solar power potential of the country

Chile

Renewable Energy Mix

Current Renewable Energy Mix 2021

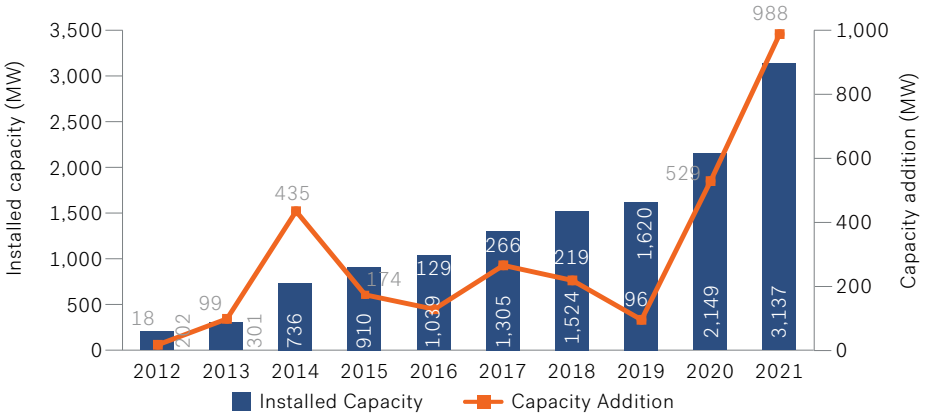


Source: IRENA Renewable Capacity Statistics April 2022

The renewable energy mix shows hydropower as the most important resource. Yet, the country is actively seeking to diversify and shift away from hydropower, as successive instances of drought made the power supply network vulnerable. Non-hydro renewable energy resources thus have a faster growth.

Installed Capacity: Status and Trend

Trend in Installed Onshore Wind Capacity



Source: IRENA Renewable Capacity Statistics April 2022

In terms of absolute capacity added in a year, the year 2021 has the highest. In fact, capacity addition picked pace since 2020 after an extended period of moderate or near-stagnant annual growth rate. The project pipeline has to be far bigger than current levels to ensure gigawatt-scale annual capacity addition. As of April 2022, the regulatory authority registered 4.37GW of renewable projects under construction, of which wind energy had just 15% share.

Demand Drivers

In 2021, the government announced plans to close half of the existing coal-based power plants by 2025. In June 2019, an agreement between the government and the power companies laid out the plan to close eight coal-based power plants aggregating to about 1,000MW in capacity by 2024. Six of them were closed in 2020. A total 28 coal-based plants, aggregating to over 5GW is expected to be retired as per policy objective. Most important is the announcement by AES Corporation to retire over 1GW worth of coal-based power generation capacity by 2025. Such voluntary decarbonization measures set the stage for renewable energy, including wind power among others. A deliberate policy push is likely to help expedite the project allocation and development pace.

A significant part of the country's wind generation resource remains untapped. The Northern parts of the country has some of the most important locations for potential wind power projects. As per an IEA study, sample studies for the northern Chilean region indicated 14.5GW worth of power generation potential. Furthermore, wind generation with potential capacity factors of over 40% were found feasible in the central North and central South – 23 GW worth of generation potential identified in the regions of Bio-Bio, Araucania, Los Rios, and Los Lagos. The Patagonian far South region notably was found to have wind generation capacity factor in excess of 60%.

Over the years, Chile's technology-neutral auctions for long-term power purchase agreements (PPA) have lately emerged as an important demand driver. These are typically 15-20 year long PPAs with the power distribution companies. A market-oriented approach, without relying on subsidy support, has helped get the investor interest. It also helps that policy-wise the country has been shifting towards the non-hydro renewable energy technologies due to the limitations and challenges in relying entirely predominantly on hydropower generation.

Market Opportunity

Wind energy is made to compete against other renewable energy technologies in the auctions for PPAs. The response to such auctions reflects the industry's response to the potential opportunity. As of August 2022, the Chilean National Energy Commission (CNE) announced results of one such auction. The notable element in this regard is that the Spain-based company Fotowatio Renewable Ventures (FRV) secured a 651GWh annual supply procurement contract based on a wind-solar hybrid power project at a price of USD0.03719/kWh. In an earlier auction of September 2021, EDP Renovaveis SA was one of the five companies that secured the power procurement contract, with average price of USD23.78/MWh. The company's contracted power supply was related to its 120MW San Andres wind farm in Chile's Araucania region.

