

# GLOBAL OFFSHORE WIND REPORT 2023



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# Welcome to the Global Offshore Wind Report 2023

The 2023 Global Offshore Wind Report marks a new frontier in the global growth of offshore wind. Our analysis shows that over 380 GW of offshore wind capacity, across 32 markets, is predicted to be added in the next ten years. There are plans in place for offshore wind to provide large-scale, renewable energy in every continent in the world, save for Antarctica. This is excellent news for the planet and an increasing number of communities that want clean, reliable electricity to power lives, develop local economies and boost industrial growth and jobs.

For the 2023 edition, we are launching the report at the inaugural GWEC Asia Pacific Offshore Wind and Green Hydrogen Summit in Australia. This new, annual event recognises the huge offshore wind opportunity for the Asia Pacific (APAC) region. Indeed, our report shows that nearly half of all offshore wind installed worldwide in the next ten years will be in this region, from an ever-greater number of new offshore wind markets.

As more countries in APAC pledge to work towards carbon neutrality, there is a growing demand for renewable energy sources, such as offshore wind. Whilst China continues to be the biggest single market in the region, we are forecasting capacity additions in an increasingly diversified set of markets. Our outlook shows more than 180 GW capacity of offshore wind project pipeline identified outside of China. This year alone, we have so far

electricity business licences (EBL) and is developing a 'dual-track' system for offshore wind development; and the Philippines is moving towards its first Green Energy Procurement auction for offshore, which could be as early as next year; from humble offshore wind beginnings, Australia now has a pipeline of 50 GW of capacity, with the event host city, Melbourne, in the state of Victoria, recognised as the epicentre of the Australian offshore wind industry.

The central challenge governments and industry now face in this region is realising this potential. APAC is poised for growth but the market

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**Achieving the rollout of offshore wind at this scale in the APAC region will require unprecedented collaboration and cooperation between governments and industry.**

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seen important breakthroughs in several markets: Bangladesh announced plans for its first ever offshore wind project; Vietnam published the Power Development Plan 8, that sets an offshore wind target of 6 GW by 2030 and 70–91.5 GW by 2050; South Korea granted over 20.8 GW of offshore wind

alone will not deliver in its current state. Achieving the rollout of offshore wind at this scale in the APAC region will require unprecedented collaboration and cooperation between governments and industry.

While the stage may be set for APAC growth, in both Europe and the US

the industry is dealing with some acute growing pains. Challenges such as inflation, increased capital cost and the supply chain crunch have been brought into sharp relief in markets that have prioritised race-to-the-bottom pricing schemes. Meanwhile, offshore wind projects have been delayed or indefinitely stalled by inadequate and inefficient permitting and licensing rules. These factors have created uncertainty and have forced developers to review the viability of their projects, in some cases even to stop developing.

Such ineffective policies centred on a downward price competition and, where coupled with impractical and unattainable local content stipulations, will add to project costs and slow the pace of offshore wind deployment needed for the world to meet net zero.

At the same time, GWEC analysis shows that by the mid-2020s there may be supply chain bottlenecks in every region of the world except China. Immediate investment and global cooperation will be needed to address these bottlenecks.

Restrictive trade and investment policies – and calls to decouple from China's supply chain – may risk delaying the global energy transition.

The headwinds faced by the sector are symptomatic of policy and financing environments that are no longer fit for purpose as the world works towards a 1.5C pathway where wind generates one-fifth of the world's electricity by 2030 and two-thirds by 2050.

The UAE COP Presidency, IEA and IRENA are now leading countries to align behind the ambitious aim of tripling renewable energy capacity by 2030, to around 11 TW ahead of COP28. This target would send a serious message that countries are prepared to make sure their energy objectives are aligned with climate goals, providing the basis for policy action that could accelerate deployment of offshore wind power. The setting of this target, and the evidence of the headwinds faced by the sector, shows that the time has come to take a new, simpler approach to policy for offshore wind. Such an approach should prioritise the delivery of large volumes of offshore wind, supported by incentive-based industrial policies to deliver the socio-economic benefits the world now expects from the industry.

It is evident that scaling offshore wind will require shared problem-solving to find effective policy solutions across the sector, including crucially

how we scale the global supply chain. The key message here is that achieving the necessary growth in offshore wind energy production cannot rely on protectionist policies that isolate domestic markets. Our message is clear: We need partnership, not protectionism.

Collaborative efforts between industry and governments will be essential to addressing these challenges. The



## GWEC analysis shows that by the mid-2020s there may be supply chain bottlenecks in every region of the world except China

establishment of the Global Offshore Wind Alliance, a multi-stakeholder and diplomatically led initiative, signifies the industry's commitment to public-private partnership.

By working together, the industry and governments can create an environment that fosters innovation, investment and the development of a robust offshore wind supply chain. This approach is essential to meet the growing global demand for clean energy and make a significant positive impact on both the energy transition and environmental goals.



**Alvaro Martínez Palacio**  
Managing Director,  
Offshore Wind, Iberdrola

## Delivering on the big ambitions of global offshore wind

The world is changing rapidly: last year was one of the most challenging in the energy sector. While we were recovering from the impacts of the COVID-19 pandemic, different geopolitical movements, including a war in Europe that triggered an energy crisis, further increased the political willingness to accelerate renewables deployment as the right and only way forward. However, it is necessary to act now to create the conditions required for this transition to happen. For several decades the wind industry has demonstrated its ability, flexibility and resilience to create wealth and a sustainable future for society. We should continue working together to overcome the short-term challenges and to deliver on these big ambitions.

Thanks to the huge effort of all the actors, in the last 15 years offshore wind has proven it is able to deliver large amounts of green energy at a reasonable and affordable cost, becoming a key piece of decarbonisation plans worldwide. By the end of last year, the world had more than 60 GW of operational offshore wind capacity, with almost 9 GW installed in 2022 alone. This is the

second-best annual deployment figure in offshore wind history and represents more than 10% of the total wind capacity installed in 2022. We expect offshore wind installations to continue increasing significantly in the near future. Despite current difficulties, such as supply chain constraints, inflation and high interest

predictability in order to unlock the necessary investment.

Special attention should be paid to supply chain resilience and preparedness. Major investments in supply chain capabilities and equipment will be required to meet growth targets. This will bring massive positive returns in the economy but will only happen if suitable frameworks are in place to give the right long-term signals for these investments. If no action is

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**Offshore wind energy is a capital-intensive solution that requires regulatory stability and long-term predictability in order to unlock the necessary investment.**

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rates among others, we will probably see several projects being delivered between 2023 and 2025.

To ensure we can continue delivering sustainable growth for the industry post-2025, the sector and policymakers should invest all their efforts today in paving the way for the decisions we need to take in the short term. Offshore wind energy is a capital-intensive solution that requires regulatory stability and long-term

taken, the supply chain will face serious disruptions from 2026, as this report outlines. Equal consideration should be given to attracting and developing talent – already a key factor for delivering the overall objectives of the energy transition.

Being mindful of price and cost pressure on consumers and the supply chain, designing the right auction processes to award sites becomes paramount for achieving the sector's goals. We should question whether the



uncapped negative bidding schemes currently running in some countries will threaten offshore wind growth targets. These schemes impose significant additional costs on projects and heighten pressure on the supply chain, leading to higher electricity prices and increasing the risk of delaying project investment decisions.

Facilitating onshore and offshore grid development, designing seabed allocation mechanisms that focus on project delivery and streamlining permitting processes are key enablers for deploying our ambitious goals. Recent market volatility also calls for price risk reduction in auctions, for example, through indexation to inflation and commodities, to ensure faster and timely construction of projects. At the same time, discussions should shift from cost to value by designing frameworks that promote solutions involving generators and offtakers. This will boost the advantages that offshore wind can offer by contributing to sustainable transformation of the economy.

Over 20 years ago, Iberdrola anticipated that wind energy would be a key driver for future power systems. Since then, it has been committed to the wind sector and the energy transition. Fifteen years ago, the company entered the offshore

wind market. We can now say that these were the right decisions. Thanks to its vision, by the end of 2022 Iberdrola had 1.4 GW of offshore wind capacity in operation, more than 3 GW under construction, an additional 14 GW of sites secured and more than 20 GW under development.

More recently, Iberdrola decided to expand its onshore and offshore wind activities to the Asia Pacific region and is currently developing offshore projects in Japan, Taiwan and Australia, bringing together its experience in other markets and its existing local footprint. We believe this region can become a key growth area for the offshore wind sector, and the authorities are making great efforts to create suitable frameworks to promote the necessary investments.

There is no doubt that offshore wind energy will play a key role in the decarbonisation of all sectors of the economy with its mature, cost-competitive and reliable energy. Collaboration is crucial to achieving the increase in pace of installations described in this report. The industry needs to keep working together with the support of GWEC to engage with governments and communities globally in creating an enabling environment to foster growth for the offshore wind sector.



A wide-angle photograph taken from the deck of a ship, looking out over a vast blue ocean. In the distance, a line of offshore wind turbines stretches across the horizon. The sky is filled with soft, white clouds. The foreground shows the white, curved structure of the ship's deck, with metal railings and bolts visible. The overall scene is bright and clear, suggesting a sunny day.

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# EXECUTIVE SUMMARY



# The Data: 2022 was the offshore wind industry's second-best year

## Market status

Feeding 8.8 GW of new offshore wind into the grid – 58% lower than the bumper year of 2021 – still made 2022 the second highest year in history for offshore wind installations. The 8.8 GW of new installations brings the total global offshore wind power capacity to 64.3 GW, showing year-on-year (YoY) growth of 16% and representing 7% of global cumulative offshore wind installations.

China continued to lead global offshore wind development, although its new installations dropped to 5 GW from 21 GW in 2021 – which was a record year driven by the end of the feed-in tariff (FiT). Two other markets reported new offshore wind installations in Asia-Pacific last year: Chinese Taiwan (1,175 MW) and Japan (84 MW). No intertidal (nearshore) wind projects achieved commercial operation in Vietnam in 2022. This was due to the absence of a ceiling price until January 2023 to be used by Vietnam Electricity (EVN) to negotiate PPAs with investors for their renewable projects.

Europe connected the remaining 2.5 GW of capacity in 2022, with France and Italy each commissioning their first commercial offshore wind projects. Despite the rate of installations last year being the lowest since 2016, Europe's total offshore wind capacity reached 30 GW, 46% of which is from the UK.

## 2022 the second highest year in history for offshore wind installations.

With total installed offshore wind capacity reaching 34 GW in Asia-Pacific in 2022, Europe relinquished its title as the world's largest offshore wind market. Nevertheless, Europe continues to lead the way in floating wind. Norway commissioned 60 MW of floating wind capacity last year, bringing the region's total installations to 171 MW, equal to 91% of global installations, followed

by Asia-Pacific (16.7 MW, or 9% of global market share). Outside Europe and Asia-Pacific, North America has 42 MW of offshore wind in operation as of the end of last year, contributing 0.1% of total offshore wind installations.

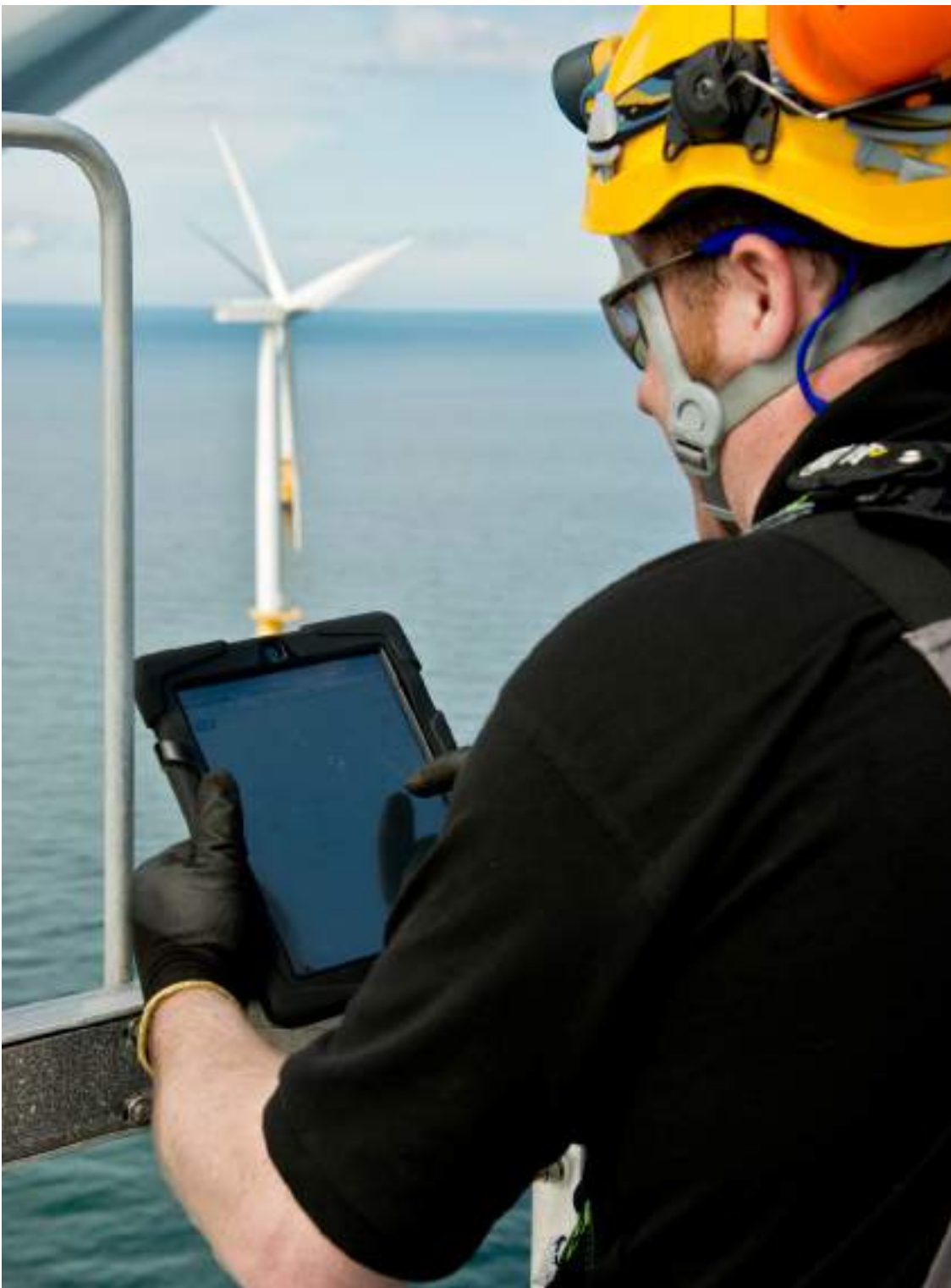
## Market outlook

The need to ensure secure and affordable energy supplies while meeting climate targets has propelled wind power development into a new phase of ever faster growth. Challenges such as inflation, increased capital cost and a supply chain crunch have created uncertainty and forced developers to review the viability of their projects – even, in some cases, to terminate their offtake contracts and stop developing projects expected to be built in the next five years. But the global offshore wind market outlook in the medium and long term, from 2028, still looks promising.

With a compound average annual growth rate (CAGR) of 31% to 2027 and 12% to 2032, new installations are expected to sail past the



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milestones of 30 GW in 2026 and 50 GW by 2030.

GWEC Market Intelligence expects that over 380 GW of new offshore wind capacity will be added over the next decade (2023-2032), bringing total offshore wind capacity to 447 GW by the end of 2032. However, only one-third of this projected new volume will be added in 2023-2027, in part because challenging market conditions have pushed back offshore wind development in Europe and the US in the near term. Annual offshore wind installation capacity is expected to quadruple in 2028 from 8.8 GW in 2022 and pass 60 GW in 2032, bringing its share of global new offshore wind installations from 11% in 2022 to 30% by 2032.

Although the global floating offshore wind pipeline doubled in the past 12 months, topping 240 GW, GWEC Market Intelligence still predicts that floating offshore wind will not reach commercialisation until 2030. Taking into account the higher cost of floating wind energy, current challenging economic and financial conditions and expected supply chain bottlenecks in floating wind foundations and port facilities, we have downgraded our global floating wind forecast to 10.9 GW by 2030,

42% lower than the previous year's projection.

GWEC Market Intelligence's near-term outlook (2023-2027) is primarily based on the existing global offshore project pipeline of projects under construction and in the different stages of development across the globe. Our medium-term outlook (2028-2032) reflects current declared national and regional targets. Given the energy system reform packages still underway in Europe and other regions in response to Russia's invasion of Ukraine as well as calls for radical action on climate change, it is highly likely that these targets will increase further. Our ten-year forecast could be revised upward next year as a result.

However, the last 12 months saw a growing implementation gap between declared targets and the rate of annual installations. To accommodate an exponential growth in offshore wind installations and a consequent acceleration of the global energy transition, decisive action on leasing, permitting, market design, supply chain, infrastructure – including grid and port facilities – as well as regional collaboration remain of crucial importance.

# The Story: Accelerating Offshore Wind

The outlook for the offshore wind sector, as it seeks to fulfil its major role in electrifying and decarbonising energy systems, can best be described as exhilarating and challenging in equal measure.

Global opportunities and challenges are manifold, but both are faced the pressure of time and scale in the fight against climate change. Under scenarios outlined by the world's leading energy institutions, including the International Agency Energy (IEA) and the International Renewable Energy Agency (IRENA), achieving carbon neutrality by 2050 – a commitment shared by a majority of countries and conglomerates – will call for rapid and tremendous growth in offshore wind installed capacity.

The IEA's latest roadmap requires offshore wind annual installations to grow ninefold, from 8.8 GW in 2022 to 80 GW by 2030, with 70 GW to be deployed every year between 2031 and 2050. IRENA foresees nearly 500 GW of cumulative offshore wind installed capacity by 2030 in its latest 1.5C-compliant scenario, and nearly 2,500 GW by 2050.

There is plenty of activity across markets worldwide. New offshore wind installations are expected to sail past the milestones of 30 GW in 2026 and 50 GW by 2030. The sector will reach a compound average annual growth rate (CAGR) of 31% until 2027 and 12% up to the early 2030s.

True acceleration for floating projects will not be seen before 2030. Although the global floating offshore wind pipeline doubled in the past 12 months, topping 240 GW, GWEC Market Intelligence predicts that – due to the higher cost of floating wind energy, current challenging economic and financial conditions, and supply chain bottlenecks in foundations and port facilities – only 10.9 GW is likely to be built globally by 2030, which is 42% less than the previous year's projection.

## Early success factors

A number of crucial elements have to fall into place if exponential offshore wind growth is to be achieved. This starts with the very beginning of the process, when seabed is leased to developers for offshore wind development. It is

essential that the amount of seabed available for development is aligned with global long-term climate (and offshore wind) targets.

A successful leasing model will facilitate collaboration between the public and private sectors from the get-go while crucially working in harmony with wider priorities such as clean power production, economic growth, social value creation, job generation and energy security.

Leasing frameworks should emphasise both the short-term and long-term impacts of leasing fees and allocation, so that revenues for governments are not generated at the expense of energy costs for consumers or unsustainable pressure on supply chains. A dedicated leasing authority that takes the lead on managing stakeholder conflicts and maritime spatial planning (MSP) concerns will streamline processes and promote efficient operations.

Before an offshore wind farm can be built, all the necessary permits need to be in place. These can take developers up to nine years to




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It is essential that the amount of seabed available for development is aligned with global long-term climate (and offshore wind) targets.

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obtain, as a global average, which can lock projects into outdated technology by the time construction begins. Fast-track procedures that limit maximum lead times for permitting and simplify the process are being introduced in the EU through the RePowerEU plan, in response to the energy crisis. The goal is for member states to commit to identifying 'renewable acceleration areas' where permitting processes are streamlined and shortened.

Another important step forward would be wider adoption of the so-called one-stop-shop (OSS) approach – already used in mature European markets like Denmark, the UK and the Netherlands – guaranteeing not only shorter lead times for the consenting process but also a reduction in uncertainties and delays.

### **Creating social and economic value**

Discussions on energy policy and the security of supply are often bogged down by arguments focusing exclusively on costs. While the cost profile of offshore wind is already favourable in comparison with fossil fuels, pursuing the 'cheap' angle is a dangerous approach.

Current market design and

procurement often encourage a 'race to the bottom' on wind pricing. This, coupled with inflationary pressures and auction price caps, has led to a squeeze on profitability for the wind industry that threatens the very ambitious installation goals it is being asked to deliver.

Offshore wind's true benefits are best evaluated with a holistic socioeconomic lens. To this end, governments and the industry have to work together to review market design and offtake mechanisms to ensure a balance between the need for affordable energy, delivery of wider socioeconomic benefits, and a sustainable supply chain.

When employing non-price criteria, including local content requirements, governments need to be aware of the bigger picture and avoid overly prescriptive requirements and restrictive trade practices that risk stifling investment. An incentive-based approach such as the long-term investment and tax credits under the USA's Inflation Reduction Act (IRA) will give the industry confidence to overcome challenges and scale up.

Another significant societal benefit that offshore wind brings is the creation of long-term highly skilled jobs. Already in 2022, the clean

energy labour force outnumbered employees in the fossil fuel sector, according to the IEA. Local, sustainable opportunities for a diverse workforce will grow exponentially as offshore wind deployment surges.

### **The grand challenge to connect wind farms**

Widespread electrification of homes and businesses is reliant not only on sufficient amounts of renewable energy but also on adequate grid connections. A common challenge for large offshore wind markets is how to scale up connections involving both the physical volume of offshore and onshore cables and the necessary infrastructure, while reducing wait times for connections.

Earlier this year, Dutch state-owned transmission system operator TenneT awarded 11 contracts for North Sea offshore wind project connections for a combined value of \$25 billion. Other similar projects are currently in the offtaking stage, but because the majority of larger projects are likely to be located further offshore, grid connections risk becoming a major bottleneck.

Energy islands, meshed grids, larger-capacity and superconductive cables are all being explored as



possible solutions. The bottom line remains that the fundamental building block of offshore wind is a reliable grid system.

### **A fit-for-purpose supply chain**

Equally critical is the issue of equipment availability. Supply chains are stretched in many parts of the world. Starting in 2027, we expect Europe's offshore wind turbine nacelle assembly capacity to struggle to cope with the growth expected in Europe alone. In the US and APAC excluding China, it is imperative that announced investments in nacelle assembly capacity quickly materialise as production capacity if demand towards the latter part of this decade is to be met.

A delicate balance between demand and supply exists for key turbine components in 2023–2025, with gaps expected to emerge in the second half of this decade if no further investments are made. With China controlling more than 70% of the global market share for gearboxes, generators, slewing bearings, castings, forgings, towers and flanges, restrictive trade policies proposed by the EU and the US are almost certain to create bottlenecks.

The demand for large offshore wind turbine installation vessels (WTIVs) towards the end of the decade, coupled with a trained workforce with adequate operational knowhow, requires regional cooperation in the

APAC region to ensure timely deployment. This cooperation is especially crucial in new markets such as India, the Philippines, Australia and New Zealand.

In the US, where Jones Act-compliant WTIVs will be needed, only one is under construction. Plans for new vessels will have to be executed in the next two years to deliver on the Biden Administration's ambition of 30 GW of offshore wind by 2030.

### **Meeting great expectations**

Offshore wind is a fast-growing sector with a great future ahead and some big challenges to overcome. Floating offshore wind, in particular, is still very much in its infancy and

faces a steep learning curve as it looks to scale up from a handful of demonstration projects to gigawatt-scale developments.

There is no limit to the contribution that offshore wind can make to the energy transition, nor is there any shortage of ambition on the part of the industry. The threat lies in the growing gap between stated targets and annual installations – and the even wider gap between the current pace of growth and 1.5C-compatible volumes of deployment. All of the elements outlined in this year's Global Offshore Wind Report must come together to enable the sector to deliver on these great expectations.



GOWA will address the major building blocks for the sector, such as framework conditions, financial de-risking, system integration and economic benefits

# The Global Wind Energy Alliance (GOWA)

The government of Denmark, IRENA and GWEC founded the Global Offshore Wind Alliance (GOWA) in September 2022 to drive the uptake of offshore wind through political mobilisation and the creation of a global community of practice. GOWA aims to contribute to achieving a global offshore wind capacity of at least 380 GW by 2030 and 2,000 GW by 2050, with 35 GW being deployed on average each year through the 2020s and a minimum of 70 GW annually from 2030.

GOWA envisions offshore wind making a significant contribution to the energy transition and the achievement of the sustainable development goals through large-scale renewable power generation benefiting regions, nations and critical sectors such as industry and transport.

To benefit from the substantial potential and opportunities deriving from offshore wind, it is pivotal that governments, private-sector actors, international organisations and other relevant stakeholders work together to remove the barriers to scaling up investment and supply chains.

GOWA is a multi-stakeholder, diplomatic and workstream-based initiative that has public-private partnership as its guiding principle.

**GOWA will work to:**

- Raise ambition – crucially ambition for implementation – for offshore wind amongst governments and other public and private stakeholders.
- Support the creation of policy frameworks and efficient offshore wind value chains to bring new and

existing markets to maturity through, for example, the sharing of best practices and capacity building.

- Create an international community of practice to drive action on offshore wind deployment as a key to achieving 1.5C pathways.
- Work together as a multi-stakeholder group that supports the role offshore wind will play in a renewables-led energy transition.

To support countries as they seek to develop offshore wind, GOWA will address the major building blocks for the sector, such as framework conditions, financial de-risking, system integration and economic benefits. These are all important drivers to reduce costs, ensure competitive market prices and create project pipelines at country and regional level.

**At the time of writing, GOWA has 14 country members:**

- |   |   |  |  |   |
|---|---|--|--|---|
|  Australia |  Denmark |  Japan           |  Portugal |  State of Victoria |
|  Belgium   |  Germany |  The Netherlands |  Spain    |  UK                |
|  Colombia  |  Ireland |  Norway          |  St Lucia |  USA               |

A composite image featuring a close-up of a metallic ship hull with rivets on the left and a single offshore wind turbine in the distance on the right, set against a cloudy sky and the ocean.

# PART 1: OFFSHORE WIND ENABLERS

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# Leasing

Offshore wind flourishes in an environment with long-term system planning, where policies and regulations are aligned to deliver clear objectives. A lack of suitable project sites has been cited as a major obstacle to the rapid scale-up of offshore wind. This underlines the importance of leasing, the process that determines how much seabed will be allocated to offshore wind development.

The term ‘leasing’ encompasses the contractual process of granting seabed rights for offshore wind development and operation. Leasing processes are overseen by the designated seabed authority. While approaches vary depending on the market, they are procedurally based on a framework that is adapted to national preferences. Leasing terminology varies between markets; ‘leasing’ is

also often referred to as a ‘concession’.

A well-executed leasing framework must ensure a steady pipeline of projects and aim to attract the participation of experienced actors (suppliers, investors, developers) to the market. These actors will bring valuable expertise, resources and extensive market knowledge to develop successful projects and be key facilitators in the global expansion of the offshore wind sector.