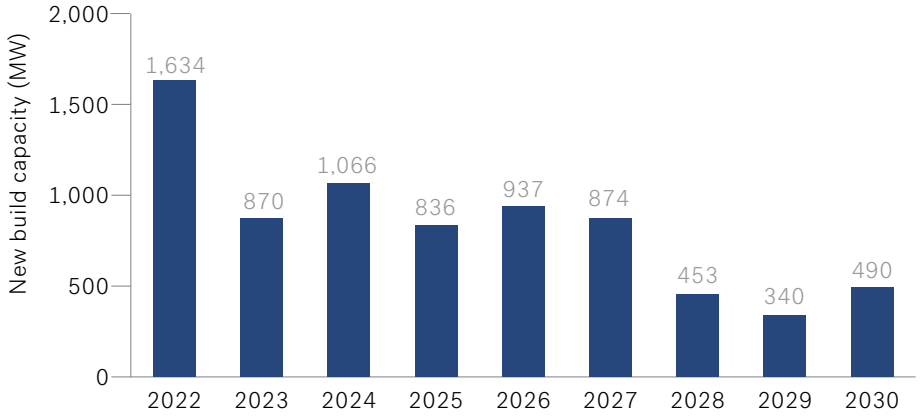
Growth in the renewable energy penetration is also spurring developers to opt for hybrid power projects – combining battery-based storage or solar power projects, or even both. In October 2021, the Norweigian company Statkraft secured a develop-build-operate contract for a 400MW wind-plus-storage project in Chile's Antofagasta region. The project will entail about USD500 million worth of investment. As per the company, even a solar power plant could be considered in the project configuration. The same region Antofagasta region is host to several other hybrid projects such as those of Engie Energia Chile which got land concessions for 1,500MW of wind-solar-battery projects. Another major company Enel Chile announced in November 2021 its first major battery storage-linked wind power project covering two wind farms aggregating 286MW (about 60MW in battery). Also notable is that in August 2022, the same company received regulatory approval for another hybrid project, involving a wind power project running alongside a solar one.

On it own, battery-based storage industry is finding significant traction in the country, as the policy and regulatory authorities seek rapid integration of renewable energy generation in the overall grid-based power supply. In November 2021 for instance, during the COP26 UN Climate talks at Glasgow, it was held that the US-based AES Corporation was working with the Chilean government towards augmenting Chile's battery-based storage capacity to 300MW by 2023. This is likely to be an investment worth USD400 million. The investment flow can be expected to rise once the regulations are defined for energy storage business.

The rising integration of renewable energy source in the grid imposes demand on the power transmission capacity both for capacity and reliability. In April 2021, the energy regulatory authority's report on the transmission expansion plan outlined 46 projects amounting to a total investment of USD511 million. The development of such identified projects could start in 2023. Projects identified by policy/regulatory authorities will be in addition to potential dedicated transmission lines required for the utility-scale projects allocated in auctions. Furthermore, with rising emphasis on cross-border transmission lines, there is likely to be greater interest in high voltage transmission systems. An example is a consortium selected in August 2021 for the project tender related to a 1,500km 600kV High Voltage Direct Current transmission line in Chile. The project is worth USD2 billion.

Outlook

Chile's Projected Onshore Wind Builds



Source: BNEF Global Wind Market Outlook

Chile's wind capacity addition outlook is bolstered by the strong pipeline, due to the recent auctions. An average 900MW of annual capacity addition is expected by 2027, as per the BNEF estimates. Post-2027 the projected capacity addition tapers off, reflecting the low visibility on project pipeline. It could however change with developments on new capacity approvals.

There is an active policy interest towards the energy storage segment to support the decarbonization objectives in the economy. As per the government estimates, the goal to achieve 80% renewable energy-based grid by 2030 will also entail about 2GW worth of energy storage capacity requirement. This is meant to support the energy mix through availability of flexible generation capacity to replace baseload coal-based power plants. For the onshore wind power market, the likely implication is the rising deployment of hybrid projects involving a storage component based on batteries. Furthermore, such a trend could also act as driver for formulation of the appropriate regulations in this regard.

The short-term challenges of managing the energy transition could potentially delay the decarbonization plan, especially in terms of phasing out conventional energy-based power plants. By 2040, the aim is to close all the coal-fired power plants in the country – five were already closed by end-2021 and another four are in line for 2022. But the massive drought in the country – impacting hydropower plants' reservoirs exposed the vulnerability, as grid operators were unable to requisition alternate power supply in time and resorted to rationing. Diesel-based power was deployed, among other options, indicating the challenge.

The outlook for wind capacity growth is also shaped by the competitive options in the renewable energy mix. Chile's vast untapped solar power potential makes it a competitive option to the onshore wind. This is most clearly visible in the technology-neutral auctions that revealed solar-based developers outbidding the wind energy ones. While this may vary across technology configurations, the emerging trends around wind turbine prices and the investments towards solar power projects indicate the growth trajectory will not be predictable one between the options available.

06

About CleanBridge

About CleanBridge

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Sustainable Energy

Climate Finance

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