GWEC finds that, when establishing a successful leasing framework, the incorporation of pragmatic Marine Spatial Planning (MSP) processes can significantly enhance an efficient rollout of offshore wind deployment. Not only do MSP frameworks play a crucial role in managing marine spaces and resources; they can also address upstream environmental and social considerations ensuring a holistic

approach to offshore activities, generating a sustainable blue economy.<sup>1</sup> The early engagement of stakeholders in the MSP process can mitigate potential future conflict and strike a balance between various sectoral priorities.<sup>2</sup>

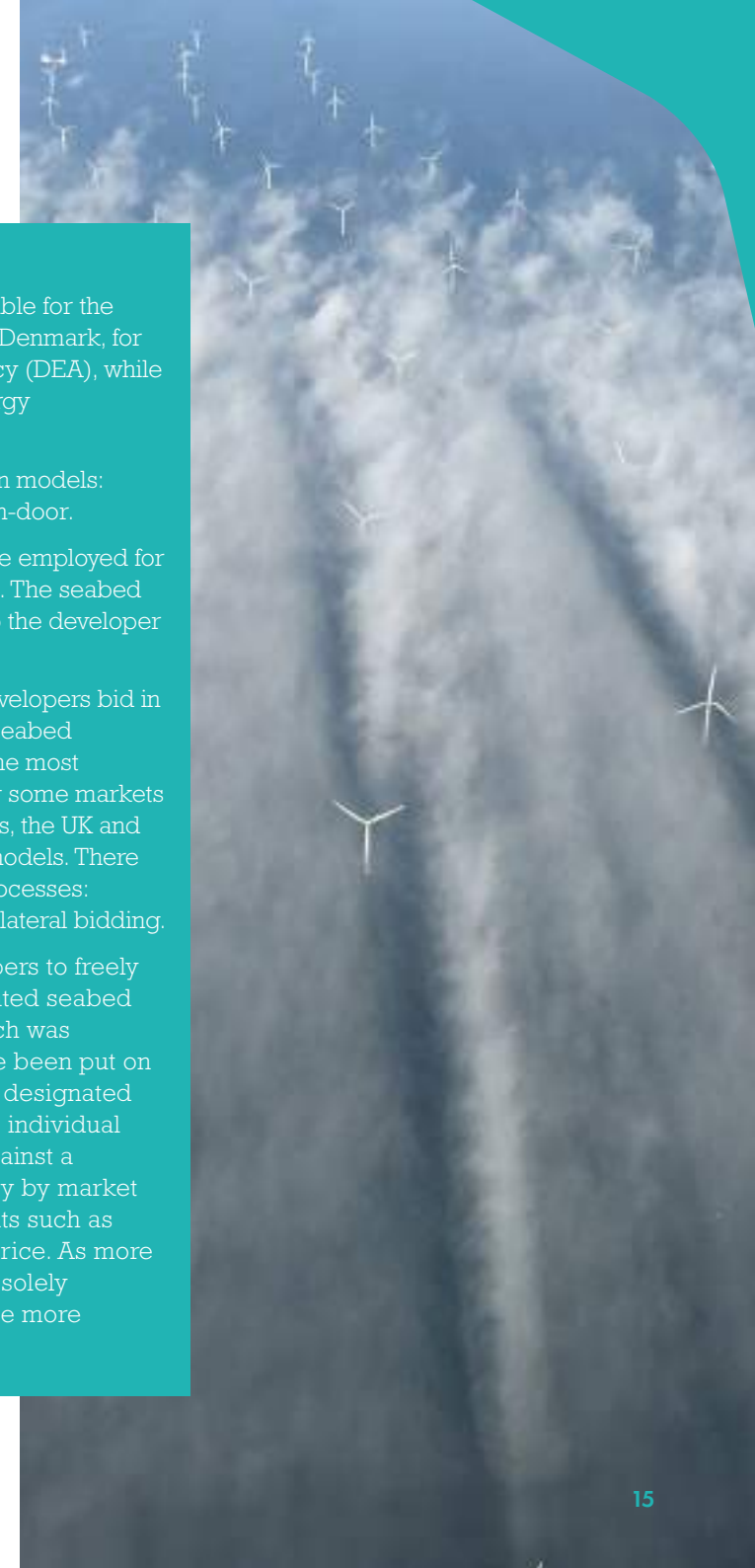
MSP can serve as a valuable tool for effective implementation of national climate targets, ensuring that the target setting process explicitly considers the requirements for scaling up ocean energy. By aligning MSP with climate objectives, countries can strategically plan and allocate seabed areas to support the growth of offshore wind whilst also remaining compatible with climate commitments.<sup>3</sup>

1. World Bank. 2022. <https://documents1.worldbank.org/curated/en/099813206062230702/pdf/IDU0afe34d600494f04ee009e8c0edf0292c1a96.pdf>  
2. IOC-UNESCO/European Commission, 2022. <https://www.mspglobal2030.org/wp-content/uploads/2022/11/MSProadmap2022-2027.pdf>  
3. IRENA and OEE. 2023. <https://www.irena.org/Publications/2023/Mar/Scaling-up-investments-in-ocean-energy-technologies>

## Leasing framework milestones







### Leasing framework milestones:

1. Raise the political priority of climate action by legislating national climate targets that account for offshore wind sector growth, e.g., developing a national offshore wind strategy
2. Conduct pragmatic and proportional MSP to designate suitable areas for development with high wind resource and management of potential stakeholder conflict
3. Establish leasing authority
4. Determine preferred approach to leasing and revenue support
5. Put into place relevant legislation
6. Implement first leasing competition

### Differences in approach

Offshore wind markets have evolved to conform to two primary frameworks: a centralised, one-stage approach, and a decentralised, two-stage approach. These frameworks are not rigidly followed, and the USA and Taiwan have adopted a hybrid framework.

In the centralised framework, one process is used to secure the seabed lease and the power purchase arrangements. The government will conduct surveys to determine site feasibility, complete an Environmental and Social

Impact Assessment (ESIA) and gain consent for project development. The government has the authority to specify wind farm sites and certain design elements. This approach has been adopted in Germany, Denmark and the Netherlands.

In the decentralised framework, the government will use MSP to identify large areas within which to conduct the leasing rounds. The developer will then decide project siting, conduct site surveying and the ESIA, and gain project consent – all of which incur extra cost. This approach has been used in the UK.

Each model offers some advantages, depending on the desired goals of the leasing round. Under a centralised model, the government has more control over project planning but could expose developers to a higher degree of policy risk or interference. There is also a risk that governments may not be adequately resourced to undertake the complex technical functions required to implement the centralised model successfully. Experienced developers may be better positioned to make informed decisions regarding project

4. <https://ens.dk/en/our-responsibilities/wind-power/offshore-procedures-permits>

### How leases are allocated

A designated body should be responsible for the tender and award of seabed leases. In Denmark, for example, it is the Danish Energy Agency (DEA), while in the US it is the Bureau of Ocean Energy Management (BOEM).

Leases are awarded through three main models: non-competitive, competitive, and open-door.

Non-competitive leasing models can be employed for pilot projects and in emerging markets. The seabed authority can directly grant the lease to the developer through negotiation.

Competitive leasing models, where developers bid in a competitive tender overseen by the seabed authority and the lease is awarded to the most suitable bidder, have been adopted by some markets as they mature. The US, the Netherlands, the UK and Germany all use competitive leasing models. There are two further competitive bidding processes: competitive auction and competitive bilateral bidding.

The open-door model allows developers to freely submit lease applications for designated seabed areas at their discretion. This approach was pioneered by Denmark<sup>4</sup> but has since been put on hold pending a review of EU law. The designated body is responsible for assessing the individual bids/applications from developers against a predetermined set of criteria that vary by market but typically include financial elements such as highest seabed bid or lowest strike price. As more developers have entered the market, solely financial criteria are shifting to include more qualitative metrics.



development and the associated risk. A decentralised approach may be more appealing as developers are given the freedom to make more project decisions. When deciding on an approach, there is a constant balance to be struck between where the risk is placed and who is best placed to carry this risk.

#### **Policy recommendations**

GWEC sees the urgent need for an alignment of the amount of seabed leased with long-term climate targets. For a Paris-compliant net

transparent and visible leasing framework, ensuring that the needs of the private sector and the abilities of the public sector are taken into account. A leasing framework that is attractive to developers will engage the participation of experienced actors (suppliers, investors, developers) that bring valuable expertise, resources and extensive market knowledge to develop successful projects and be key facilitators in the global expansion of the offshore wind sector.

consumers and cause financial pressures for supply chain stability.

Leasing terms should take into account coherent government priorities. Development of the offshore wind sector can encourage economic growth, create jobs and enhance energy security. Having an open dialogue between stakeholders can ensure that leasing frameworks function in harmony with these wider priorities.

As part of a successful leasing process, GWEC recommends the integration of pragmatic and proportional MSP to aid the achievement of an efficient rollout of offshore wind deployment by mitigating environmental and social concerns through better interaction with stakeholders; implementing national climate targets; and designating sites with the best wind resources.

The establishment of a dedicated leasing authority to proactively address any stakeholder management issues in the marine space is essential. Creating a specialised body that grants consent and manages conflict ensures an efficient operation and can streamline the process.

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## **GWEC recommends the integration of pragmatic and proportional MSP to aid the achievement of an efficient rollout of offshore wind**

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zero by 2050 scenario, IRENA estimates that fixed and floating offshore wind must scale up from its current 64.3 GW capacity to 380 GW by 2030 – en route to 2 TW in 2050.

Leasing must involve a collaborative effort between the public and private sectors. Early dialogue should aim to create a

Choosing a leasing model requires careful deliberation on the short-term and long-term consequences associated with leasing fees and allocation. Leasing frameworks should emphasise comprehensive lease term evaluations. An uncapped competitive auction, for example, may increase short-term revenues for the government but can increase the cost of energy to



## Permitting

Globally, offshore wind projects typically take up to nine years to move from the early development stage to full commissioning. The bulk of this time is spent in the permitting and consenting stage, with timelines extending even further when there are barriers or delays in the permitting process. Generally, once permitted, large-scale offshore wind projects can be constructed very quickly – typically in two years, depending on the project size.<sup>6</sup>

Elongated permitting timeframes

can result in projects reaching the construction stage with outdated technology in their plans, including wind turbine models that are no longer manufactured at optimal scale. If a developer applies to modify the original project design in order to use newer technology, it runs the risk of further delays.

Done right, effective permitting regimes can unlock significant amounts of offshore wind capacity, enabling it to contribute to economic growth, as well as to the provision of large-scale, homegrown clean electricity. Holistic approaches to permitting can also help capture

benefits and opportunities related to biodiversity and nature conservation, ensuring the wind industry continues to lead in delivering positive socioeconomic outcomes for all communities.

One way to reduce maximum lead times to permit offshore wind is through fast-track procedures. The European Commission has introduced the RePowerEU plan in response to the energy crisis, which calls for renewable energy projects permitting to be “drastically accelerated”. To that end, member states will design dedicated “renewable acceleration areas” with

shortened and simplified permitting processes. Land, sea or inland waters areas would be chosen because they are particularly suitable for specific renewable energy technologies and present lower risks for the environment. Protected areas should be avoided, for example. For renewable acceleration areas, the EU Council and European Parliament came to a provisional agreement on 30 March 2023 allowing three years for

<sup>6</sup> Joint Statement by the Global Wind Energy Council and the Global Solar Council on the Occasion of the G20 Investment Forum on Energy Transition (2022) <https://gwec.net/wp-content/uploads/2022/08/Joint-Statement-by-GWEC-and-GSC-Final-Aug-2022.pdf>

## Part 1: Offshore Wind Enablers

offshore projects and two years for onshore projects, including environmental impact assessments. In designated “renewable acceleration areas”, the deadlines are reduced by one year and, in principle, no environmental impact assessment is required. In duly justified extraordinary circumstances, the period may be extended by up to six months.

To reduce lead times for offshore permitting, countries are exploring more innovative and newer supporting schemes. The UK has been exerting efforts to shorten the permitting time. Announced in June 2023, the Offshore Wind Environmental Improvement Package (OWEIP) aims to support the accelerated deployment of offshore wind by reducing consenting time from up to four years to one year. The concept of a One-Stop-Shop (OSS) – a single contact point for a smooth and administratively lean process from consenting through to decommissioning – has long been used in mature European markets like Denmark, the UK and the Netherlands. The OSS for project permitting not only speeds up the consenting process, but also reduces uncertainties and delays.

7. <https://ens.dk/en/our-responsibilities/wind-power/offshore-procedures-permits>



### Case study: Denmark’s open-door policy

Long-term planning, alongside a stable and supportive policy framework, has been fundamental to the success of Danish offshore wind development. The Danish Energy Agency (DEA) runs offshore wind tenders through an open-door-procedure.<sup>7</sup> The project developer takes the initiative to establish an offshore wind farm. The first step is for the project developer to submit an application for a license to carry out preliminary investigations in the given area. The application must, as a minimum, include a description of the project, the anticipated scope of the preliminary investigations, the size and number of turbines, and the limits of the project’s geographical siting. In an open-door project, the developer is responsible for covering the costs of connecting the grid to land. As part of the OSS concept, the DEA initiates a hearing of other government bodies to clarify whether there are other major public interests that could block the project before processing an application. Based on the result of the hearing, the DEA decides whether the area in the application can be developed, and in the event

of a positive decision, it issues an approval for the applicant to carry out preliminary investigations, including an ESIA.

Electricity produced by offshore wind farms under the open-door-procedure will receive a price premium of 25 øre/kWh (\$0.36/kWh) on top of the market price – the same as onshore wind. If the market price added to the subsidy exceeds 58 øre/kWh the subsidy will be reduced accordingly.

While the open-door policy has created great opportunities for developers in acquiring offshore wind projects, the Danish government decided in June 2023 to suspend projects under this scheme, fearing it may breach EU rules. The country’s new marine plan will not allocate space for future offshore wind farms under the open-door scheme, effectively shelving the majority of projects. A total of 33 projects were under assessment as part of the scheme. Nine of the pending open-door projects had previously been assessed as approved, however the remaining 24 will be denied a preliminary investigation permit.



### Case study: Spain's use of MSP

In December 2021, Spain published a 'Roadmap for the development of offshore wind and marine energy in Spain', which lays the foundations for a state-level framework for the orderly deployment of offshore renewables that highlights three key elements: spatial planning, grid connection and business model. The roadmap promotes the use of marine spatial planning (MSP) to catalyse permitting activities. It also supports coordinating the access and connection framework and new grid management models and adapting the administrative framework for the permitting of offshore renewable installations.

In June 2022, the Ministry for Ecological Transition and the Demographic Challenge (MITECO) launched a public consultation on the design of the regulatory framework for offshore

wind and marine energy facilities. The aim of the consultation was to engage, from day one, public and private agents, the wind and offshore energy sector and the other sectors that use the sea for their activities, including fishing, aquaculture and navigation.

Spain's Maritime Spatial Planning, approved in March 2023 through Royal Decree 150/2023, identifies the most suitable marine areas for the future development of offshore wind farms at the same time as integrating general interest planning objectives, horizontal multi-sectoral objectives and seeking sectoral convergences and synergies.

This complex MSP exercise was achieved through a highly participatory process. All the

ministerial departments with sectoral responsibilities in the marine environment, the coastal Autonomous Regions, representatives of all involved sectors and civil society contributed.

The process resulted in the use of MSP (POEM by its Spanish acronym) as a zoning instrument, identifying the most suitable areas for the development of offshore wind energy based on technical and environmental feasibility. Additionally, future electrical evacuation electricity exports from the offshore wind farms through coastal evacuation nodes in the vicinity of the relevant areas have been considered in the Electricity Transmission Network (ETN) plans for 2021-2026 and will be covered in more detail in the next ETN planning cycle.



### Case study: A single contact point in Costa Rica

Costa Rica does not have a dedicated 'one-stop shop' for processing offshore wind projects but has developed a similar platform for energy projects of national interest, known as the Ventanilla Única de Inversión (VUI), or single investment window. Businesses can use the digital VUI to submit their application, request a construction permit and submit environmental assessments, among others. The platform has drastically reduced the processing time for permits from 406 to approximately 35–45 days. Costa Rica has committed to leveraging this platform for offshore wind projects and will be engaging with relevant stakeholders and investors in the near future.

In Denmark, the Act on Promotion of Renewable Energy defines the rules, requirements and procedures for issuing licences for offshore wind development. According to the Act, the Danish Energy Agency (DEA) has the mandate to both plan and issue permits for offshore wind projects within territorial waters and Denmark's Exclusive Economic Zone (EEZ). The permit compiles information from all relevant authorities, with the DEA 'championing the project through the permitting process. DEA prepares and grants the required licences through an iterative process involving contributions from other authorities in order to mitigate conflicting interests. Once the concession is granted, the DEA remains a single point of contact for developers requiring assistance on issues related to the granted licenses and procedures.

Learning from European best practices, other countries are now starting to adopt this approach. In 2022, Brazil introduced an OSS system through an information portal that manages offshore areas used for power generation. Similarly,

8. <https://www.evoss.ph/Home/About#:~:text=The%20Energy%20Virtual%20One%20Stop,involved%20in%20the%20approval%20process.>



### Case study: Innovative permitting scheme in the Netherlands

In the Netherlands, the upcoming permit that will be granted for the 4 GW offshore wind project IJmuiden Ver will include criteria to stimulate circularity and international responsible business conduct. The Netherlands is drafting a legislative amendment to include these criteria in future permits for offshore wind farms.

The criteria for responsible business conduct will align with UN principles for human rights and business and OECD guidelines for multinational enterprises suggesting that companies perform human rights and environmental due diligence for their international activities, including in their supply chain. Companies are urged to take action in multi-stakeholder

cooperation to prevent or mitigate risks, implement a complaint mechanism and report publicly on their due diligence processes.

For circularity, the criteria will be in line with the EU's Sustainable Product Initiative, enabling governments to introduce product requirements concerning recyclability, reusability, lifetime extension, phasing out of hazardous substances and the level of secondary and renewable resources used when manufacturing new products. The European Commission is working on introducing legislation and regulations for responsible business conduct and circularity. The Netherlands is anticipating this legislation by already including these criteria in its offshore wind permits.

the Philippines issued an executive order in 2021 to implement the Energy Virtual One-Stop Shop (EVOSS)<sup>8</sup>, an online platform to coordinate data and information for energy project applications. In Vietnam, an OSS model has been proposed, grounded in the National Steering Committee on Marine Economic Development established in 2020, chaired by the prime minister. South Korea's National Assembly has been discussing since May 2021 a proposed OSS Bill to make progress on the current system, which requires offshore wind developers to spend up to ten years or longer consulting 29 pieces of law across ten ministries. However, this Bill remained in draft form due to the fishing community's concerns and opposition. Two new OSS bills were proposed in February 2023 by the ruling People's Power Party (PPP) and the Democratic Party (DP). They outline the government's intent to move to a centralised system but are lacking sufficient information and clarity regarding site selection and allocation of offshore wind projects. GWEC hopes that the South Korean government will soon come up with suitable schemes to ensure the co-existence of offshore wind farms and fishery and enhance the clarity of the two Bills.



# Regulation & Market Design

## **Growing Pains: The status of the wind industry in 2023**

Major western OEMs in the wind sector have faced a profitability crunch over the last few years, causing them to retrench and selectively withdraw from smaller or slower-moving markets. Amid these challenges, they are raising their prices. This is due, in large part, to

development efforts and withdrawing from certain countries or projects, or even opting out of markets and auctions where they perceive an imbalance in risk versus reward – as in recent announcements regarding Ørsted's withdrawal from Vietnam, Vattenfall Boreas projects in the UK, and the US Avangrid development.

As they seek to combat climate change, countries, regions, companies and financial institutions around the world are setting aggressive net zero and energy transition targets. If business profitability and stability are not present in the wind sector, however, these targets will become increasingly unlikely to be met.

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**GWEC believes that the industry is experiencing the growing pains of a large, high capital cost infrastructure that experienced over a decade of heated market growth rather than a real crisis.**

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recent spikes in commodity prices, general inflation across the entire supply chain, high logistics costs and higher interest rates implemented by central banks to combat higher inflation, together with the realisation that participating in slow-developing markets can tie up crucial human and financial capital with insufficient returns.

On the project development side, developers are 'high grading'

There is a massive pool of global and local capital, increasingly driven by climate finance and ESG initiatives, ready to deploy into the offshore wind sector but at the same time there is a lack of properly structured, fully permitted and de-risked projects with viable offtakers. There are many reasons for this lack of bankable projects, but permitting bottlenecks and inadequate grid infrastructure are at the top of the list.

GWEC believes that the industry is experiencing the growing pains of a large, high capital cost infrastructure that experienced over a decade of heated market growth rather than a real crisis. It is worth considering a few factors that have led us to this stage, and what other industries have done in the past to manage similar challenges.

## **The industry is still comparatively young**

All other major, high capital cost infrastructure sectors – energy, petrochemicals, mining, ports and others – are relatively mature at 100+ years old and therefore benefit from a fairly clear understanding of the needs of the industry by politicians, policymakers and regulators, as well as by the industry players themselves.



Those sectors have also lived through significant volatility in the past. For example, West Texas crude oil prices have ranged between \$17 and \$120 per barrel over the last eight years. How do these industries manage within such volatile pricing structures – similar to what the wind industry is now facing in terms of supply chain inputs and critical materials? They do several things:

- They expect volatility and build those expectations into everything they do across their value chain through hedging, risk sharing in offtake contracts, supply chain resilience and diversification, sophisticated commodities market monitoring and hedging, and so forth.
- Contracts with buyers are often negotiated such that higher prices can be paid to ensure less volatility, and/or with price caps and price floors to protect buyers and sellers, respectively. The terms of these contracts swing substantially depending on market conditions ('buyers market' vs 'sellers market'), but there are almost always elements of risk-sharing between buyers and sellers.

While the recent price volatility may not have been any different from previous periods of volatility, it is the



first time that the modern wind industry has been subjected to such volatile conditions.

The post-COVID demand surge that caused global logistics and supply chain disruptions was remarkable, and the subsequent invasion of Ukraine by Russia caused massive disruptions in the global gas market, as well as grain and other markets. Further global logistics bottlenecks made this a “perfect storm” that few, if any, could have predicted. The impacts were devastating globally, especially in emerging markets which are less able to absorb higher costs for everything from grain to gas.

The impact on a young wind industry of such massive disruptions was unpredictable. But the response from the industry was very predictable: pull out of markets and/or projects that are not profitable, rationalise supply chains, increase prices.

This is an understandable contraction after a decade of breakneck market growth. As noted in a recent Financial Times article, “developers’ willingness to get out of unprofitable projects is a sign of discipline as the industry matures — but may slow down the pace of the rollout.” However, the world now needs massive investments in wind to meet net zero commitments and slow climate change.

How can the industry work with others to secure an offshore wind project pipeline that can support net zero and other climate targets? And what can we do to move the industry forward onto a more sustainable path where the industry is supported in accelerating the energy transition, compensated at a reasonable level, and contributing to the public good in numerous ways?

**Where the industry is today:** The industry is comparatively young. As it emerges from global crises, such as the COVID-19 pandemic and the Ukraine invasion, it has been significantly impacted by low profitability and challenging markets. As such, it is disciplining itself and



withdrawing from markets and projects that are not attractive or profitable enough. The industry is also examining how it approaches the issue of ever bigger turbines with the need for economies of scale, and other ways to build in more efficiencies in the value chain.

**Where it needs to go:** Massive amounts of investment are required to meet various net zero and other climate targets. Based on the current projected trajectory of wind installations, it is unlikely that many targets will be met.

**What can be done:** There are some conditions that are needed for any large, high capital cost industry to thrive. Key to this is the role of government: Where can it be supportive and productive? When is it best to leave decisions and investments to the private sector?

**Predictability and visibility:** This is critical for any industry, as businesses will invest in supply chains and develop projects when they know there is going to be a relatively constant flow of projects.

**Reasonable returns:** In any industry, businesses want to make reasonable returns for their shareholders. They

will also expect higher returns when risks are higher, hence a balanced approach to risk-sharing is essential to ensure affordability. There is always a tension between investors, who want reasonable returns, and governments, who desire low prices – through approaches like reverse auctions – and energy security (it is uncertain whether auctions deliver this). Compromises will need to be made.

**Clear route to market for projects:**

Is it possible to get the necessary business licences and project permits in a reasonable amount of time? Is it clear which permits are required and who can provide them? Are monetisation options through auctions, corporate PPAs or other means clear? Is grid planning advanced enough to provide clarity on when the grid will be ready to connect a project? Consideration of these questions can help create a clear route to market.

**Essential infrastructure and workforce:** Offshore wind needs grids, ports, transport corridors and supply chain facilities, as well as a skilled and trained workforce to build, operate and maintain wind farms. If these are not available, are there implementation plans with

reasonable support and planning from government? Do the plans include options for private investors to provide the capital?

**Bankable offtake mechanisms:** Are the offtakers – be they utilities, corporates or others – able to provide viable offtake mechanisms/contracts/PPAs such that the projects can access international finance without undue risk of default, counterparty risk, curtailment and other risks?

**Tax and other incentives:**

If governments want to encourage wind and other renewables and storage technologies to meet net zero and other commitments, they may need to provide concrete incentives to attract investments. Think of the USA's Inflation Reduction Act and other incentive mechanisms. The role of REPowerEU can also be considered. What happens if every country unrolls an IRA-size industrial policy package? Will it potentially introduce a disincentive for public and private actors to coordinate rather than compete for resources and supply chain investments?

This is an ongoing debate, and while GWEC does not have all the answers today, our approach is to encourage



## Part 1: Offshore Wind Enablers

By embedding market and regulatory imbalances that favour projects with the lowest bids, governments across the world have encouraged a 'race to the bottom' on wind pricing. This, combined with inflationary pressures, has exacerbated the squeeze on profitability for the wind industry.

Limited profitability has in turn led to underinvestment in manufacturing capacity globally, creating the likelihood of supply chain bottlenecks post-2026.<sup>10</sup> To meet the increasing offshore wind ambitions globally, massive investments are needed to build up the offshore wind supply chain and deploy offshore wind projects at the pace and scale needed to achieve the 380 GW of cumulative capacity by 2030 projected under IRENA's 1.5C scenario.<sup>11</sup>

To restore and build a healthy offshore wind industry, governments and industry must ensure a balance between the need for affordable energy, delivery of wider socioeconomic benefits and a sustainable supply chain. Several countries are trying to capture greater socioeconomic value by

collaboration. Given the 'public good' nature of wind energy and its crucial contributions to a just energy transition, GWEC encourages governments to work together and focus more on incentive-based approaches to fostering market growth rather than prescriptive policies, strict local content requirements and other policies that may inhibit collaboration.

Collaboration across the board – between industry and government, OEMs and developers, governments across and within regions, within supply chains – will increase common understanding, build trust, encourage technology transfer and the efficient flow of resources. It will also harmonise approaches to market development, risk-sharing in

the value chain and investment protocol. All of these outcomes will help to advance the growth of offshore wind at the pace and scale required to meet net zero commitments and deliver the global energy transition.

### **Moving from cost to value**

Offshore wind is a scalable, affordable and commercially available energy technology. With tremendous capacity to produce power, offshore wind has significant potential to rapidly displace fossil fuels, delivering economic growth and bolstering energy security.

After a decade of cost reductions, offshore wind is at an inflection point with a highly competitive levelised cost of electricity (LCOE) that is \$3/

MWh below that of coal and \$18/MWh below that of gas.<sup>9</sup> This means that the rate of price reductions that we have seen is likely to slow. Despite this, the cost profile of electricity generated from wind energy versus electricity generation from fossil fuels remains favourable – it has been for some time and will continue to be.

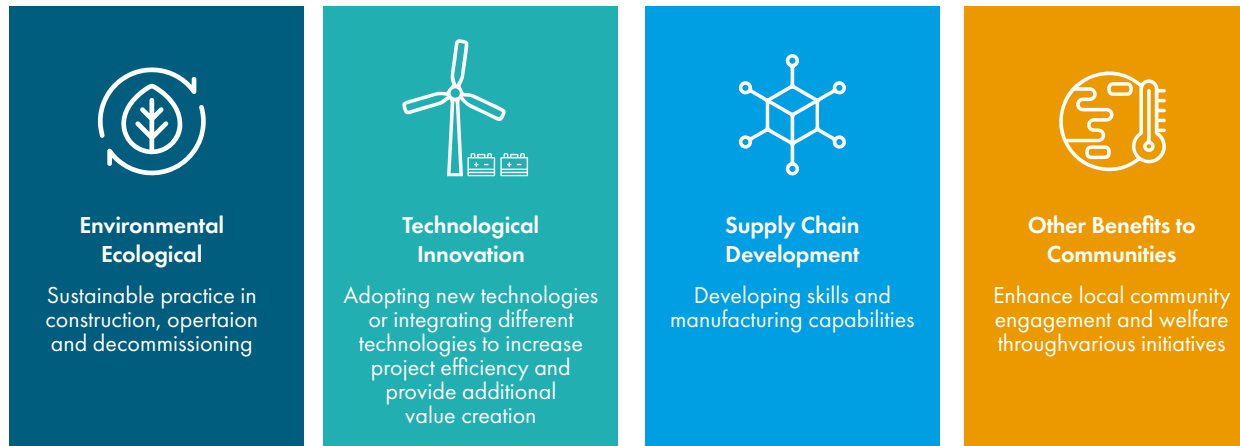
Because the offshore wind supply chain is subjected to the fluctuation of commodity prices globally, fluctuations in the cost of wind have to reflect the underlying cost of capital, commodity costs for steel, copper and other materials, and logistics costs. The past two years have shown the world how volatile the commodity markets are during a global crisis.

9. 2H 2022 Levelized Cost of Electricity Update (BNEF) <https://about.bnef.com/blog/2h-2022-levelized-cost-of-electricity-update/>

10. Global Wind Report 2023 (GWEC, 2023)

11. Scaled-up Investments and Enabling Frameworks Will Unlock Offshore Renewables Potential (IRENA, 2023)

Four main categories of non-price criteria



Governments are under pressure and grappling to introduce and implement NPCs that are effective and balance the needs of local and international stakeholders.

including non-price criteria (NPC) in project selection.<sup>12</sup>

NPC can be broadly categorised into four groups<sup>13</sup>:

1. **Environmental/Ecological**  
- sustainable practice in construction, operation and decommissioning
2. **Technological/Innovation**  
- adopting new technologies or integrating different technologies to

increase project efficiency and provide additional value creation

3. **Supply Chain Development**  
- developing skills and manufacturing capabilities
4. **Other Benefits to Communities**  
- such as, enhancing local community engagement and welfare through various initiatives

The inclusion of NPC presents both opportunities and challenges for

wind industry stakeholders. It has to be carefully considered and integrated considering the stage of development of different offshore wind markets. It also sits alongside incentive mechanisms that can enable different stakeholders to introduce and implement NPC.

Governments are under pressure and grappling to introduce and implement NPCs that are effective and balance the needs of local and international stakeholders. Developers are faced with a double-edged sword when navigating the increasingly complex bidding processes incorporating NPCs that have proliferated in many jurisdictions. Supply chain actors enjoy advantages in their home markets but are faced with steep

competition in emerging markets with unrealistic Local Content Requirements (LCRs) – a form of NPCs often favoured by governments as a measure that they claim can help develop domestic manufacturing capacity, create local jobs and encourage technological innovation.

Australia, Germany, Ghana, Japan, Oman, the UK and Taiwan only implemented onshore and offshore LCRs in 2015.<sup>14</sup> In Japan, LCRs accounted for 40 out of 120 project feasibility evaluation points in the first offshore tender round in 2020. They included having a track record of engagement with key stakeholders and impact on local and national employment and manufacturing. In Taiwan, the LCRs are even more stringent: developers participating in the round 3 auction must locally procure 26 ‘key development items’ for at least 60% of the project’s proposed capacity.

When implementing LCRs, governments have choices. They can use incentives or preferential treatment for domestic suppliers, or they can reserve procurement of

12. <https://www.weforum.org/projects/system-value>  
 13. Leasing Report 1Q 2023 (Westwood Global Energy Group, 2023)  
 14. Overcoming Barriers to International Investment in Clean Energy (OECD) <https://doi.org/10.1787/9789264227064-en>

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## Most importantly, early markets looking to introduce LCRs need a clear implementation pathway and an adequate support mechanism from government.

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certain goods or services for them. GWEC advises against prescriptive localisation requirements or restrictive trade practices. This often leads to price increases and disruption. Instead, we ask for flexibility that can build on national and regional competitive advantages, giving OEMs and the supply chain more flexibility in optimising their production.

An incentive-based approach will give the industry the confidence to overcome challenges and scale up. For example, the introduction of the IRA in the US, which aims to drive domestic manufacturing capability, regional transmission plans and investment, is heralding a new era in the international race for offshore wind. The beneficial changes to the tax credit available, when implemented successfully, will create a robust domestic supply chain to enable project development in the long term.

Most importantly, early markets looking to introduce LCRs need a clear implementation pathway and

an adequate support mechanism from government. If introduced, NPCs should be harmonised on a regional level, transparent, measurable and verifiable without inflating costs or artificially foreclosing competition.

### LCRs should be:

- Clear and objective to identify the right project without being discriminatory against any group of stakeholders.
- Transparent and measurable to avoid introducing additional administrative processes and complex bidding activities.
- Reasonable and practical to build on current industry capabilities without further inflating costs or delaying project development.

It is imperative that any NPCs selected can be fulfilled in the near term without leading to further delay in project development. As a market develops, NPCs can become more ambitious over time.<sup>15</sup>

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15. Auction Design for Wind Energy - from cost to value (Vestas, 2023)



# Regional & International Supply Chain Development

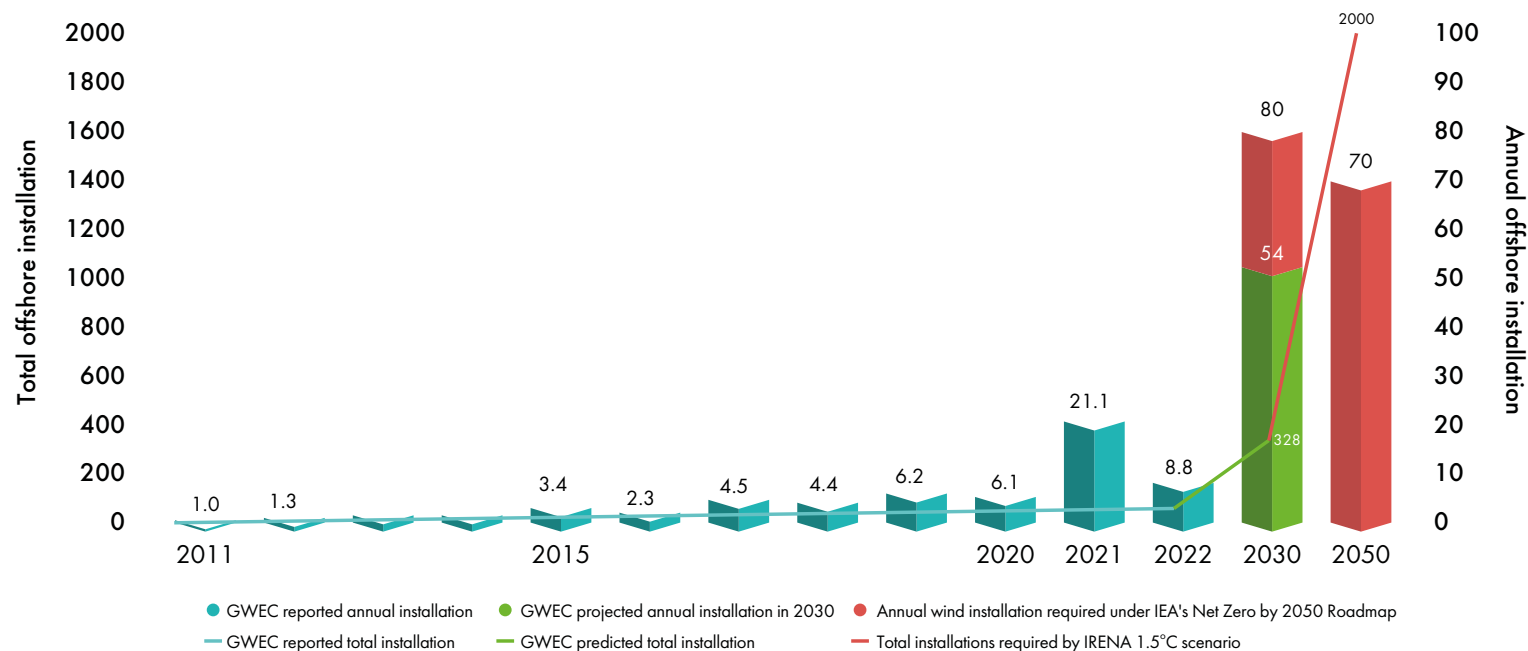
## Challenges in the global offshore wind supply chain

Consensus on developing offshore wind to address the unprecedented twin challenges of ensuring secure and affordable energy supplies and

meeting climate targets has never been stronger. Both the IEA and IRENA have mapped out pathways to net zero by 2050 where offshore wind together with other regional energy sources such as onshore wind and

solar PV need to scale up dramatically to deliver the required deep emission reductions. The IEA's roadmap requires offshore wind annual installations to grow nine-fold, from the 8.8 GW installed in 2022 to 80 GW by 2030 and thereafter 70 GW up to 2050. IRENA foresees more than 2,000 GW of offshore wind installed capacity by 2050 in its 1.5C scenario, nearly one-quarter of total wind power capacity required at that time.

Closing the offshore wind gap by 2050



Source: GWEC Market Intelligence, IEA Net Zero by 2050 Roadmap (May 2021), IRENA WETO 1.5C Pathway (June 2021)



**What is the expected offshore wind demand in this decade?**

Although less than 9 GW of new offshore wind capacity was commissioned worldwide in 2022, the global offshore wind market is projected to bounce back in 2023. We expect stable growth to continue in Europe and China this decade while huge offshore wind potential will be unveiled in emerging markets from North America to the Asia-Pacific region.

With a compound average annual growth rate of 25%, GWEC Market Intelligence forecasts new installations to sail past the 30 GW milestone in 2026 and 50 GW in 2030. Although expected annual growth rate in 2030 is still 32% lower than what is required by then for the Paris-compliant 1.5C pathway, GWEC believes a total of 328 GW of offshore wind capacity will be built by end of 2030, helping the wind industry to bring total global wind installation from today's 1 TW to 2 TW by the end of this decade.

**Is the supply chain ready to feed growth?**

**Turbine nacelles**

According to a GWEC Market Intelligence survey in Q1 2023, 163 GW of nacelle production capacity is available globally in 2023. At first

**Table 1. Overview of global wind turbine nacelle facilities**

	China	Europe	India	USA	LATAM	Asia Pacific	Africa& ME	Total
Total number of nacelle assembly facilities (offshore)	20 (1)	5	0	0	0	4	0	30
Number of announced nacelle assembly facilities (offshore)	47	1	0	3	0	4	0	55

\* Facilities owned by western turbine OEMs  
Source: GWEC Market Intelligence, February 2023

The supply chain for offshore wind turbines is more concentrated, because more than 99% of offshore wind installations are currently located in Europe and APAC.

glance, the wind industry appears to have enough nacelle assembly capacity to meet projected global demand. However, bottlenecks are likely to emerge from the middle of this decade if a separate benchmark is applied for offshore wind, especially at a regional level. Compared with onshore wind, the supply chain for offshore wind turbines is more concentrated, because more than 99% of offshore wind installations are currently located in Europe and APAC.

Worldwide, there are 30 turbine assembly plants currently in operation, with another 55 facilities either under construction or in the

planning stage. China has more than 20 nacelle assembly facilities in operation and another 47 under construction. With turbine nacelle production capacity of 16 GW per year, the country accounts for 58% of the global market share, making it by far the world's largest offshore turbine nacelle manufacturing hub. Excluding China, the APAC region has an offshore turbine nacelle capacity of 1.9 GW, mainly located in the Taiwan area and South Korea.

Europe is the world's second largest offshore wind turbine nacelle production base. With assembly facilities mainly located in Denmark, Germany and France, the region can

## Part 1: Offshore Wind Enablers

roll out 9.5 GW of offshore wind turbine nacelles per year at present, which we anticipate reaching 11.5 GW next year when a new nacelle facility comes into operation in Eastern Europe.

North America currently does not have offshore nacelle facilities in

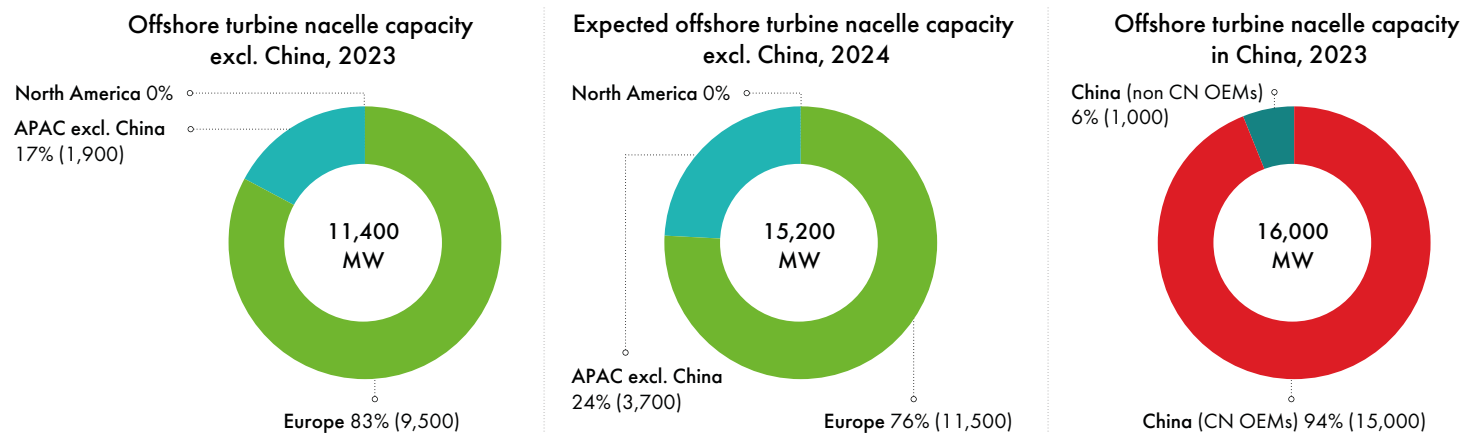
operation, although nacelle investment plans were announced in Q1 2023 by the three leading western turbine OEMs: Vestas, Siemens Gamesa and GE for New York and New Jersey. The same is true of LATAM, Africa & the Middle East.

Looking at the demand and supply profile for this decade, our benchmark results show more challenges for offshore wind than for onshore wind. GWEC Market Intelligence does not see any problems arising in the near term, given that European OEMs are able

to share spare offshore nacelle assembly capacity with emerging markets in APAC and North America in 2023–2024.

However, the situation is going to change. Starting in 2026, we expect Europe’s existing offshore turbine

### Offshore wind demand and supply benchmark, 2023–2030 (MW)



Source: GWEC Market Intelligence, February 2023

	Demand vs supply analysis 2023-2030 (MW)							
	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e
Europe	5148	2916	6527	9598	10808	16225	20465	26400
China	8000	12000	14000	15000	15000	15000	15000	15000
APAC excl. China	1769	1559	2884	2695	3256	5030	5535	6995
North America	533	955	2335	3535	4500	4500	4500	4500
LATAM	0	0	0	0	0	0	0	1350
<b>Global</b>	<b>15450</b>	<b>17430</b>	<b>25746</b>	<b>30828</b>	<b>33564</b>	<b>40755</b>	<b>45500</b>	<b>54245</b>

Source: GWEC Market Intelligence, July 2023

● Sufficient ● Potential bottleneck



nacelle assembly capacity to no longer be able to support growth outside of Europe. In fact, we expect that from 2027 Europe's offshore wind turbine nacelle assembly capacity will struggle to cope with the growth expected in Europe alone. Existing capacity needs to double in order to meet the projected demand for this region in 2030.

Looking at APAC (excluding China), although offshore turbine nacelle capacity is likely to increase to 3.7 GW after expansion work is completed at one of the existing facilities in the Taiwan area in 2024, it will still be insufficient to meet demand in this region from 2027/2028. Given estimates indicating that demand for offshore wind turbines in this region will reach 7 GW in 2030, it is imperative that the investment plans announced by western OEMs in partnership with Japanese and Korean firms materialise in time.

In the US, considering local content requirements (LCRs), associated tax credits and incentives under the IRA and the two-year lead time needed to build a new offshore wind nacelle production facility from scratch, it is of the utmost urgency that GE Renewable Energy, SGRE and Vestas turn their investment plans into concrete action.

There are no plans for offshore wind projects to be built in LATAM until the latter part of this decade. However, early investment is needed to avoid bottlenecks. This is especially true of Brazil, where environmental investigation licences linked to 71 offshore wind projects, totalling more than 170 GW, had been filed by the end of 2022, according to the country's Ministry of Mines and Energy.

In addition to offshore wind turbine nacelles, we find a similar supply chain situation for offshore wind turbine key components. There is a delicate balance between supply and demand in 2023–2025, but a gap is expected to occur from the second half of this decade if no further investment is made. As China controls the global supply chain for gearboxes, generators, slewing bearings, castings, forgings, towers and flanges with a market share of more than 70%, restrictive trade policies such as those proposed by the EU and the US look certain to create bottlenecks.

#### Offshore Wind Turbine Installation Vessels (WTIVs)

According to GWEC Market Intelligence's Global Offshore Wind Turbine Installation Vessels (WTIVs)

database, updated in July 2023, China and Europe operate the majority of jack-up and heavy-lift vessels used for offshore wind turbine installation. Based on current supply chain conditions and market dynamics, we expect no bottlenecks in meeting the global demand for offshore WTIVs up to 2026.

Following an offshore wind installation rush in China driven by the feed-in-tariff cut-off in 2021, new installations slowed down in 2022 and we do not expect to see 2021-level installations (15 GW) again until 2026. We believe that current Chinese WTIV supply chain availability is well-positioned to accommodate the projected domestic offshore wind growth in the near term. At the same time, we believe that Chinese EPC contractors will continue to use Chinese WTIVs to support nearshore wind turbine installation in Vietnam.

In Europe, the current WTIV supply chain can cope with demand, given that annual offshore wind installations are relatively flat and unlikely to reach the 10 GW level until 2026 – which also explains why European vessel operators are able to release their jack-up and heavy lift vessels over the next two years to support demand from emerging markets in



## Part 1: Offshore Wind Enablers

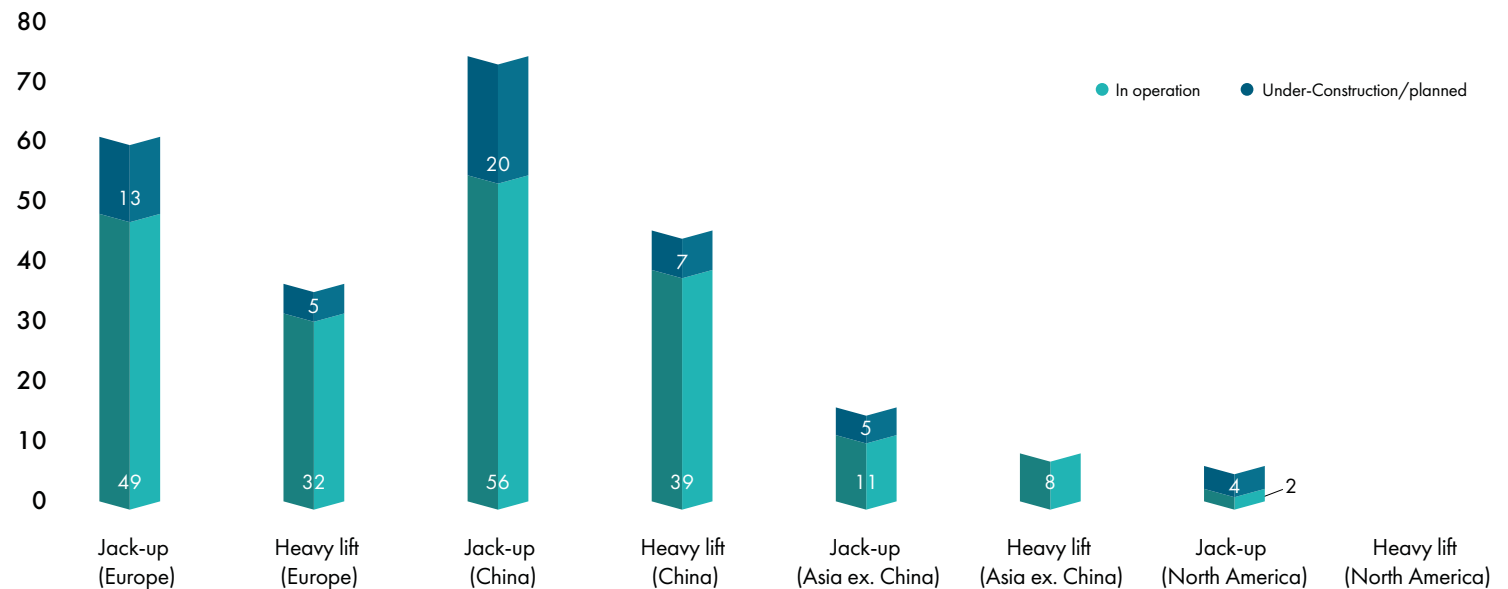
Asia – mainly the Taiwan area and Japan – and the US.

Looking at the 2027–2030 supply chain situation, GWEC Market Intelligence does not expect WTIV supply chain constraints in China. We saw in 2021 how quickly the country can mobilise vessels across the world and build vessels to support astonishing annual growth.

Although the average turbine size in China has reached 7.4 MW and turbines with power ratings greater than 10 MW will soon become the prevailing product, we believe the local industry can handle the challenge. In June 2023, Chinese developer CTG installed in Fujian the world's largest offshore wind turbine, Goldwind's GW252-16 MW, with its newly built WTIV 'Bai He Tan'.

As of June 2023, 27 offshore WTIVs are under construction in Chinese shipyards, of which 20 are tailor-made jack-up vessels and seven are purpose-built heavy lift vessels. In addition, local shipyards such as COSCO, CIMC Raffles and CMHI won the majority of WTIV orders placed in the past three years by large European vessel operators, namely Cadeler, Jan De Nul, Seaway 7 ASA, Van Oord and Havfram.

Number of wind turbine installation vessels in 2023



Source: GWEC Market Intelligence Global Offshore Wind Turbine Installation Vessel Database, July 2023

## Vessel Availability APAC- Country Cards

## Japan

With 'Blue Wind' – a new WTIV delivered in March 2023 – four operational jack-up vessels and three heavy lift vessels are available in Japan as of H1 2023, but two of the jack-up vessels are too small to handle today's large offshore turbine. However, four tailor-made WTIVs are to be delivered in the near future: a 'CP16001', a self-propelled jack-up WTIV, due to be delivered to Penta-Ocean Construction in 2023; a jack-up barge to be delivered to Obayashi Corporation and Toa Construction SEP in 2023; the upgraded 'Sea Challenger', expected to be reflagged and delivered to Penta-Ocean and DEME Offshore Joint Venture in 2025; a jack-up barge, 'DKK 107', planned by Daiichi Kensetsu Kiko but without a delivery date.

Japan has released an offshore wind vision with 10 GW of offshore wind by 2030 and 30–45 GW by 2040. The past two years saw MoUs or partnerships being signed between NYK and Van Oord, Penta-Ocean and DEME Offshore, Fred. Olsen Ocean and Shimizu Corporation, and Shimizu and Heerema Marine Contractors.

As of today, European operators including Jan De Nul, Fred. Olsen Windcarrier, Seajacks (now Enefi), Heerema, Seaway 7, Van Oord and Sapura Energy have chartered their vessels to support offshore wind project construction work in Japan. Since construction for those large-scale projects is not expected to accelerate until 2027/2028, if the new vessels in the pipeline are delivered on time, no bottlenecks are likely to occur in Japan during the forecast period. In fact, local WTIVs from Japan could be used to support project work in other APAC markets.

## South Korea

Two jack-up WTIVs, 'Hyundai Challenger 1' and 'Hyundai Frontier', and the heavy lift vessel 'KMMB 1500' were identified for offshore wind installation in South Korea. 'Hyundai Challenger 1', owned by Hyundai Engineering & Steel Industries, installed the wind turbines at the 30 MW Tamra Offshore wind project and 60 MW South-West Offshore wind project Phase 1. 'Hyundai Frontier', a tailor-made WTIV capable of installing turbines with power ratings greater than 10 MW, is now ready to carry out practical installation and demonstration work. 'KMMB 1500', a tailor-made heavy lift vessel delivered two years ago, has already installed a 4.3 MW Unison wind turbine at the Gunsan Demonstration project. The 100 MW Jeju Hamlin offshore wind project, the 400 MW South West – Phase 2 and the 300 MW Sinan offshore wind project phase 1 are also included in its execution pipeline. At present, only one jack-up WTIV called 'Hyundai Steel' is under construction. Supported by government funding, it was originally scheduled to be delivered in 2021 but the exact delivery date is now unclear.

Since only small- and medium-sized fixed-bottom offshore wind projects are expected to be built in South Korea before 2027, no shortages are likely to occur. After that date, the vessel supply chain situation for this country will depend on how quickly the GW-level wind projects in the pipeline are installed and what kind of installation method will be used – the majority of the expected additions in the next ten years are from floating wind.

If the current mainstream floating wind installation approach, 'built and towed', is used, South Korea is capable of supporting other markets in the region. If new WTIVs are needed to cope with growth in the 2030s, we believe they can be built locally as South Korea has the advantage of high R&D intensity in shipbuilding. In fact, Korean industrial conglomerates including Samsung, Hyundai and Daewoo (DSME) have already built offshore wind installation vessels for themselves and their European clients.

## Taiwan (China)

No locally built operational offshore WTIV was available in the Taiwan area before this summer, which means that the projects currently in operation and under construction rely on European WTIVs. European operators including Seajacks (now Enefi), Jan De Nul and Heerema, supported project installation at three demonstration offshore wind projects in Taiwan before 2022. Four projects, totalling 2.5 GW,<sup>16</sup> are under construction in the Taiwan area. European heavy lift vessels Javelin, Sapura 3500, Aegir, Bokalift 1 and 2 and jack-up WTIVs vessels including Brave Tern, Bold Tern, Seajacks Zaratán and Seajacks Scylla are carrying out the foundation and turbine installation work.

In June 2023, CSBC-DEME Wind Engineering Co, a joint venture between CSBC Corp, Taiwan and Europe-based DEME, officially launched its first tailor-made heavy lift vessel, 'Green Jade', with a main crane lifting capacity of up to 4,000 tonnes. The vessel has already been booked for installation work at the 1 GW Hai Long 2 and 3 and the 300 MW Zhong Neng projects.

As European operators are capable of sharing their vessels with APAC in the near term, and with 'Green Jade' having joined the European fleet, no bottleneck is expected in the Taiwanese offshore wind market in 2023–2025. However, if the WTIVs currently supporting installation work in the Taiwan area need to sail back to Europe to support the expected strong growth in installations, there will be a shortage in the vessel supply chain from 2026.

'Green Jade' alone cannot cover the expected demand of 1.5 GW per year on average between 2026 and 2035. Is new vessel investment needed to support the growth? Will project developers just mobilise vessels from Japan and South Korea to fill the gap? Based on past cooperation in foundations and cables between Taiwan and South Korea, regional cooperation is probably the best solution to the challenge.

<sup>16</sup> These projects are Yunlin Offshore Wind Project, Greater Changhua 1 & 2a project, Changfang and Xidao project and Formosa II.

## Vietnam

No real offshore wind project has been built in Vietnam as all projects installed in the waters so far are nearshore (intertidal) projects. The majority of EPC contractors for the 21 Vietnamese nearshore/intertidal projects that fully or partially reached their COD in 2021 came from China, although local EPC contractor Sigma Engineering JSC and Dubai-based SEPCOIII International also won project installation work. Due to the soft seabed conditions for those intertidal projects, heavy lift vessels and converted barges (barge + crawler crane) are used in Vietnam.

With real offshore wind projects expected to be built from 2028, however, tailor-made WTIVs will be needed. As of H1 2023, Vietnam does not have tailor-made WTIV in operation, but considering the strong cooperation that took place between China and Vietnam during the installation rush in 2021, we believe that Chinese WTIV operators will continue to support demand from Vietnam for the medium and long term. Whether the local Vietnamese offshore wind industry needs to build its own WTIVs will depend on how the target of 6 GW of offshore wind by 2030, included in the recently passed PDP8, is rolled out, as well as on the general availability of WTIVs in the region by the middle of this decade.



To accommodate the growing demand for vessels that are capable of handling large offshore wind turbines with power ratings greater than 12 MW and hub heights of more than 150m, European vessel operators started upgrading existing WTIVs and placing orders for next-generation WTIVs in the past couple of years. However, based on our latest market growth projection, we foresee a likely shortage in Europe towards the end of this decade, unless investment in new WTIVs is made before 2026/2027 – assuming a lead time of three years for delivering a new WTIV.

This expected bottleneck also means that offshore wind markets in APAC that are heavily reliant on European vessels need to find a solution for the future. Large offshore WTIVs are very expensive and require a skilled workforce and specific knowhow. This means that regional cooperation for vessels in APAC is vital to ensure offshore wind deployment won't get delayed, especially in new markets such as India, the Philippines, Australia and New Zealand.

In the US, where only one tailor-made Jones Act compliant WTIV is currently under construction, plans for new WTIVs will have to be

executed in the next two years if the Biden Administration's target of 30 GW of offshore wind by 2030 is to be met.

**How to build a competitive and sustainable offshore wind supply chain to cope with growth**

The global wind industry has seen increased supply chain vulnerability since the US-China trade war. The situation got worse when a geographically concentrated global wind supply chain had to deal with the impact of the COVID-19 pandemic and then the crisis brought by Russia's invasion of Ukraine. Inflation and restrictive trade policies have been among the key challenges facing the global wind industry in the past 18 months, pushing offshore wind development back instead of forward. With the Earth entering an era of "global boiling", urgent efforts must be made to enable exponential growth in offshore wind installations.

Holistically, we need global cooperation and regional collaboration, as well as alignment

between governments, industries, trade and financial bodies to build a resilient global supply chain that can deliver on the climate change goals. Lessons learnt in the past few years have shown that securing supply chain security for renewables is crucial for preventing from similar failures in the future. But restrictive trade policies should not be pursued as they can put the global energy transition at risk. Radical trade policies such as 'decoupling from China's supply chain' should be reconsidered and replaced with a more realistic approach such as 'China plus one'.

Thanks to technological innovation, the offshore wind industry has made great progress in the past decade and the LCOE of utility-scale offshore wind has fallen by more than 70%. However, the past two years have been extremely difficult, with turbine OEMs incurring significant losses due to challenging market conditions.

Size does matter, but a non-stop race in offshore wind turbine size is not healthy or sustainable, as it requires turbine OEMs to continue making huge R&D investments during a period when they are suffering losses. The short product cycle makes manufacturing economically

unfeasible due to high production costs, and insufficient time for the supply chain to develop economies of scale. OEMs also risk the substantial upfront investments required for vessels and infrastructure.

The wind industry has reached a point where it is unable to risk any more losses just at the same time as our climate has reached the point where we cannot afford any delays in the energy transition. For this reason, developers, turbine OEMs and policymakers all need to work together to build an economic, resilient and sustainable supply chain.

### **Regional collaboration on the supply chain**

Offshore wind is poised for significant growth in the APAC region: China has dominated the numbers so far, but Japan, Korea, Taiwan (China) and Vietnam are now active offshore wind markets, and newcomers like Australia, New Zealand, India and the Philippines are looking to move forward with their ambitions. Our APAC forecast shows this growth out to 2032, with project pipelines in a much wider set of markets than ever before.

However, with increased appetite for

offshore wind comes increasing demand for key supply chain components. As other regional offshore wind markets grow, new markets in APAC will need to look carefully at how to support and grow offshore wind, nurturing the supply chain but not imposing growth-hampering local content requirements.

In this year's Global Wind Report and Global Offshore Wind Report, we have explored the potential supply chain challenges around key offshore wind components. To reiterate our findings, by 2026 we see potential bottlenecks in every region of the world except for China. In the APAC region, supply chain growth through regional collaboration will be essential for realising the 250 GW of offshore wind project pipelines that was identified at the end of June 2023.

The newer APAC markets can take some key learnings from Europe's experience in working out how to balance building market confidence and helping domestic players



### Case study: The wind industry cannot yet have it all in steel

There is no shortage of steel in the world. Yet for the rapidly growing wind energy sector it is possible that bottlenecks and supply constraints will exist in the coming years unless the sector is flexible on some of its ideal sourcing requirements.

#### Wind is a fast growing but relatively small part of total steel plate demand

The wind energy sector is a key driver of demand growth for steel plate, by far its fastest growing end use worldwide. The sector's steel need could double by the end of the decade.

However, the absolute scale of wind demand for steel plate is dwarfed by other end uses, especially construction. When putting wind into the context of total reversing mill plate demand, the sector looks small.

On the surface, there seems to be plenty of steel plate in the world that could serve the wind energy industry. Why then would there be any concern over supply chain bottlenecks and shortages?

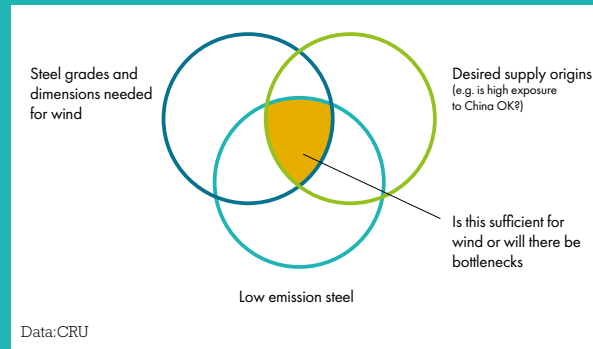
#### But it's not just about total steel plate

The challenge for the wind energy supply chain comes not because steel is scarce – it is not – but because of the way that the industry ideally requires several sub-areas of steel to all intersect.

We can illustrate this in qualitative terms with the following Venn diagram:

The steel required in wind is the result of overlaps of several sub-areas

Steel grades for wind are undemanding but dimensions for offshore are niche

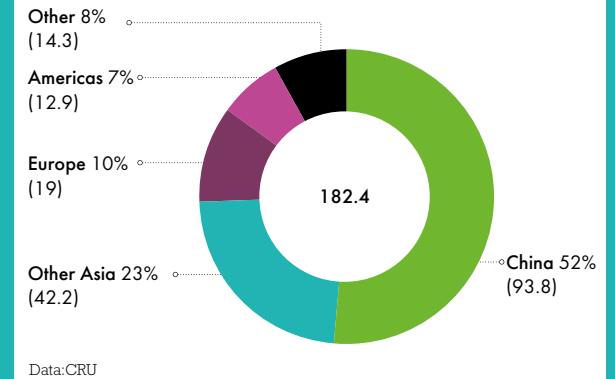


The chemical specification, or grade, of much of the steel used by the wind sector is relatively undemanding and most mills would be able to make it. Where wind becomes a more demanding customer is on product dimensions. In the more extreme cases, especially for offshore, the demand can be for plates of up to 150mm thick. The most common plate thickness in general demand is 10–60mm and so, even without extending all the way to 150mm, the requirements for wind tend towards the thicker end of mill product ranges. There is a relatively small pool of suppliers able to meet all the product needs of the offshore wind energy industry.

#### Materials origins have risen up the agenda

Over 60% of the world's reversing mill plate is produced in China, which is also the world's biggest exporter of the product. But the US is leading efforts to diversify or 'de-risk' away from China. And China has shown recently in gallium and germanium that it is prepared to act to restrict its exports. Sourcing decisions made in such an environment are complex but it may be that what looks like a wide range of possible suppliers is reduced in practice to a smaller number of acceptable origins.

#### Reversing mill capacity, Mt/y, 2023



#### Renewables are a key demand source of low emission steel

Weighted average Scope 1 emissions from the world's plate mills is 2.2 tCO<sub>2</sub>/t. The steel industry is working hard on its decarbonisation. Results at scale are likely to take years, yet the wind energy industry is growing rapidly right now. It may not be possible for all developers to access low emission steel for several years to come.



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manage external challenges such as the supply of critical materials, while also growing a supply chain but avoiding burdensome local content requirements that add costs, skew investment decisions and slow down the pace of offshore wind deployment.

These important European initiatives sit alongside other European programmes such as the European Critical Raw Materials Act and the European Commission's Green Deal Industrial Plan, published in February 2023.

This is the level of political commitment and cooperation that is necessary to accelerate offshore wind growth. Significant effort is also required to build the necessary infrastructure to underpin the rollout of offshore wind. WindEurope estimates that by 2030 Europe alone will need to invest €8.5 billion in its port infrastructure – a significant challenge, given that investments must be in place ahead of demand.

Europe also faces challenges in the readiness of its supply chain and the profitability of a sector hit by rising commodity and supply chain costs. There are recognised capacity shortages in terms of OEM production and vessels, which are

covered in the previous section of this report. But if these can be overcome, the political imperative created should help to underpin investor confidence in supply chain growth.

Initiatives like the NSEC, bringing together the countries around the North Sea, are a good model for other regions to follow. They offer the following benefits that other regions can learn from:

- 1. Raising ambition.** Working together helps instil confidence across different countries that ambitious targets can be achieved.
- 2. Allowing cooperation on shared challenges.** For example, in Europe efforts are being made to build out meshed grid systems to facilitate more efficient cross-border transmission system.<sup>17</sup>
- 3. Enabling larger companies active in the supply chain to look at how to supply growing demand.** In Europe this has resulted in blade, nacelle, tower, foundation, cable and other manufacturing facilities developing around the North Sea market over time.

<sup>17</sup> Meshed grids the next frontier in leveraging the potential of offshore wind <https://windeurope.org/newsroom/news/meshed-grids-the-next-frontier-in-leveraging-the-potential-of-offshore-wind/>

## Case Study: European collaboration on offshore wind

Since early 2022, as the impact the Ukraine war on energy prices became clear, politicians and energy sector stakeholders across Europe have been looking at options for reducing dependency on volatile global markets and Russian gas. While Europe has been a growth market for renewables, this was against a backdrop of growing energy integration and reliance on Russia as a source of fossil fuels. At short notice, Europe had to focus on diversification and home-grown energy sources.

This switch has brought greater focus to offshore wind – already one of Europe's big growth areas. To support acceleration, European countries have put in place practical programmes to underpin offshore wind deployment across the region, especially in the North Sea and the big offshore wind markets clustered around it.

May 2022 saw the signing of the Esbjerg Declaration, with Belgium, Germany, Denmark and the Netherlands raising offshore wind commitments to deliver 65 GW of offshore wind by 2030. The nine nations which make up Europe's North Seas Energy Cooperation (NSEC) agreement met in Dublin in September 2022 to agree a programme of measures to support achievement of 76 GW of offshore wind energy by 2030, rising to 193 GW by 2040 and at least 300 GW by 2050. This raised ambition of the NSEC contrasts with the EU's 2020 targets of 60 GW by 2030 and 300 GW by 2050 across the whole of the bloc.

In response to the Esbjerg Declaration, major European ports have come together to look at how they can collaborate to deliver the additional offshore wind capacity required. The ports of Esbjerg (Denmark), Oostende (Belgium), Groningen Seaports/Eemshaven (Netherlands), Niedersachsen Port/Cuxhaven (Germany), Nantes-Saint Nazaire (France) and Humber (UK) are working together to see how they can support each other to grow offshore wind activity.



At a national level, we are seeing activity focusing on national strengths and cooperation. Countries across Europe have reciprocal trade and partnership arrangements, with trade delegations moving between markets and sharing knowledge. Countries are increasingly focused on their specific capabilities and strengths, rather than seeking to win all aspects of the offshore wind value chain.

In other markets, it will be particularly important to look at port infrastructure requirements, as well as to map where there are associated skills such as shipbuilding, fabrication, electronics and engineering excellence.

**Areas of potential cooperation in the APAC region could include:**

1. Offshore wind deployment tends to require grid infrastructure upgrades and opens up the option of meshed offshore systems. In countries with interconnection, the use of power exports requires coordinated regulation to enable companies that invest to understand how different power markets work effectively together.
2. Offshore wind deployment also requires the support of large-scale port infrastructure. It will be

important to look at port infrastructure requirements especially for floating wind, and to map where there are associated skills such as shipbuilding, fabrication, electronics and engineering excellence. Regional cooperation in port infrastructure is critical particularly in the early stage of development when each individual market has yet to achieve a significant scale of deployment. For example, before

several mature offshore wind supply chain providers for towers, shipping and cables, and some existing OEM activity focused on the onshore wind market. But it needs production facilities that can accommodate larger blades and nacelles, as well as towers. OEMs are under pressure to bring local content with orders, but in practice they need to make decisions on a regional basis. Coordination between different countries can help to open up this

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## Countries are increasingly focused on their specific capabilities and strengths, rather than seeking to win all aspects of the offshore wind value chain.

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offshore wind ports were established in Germany, Netherlands and the UK, the Danish offshore wind port of Esbjerg played a vital role in supporting regional offshore wind expansion. According to Port of Esbjerg, it has so far supported more than 23 GW of offshore wind capacity crossing 59 projects, although its home country Denmark only installed 2.3 GW offshore wind by the end of 2022.

3. Some supply chain challenges are already facing APAC. The region has

conversation, given that political will and support are important factors in deciding where to invest. Regional action to foster collaboration between OEMs and local industrial companies can often be fruitful.

4. While discussions over local content often end up focusing on tier-one components, it is often useful to look at the wider supply chain and work out where national and regional strengths lie through capability assessments such as those carried out in markets like the US and UK. Across APAC there



is expertise in offshore oil and gas, shipbuilding and engineering that can be applied to manufacturing, in particular to the installation and operations phases of offshore wind, as well as to the nascent floating offshore wind sector.

5. With the growth of Power-to-X, there are opportunities for regional cooperation to incentivise the growth of low-carbon fuels. Power-to-X requires a clear regulatory regime and a route to market. Consistency across APAC will help build investor confidence and fast-track development. But countries can also cooperate on common challenges and infrastructure – for example assessing what port infrastructure a bunkering will be needed in the future. Ships moving across the region will need to be able to access common refuelling infrastructure in different ports they visit, which will require either a clear market solution or consistent regulation.

### Skills and Workforce Building the offshore wind workforce of the future

The vast expansion of offshore wind into oceans in every region of the world will require mobilisation of a trained and diverse workforce. Given

the complex and varied requirements of the offshore wind project lifecycle, from biologists to marine engineers to logistics specialists, the demands of workforce development must be recognised early in the planning stage and at a national level. Proactive planning to address occupational gaps and programmes for recruitment and training needs will attract skilled workers to this growing industry.

These activities will also be important to ensure that the clean energy transition remains on track. IRENA has identified skills gaps, misalignments between fossil fuel job losses and renewable industry job gains, and health and safety quality issues as some of the key barriers to enabling a 1.5C pathway. To meet these challenges head on, the wind industry will

need to promote the skills required to drive projects forward and enhance dialogue on workforce development with both policymakers and educational institutions.

A 2022 study conducted by GWEC and the Global Wind Organisation (GWO) revealed that at least 569,000 trained technicians would be required to safely construct, install, operate and maintain wind projects around the world through 2026.<sup>18</sup> Nearly 15% of these, or around 74,400 people, would be required for offshore wind installations. The skill sets required for these technicians are unique, including safety protocols when working at heights and survival at sea.

Since this study was published, growth projections – countries' interest in developing offshore wind

– have grown. Moreover, the study did not cover workforce requirements in the most labour-intensive segment of the offshore wind value chain, namely the manufacturing of components and assets for offshore wind farms. Additional opportunities exist to expand the offshore wind workforce pipeline, from innovation for the recycling of wind blades to the buildout of related port and ship infrastructure.

How can the industry respond to the diverse demands for offshore wind workers? In terms of communicating the comparative advantages of wind energy jobs, the industry can emphasise:

- The long-term job security attached to wind industry jobs,

18. <https://gwec.net/more-than-half-a-million-wind-technicians-needed-by-2026-for-wind-energy-construction-and-maintenance/>





compared with jobs in the fossil fuel industries, which have already been surpassed by the clean energy labour force as of 2022, according to the IEA.<sup>19</sup>

- The localised and long-term nature of the O&M segment of the offshore wind value chain, which can provide jobs for communities around wind farm installations for roughly 25 years.<sup>20</sup>
- The wage security of wind industry jobs, which are not subject to the volatility of fuel prices and production cycles.
- The return on investment for local and national authorities, as studies show that clean energy investments create more near-term jobs for every \$1 million compared with fossil fuel investments.<sup>21</sup>

Industrial and labour force policy will be critical for medium- and long-term guidance of the offshore wind workforce. The industry must encourage policymakers and decision-makers to:

- Adopt targeted programmes and skills development frameworks for populations around planned projects, with a consideration for relocation of workers in sunset industries;

- Work with industry to develop attractive incentives for encouraging upskilling and mobilising public-private investment in a talent pipeline;
- Invest in workforce data and forecasting for early identification of skills gaps and baselines on wages and labour costs, in the context of developing a green economy; and
- Collaborate with the private sector and educational institutions to attract and foster the next generation of workers in the wind industry to accelerate the clean energy transition.

Finally, as the industry workforce grows, its constituents must also be responsible for fostering a just transition for people. This could translate into efforts to encourage workforce diversity and equal access to training and educational opportunities, as well as addressing supply chain strengths and weaknesses, including in the upstream mining segment. A successful transition means decent work – labour rights, wages, occupational health and safety, job security and other factors – along the entire value chain for wind energy.

19. <https://www.iea.org/reports/world-energy-employment>  
20. <https://www.irena.org/publications/2018/May/Leveraging-Local-Capacity-for-Offshore-Wind>  
21. [https://www.ituc-csi.org/IMG/pdf/the\\_green\\_jobs\\_advantage\\_-\\_wri\\_nce\\_and\\_ituc\\_working\\_paper.pdf](https://www.ituc-csi.org/IMG/pdf/the_green_jobs_advantage_-_wri_nce_and_ituc_working_paper.pdf)

A photograph of an offshore worker in safety gear (white helmet, goggles, and a dark jacket) handling a large yellow pipe on a ship's deck. The pipe is suspended by heavy chains. In the background, another worker in an orange jacket and blue helmet is visible. The scene is set on a ship's deck with a blue railing and the ocean in the background.

## PART 2: TECHNOLOGY

# Floating Offshore Wind - Acceleration and Reality

Floating offshore wind is rapidly shifting to commercial scale, drawing from industry experience in fixed-bottom offshore wind and the oil and gas sectors. Learning from the few floating offshore wind demonstrators has been invaluable, but the sector still faces a number of known unknowns. This means that the industry needs to continue to learn from early experience as it breaks through into delivery of GW-scale projects.

experience of building and operating these 32 turbines spread across the globe, in addition to the ten single-turbine demonstrators also in operation.

## Market status and activities

GWEC Market Intelligence predicts that 10.9 GW is likely to be built globally by 2030, 42% less than the previous year's projection. This figure still highlights the rapid growth expected across the

floating will shift to France and China, which between them has 300 MW of floating projects in pre-construction and set for construction later this year or next.

China is also active in floating offshore wind, with the Fujian Nanri Island 4 MW demonstrator and the 16.6 MW Nezzy2 demonstrator both heading into construction shortly, as well as the two 100 MW phases of Power China International Group's PFS-1 Southeast Wanning project. Depending on completion times, this project is expected to become the world's largest floating offshore wind farm, demonstrating China's commitment to floating offshore wind, alongside its unequivocal leadership in fixed offshore wind deployment.

With the majority of the global floating wind resource in deeper waters, we can see that confidence in the ability of the wind sector to successfully deploy is prompting governments and leasing bodies to prepare and run auctions for seabed. In 2022/2023, we have seen progress in the UK with ScotWind, INTOG and the Celtic Seas leasing rounds, as well as activity in Korea, the US, Spain, Portugal and Norway.

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**Over the next five years, we expect to see a small number of 100–500 MW projects successfully built.**

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The sector is grappling with the shift from a handful of single-turbine demonstrators and the five wind farms that are operating or under construction today: Hywind Scotland & Kincardine (UK); Windfloat Atlantic (Portugal); Hywind Tampen (Norway); and Goto (Japan). Much applied learning needs to come out of the

remainder of this decade, though it is likely to be dwarfed by what happens in the 2030s, when floating offshore wind is expected to really accelerate.

Over the next five years, we expect to see a small number of 100–500 MW projects successfully built. The next phase of installation for

The UK has a set of projects in the pipeline, including the TotalEnergies/Simply Blue Erebus project (96 MW), the EdF/TNB Blyth demonstrator (70 MW) and the CIP/Hexicon Pentland project (100 MW), highlighting the importance of the UK as a place of learning for the global floating market.

The Scottish leasing rounds of ScotWind and INTOG alone account for 24.9 GW of floating capacity, which is approximately one-third of the known global pipeline. The original ScotWind pipeline has grown after changes to project capacity and the addition of a further three sites totalling 2.8 GW east of Shetland, after completion of the ScotWind clearing process.

Crown Estate Scotland announced the INTOG results in March 2023, with 5.4 GW of projects unveiled. INTOG includes five innovation (IN) projects totalling 449 MW. The remainder are targeted oil and gas (TOG) projects focused on the decarbonisation of oil and gas platforms. The TOG projects range from a TotalEnergies 3 MW project to Cerulean Wind's three 1,008 MW projects. The scale of this Scottish floating pipeline signals that significant learnings for the global

market will come from the development of these North Sea projects.

In South Korea, 14 sites totalling over 7 GW have exclusivity agreements in place via Electricity Business Licences (EBL). The country's major floating wind offshore hub, Ulsan, hosts 13 of these sites. Another 11.9 GW is currently in development around South Korea's coastline.

In the USA, the Bureau of Ocean Energy Management (BOEM) concluded its California floating auction in December 2022, with four sites given leases totalling 8.1 GW. In January 2023, BOEM published a Determination of No Competitive Interest for a proposed research lease area offshore Maine for a 12-turbine 144 MW floating offshore wind site.

Finally, Norway has opened up its tender process for offshore wind projects for 1.5 GW at Utsira Nord, near Stavanger. The area is suitable for floating offshore wind and permits will be split between three projects of 500 MW, which could be expanded to 750 MW.

### Overcoming technical challenges

Developers are focused on



### Case Study: French Market

Over the next two years, one of the most active global floating markets will be France, with 85 MW moving into construction at three projects – Les Eoliennes Flottantes du Golfe du Lion (EFGL), EolMed and the Provence Grand Large (PGL) – after winning government tenders to develop the sites.

The sites are using different floating technologies: Principle Power for EFGL, SBM Offshore for PGL and BM Ideol for EolMed. BM Ideol is manufacturing its platforms from steel at Port-la-Nouvelle, while Eiffage Métal is manufacturing both the Windfloat and SBM Offshore platforms at its Fos-sur-Mer site.

To build on this momentum, the French government is actively managing a number of lease rounds expected to deliver up to 2 GW of floating offshore wind. In Brittany, the French Government is tendering two 250 MW sites, while in the Gulf of Lion in the Mediterranean pre-selection is complete for two 250 MW sites: one off Narbonne - near Perpignan and one in the Gulf of Fos near Marseille. Both these Gulf of Lion sites are for 250 MW, extendable by a further 500 MW.



make sure it is ready to meet developer needs. It is worth remembering that the market does not buy innovation – it buys solutions to help mitigate risk and cost. That creates a dynamic where, as a new market, the floating offshore wind sector needs to look at new approaches yet at the same time find a route to market that is demonstrably proven and low-risk.

Floating platform companies have been carrying out a range of activities. Those at – or close to – full technology readiness are

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## As of today, the UK, Norway, Portugal, China and Japan are the top five markets in total net floating wind installations.

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bringing a range of projects to market, which means identifying suitable ports for manufacturing and assembly activities, resolving issues around wet storage, logistics, crane and heavy lift requirements, as well as ensuring that the complex logistics requirements of multi-port buildout are in place.

The wider floating offshore wind supply chain has been working to

focused on the scale-up of platforms for larger turbines later in the decade, as well as looking at construction processes and how to accelerate manufacturing. For steel platforms, this means a shift from fabrication at a single location to volume manufacturing of different platform elements for shipping and assembly to ports near the project locations. For concrete platforms, this means a shift to volume

production methods such as slip-forming and post-tensioning, and investing in large sites able to deliver concrete platforms on a production line basis.

While the focus of sector discussions is often about platform types, there is significant work underway for providers of mooring lines, anchors and connectors. This technology already exists in the maritime and oil and gas sectors, and can transition reasonably easily into floating offshore wind – provided that the sector is clear on specifications such as mooring types and numbers, diameters and redundancy. While the space needs for platform manufacturing and assembly are increasingly well understood, other activities such as cable, anchor and mooring line storage and integration also need to be factored in – and space needs to be found.

Finally, there is increasing activity amongst major EPC, shipping and port-engineering companies that are offering solutions to the market. Activity around logistics, assembly and installation requires investment. Developers can benefit from the knowledge of civil and marine engineering groups that are active in offshore wind.

### **Raising our sights to the 2030s**

As of today, the UK, Norway, Portugal, China and Japan are the top five markets in total net floating wind installations. By the end of 2030, South Korea is likely to replace Japan in the top-five grouping.

Each of these countries offers lessons for the deployment of floating offshore wind at scale. But they will all struggle to ensure that port infrastructure and the associated supply chain can accommodate the large material and space demands of floating offshore wind. Markets like the UK also require significant grid upgrades to connect the additional generation coming to the more peripheral parts of the grid system.

While energy forecasts are focused on a 2030 milestone, this point in time is not significant for floating offshore wind. We know that there will be substantial project activity by this point, with an increasing volume of projects coming through the installation phase and beginning operation by or close to 2030. But it is wiser to focus on cumulative growth into the early 2030s, with ongoing acceleration expected in the next decade.

# Offshore energy islands and hub connections

As the offshore wind market has grown, there has been a clear trend to build larger projects, with scale helping to bring down costs and maximise the benefits of power generation for power systems and decarbonisation goals. In response, the industry is looking to move from point-to-point to meshed grid systems, where multiple connections are required. In the North Sea this shift also includes the development of energy islands as locations for managing multiple connections.

As wind projects grow, they are shifting further from shore. This is obviously the case in mature markets where sites closer to shore have already been developed. The shift brings additional challenges in the construction and operation of projects – with crew, equipment and vessels needing to be brought in from further away – and in the longer distances needed for export cables to connect wind farms. Industry has made a shift to larger service operation vessels (SOVs) that are stationed close to wind

farms and act as crew bases during both construction and operation. These vessels add cost but increase the effectiveness of wind farm management.

## Raising ambition on connections

As we accelerate offshore wind deployment, the challenges around grid connection are increasing. A vast step-up in public and private investment in transmission and grid management solutions is needed, in an area that is already beset by delays for connection agreements. The scale of connections required could create supply chain pressures and increase curtailment risk, but also offers opportunities for investing in cable manufacturing. An example of industry requirements came earlier this year when Dutch state-owned electric grid company TenneT announced the award of 11 contracts for North Sea offshore wind project connections to two consortiums, with a combined value of \$25 billion.

These huge grid connection

programmes respond to a growing pipeline of wind projects awaiting connection and acute energy security concerns in the wake of Russia's invasion of Ukraine. The May 2022 Esbjerg Declaration, signed by the heads of state for Germany, the Netherlands, Denmark and Belgium, is a great example of raised commitments driving the need for accelerated connections. These four countries have a commitment to building 65 GW worth of offshore wind by 2030 as Europe tries to reduce reliance on fossil fuels and meet climate goals.

In the UK, the system operator NG-ESO is working with regulator Ofgem and the government to move the offshore wind market toward meshed connections. Its Holistic Network Design (HND) programme is currently in the second phase of connection agreements to support projects in the UK's Round 4, ScotWind and Celtic Seas leasing rounds. The HND process is a response to longstanding industry calls for coordinated transmission connections, but the shift in regulatory approach still creates challenges for individual projects looking for certainty over connection times.





### Case Study: Princess Elisabeth Island

Princess Elisabeth Island is set to be the world's first energy island. It is located 45 km off the Belgian coast and will connect up to 3.5 GW of offshore wind from the Princess Elisabeth offshore wind zone back to shore. In addition, the energy island is seen as the first building block in longer-term plans to create an offshore electricity grid in the North Sea linking into new interconnectors with the UK and Denmark.

The project is being led by Belgium transmission system operator Elia. Constructed from concrete caissons filled with sand, the island will house transmission infrastructure, a small harbour and a helicopter pad for use by the maintenance teams.

Construction work is scheduled to begin in 2024 and will last through 2026, with contracts awarded to a consortium including Deme Group and Jan De Nul. Elia aims to have the island working at full connection capacity by 2030.

The cost of the project has been estimated at €600 million, with €100 million of funding coming from Belgium's recovery and resilience plan (NRRP).

A shared challenge for these large offshore wind markets is how to scale up connections in terms of the physical volume of cables and infrastructure required while reducing the length of time that projects wait for connections. The UK's Offshore Wind Champion recently released a report – Accelerating deployment of offshore wind farms – which sets out the overarching need to accelerate the buildout of grid infrastructure and reduce connection times. "If I had to sum up in one sentence where we stand today, I couldn't use words better than those of a European developer with investments across the UK: 'The UK is long on seabed leases, but short on timely grid connections!'" Tim Pick – the UK's first Offshore Wind Champion said. "If you take just one message from this report, it should be the urgent need to upgrade our national grid for a world of high renewables penetration, and widespread electrification of homes and businesses," he added. This message needs to be understood in the many mature and emerging offshore wind markets around the globe.

### The genesis of energy islands

The continued demand for new offshore sites and GW-scale

volumes has driven the development of energy islands. The North Sea is a focus of international efforts to develop them, given the existing multinational cooperation on offshore wind, the volumes of offshore wind targeted for development and the relatively shallow waters located between the UK and Scandinavia.

Included in the Esbjerg Declaration is a commitment to collaborate on energy islands. The first bilateral agreement between Denmark and Belgium is already in place to support construction and interconnection to a first, 3 GW energy island by 2033, with plans to grow connected capacity to this island to 10 GW by 2040.

The Esbjerg Declaration also makes a commitment to establishing a second energy island in the North Sea and to carrying out further screening for energy islands as well as highlighting the need for a faster approval process. Grid operator TenneT is also looking at how energy islands can support its hub-and-spoke concept, for the connection of multiple offshore wind projects and then exporting the resulting power. Longer term, these islands also offer opportunities for power-to-X





## Without addressing bottlenecks in the supply of cable technology and grid connection availability, the growth of offshore wind risks significant delay

strategies, generating green hydrogen and derivatives like ammonia or methanol for shipment or piping back to shore.

The Danish Energy Agency (DEA) is leading work on the first energy island and seeking investors for the project. Its model is for private investors to construct the island and on completion sell a 50.1% stake back to the Danish government. Subsequently they receive rental revenues from Danish Transmission System Operator ENDK leasing

land on the island for its offshore wind connections. In addition, there may be revenue from leasing island space for other purposes such as offshore wind O&M activities or green hydrogen and other power-to-X projects.

The tender process was recently postponed, as the Danish Energy Agency seeks to explore options to make the proposed scheme profitable and justify government involvement. The tender was expected to open in summer 2023,

with the award announcement scheduled for autumn 2025; the timetable is now uncertain but the Danish government is expected to provide clarifications later this year.

### Rapid technological evolution

As volumes grow, the technical solutions to support meshed grids and bigger connections are increasing. Array and export cable sizes are increasing, moving from 33kV to 66kV, and the market is also seeking to shift to 132kV. This will make new investments in cable production necessary. Larger projects further from shore also require high-voltage direct current (HVDC) cables, where production capacity is limited. Large contract awards tie up global production, making it difficult for other offshore wind projects to secure supplies in time for connection. Alongside this, the growth of floating offshore wind calls for the production of more dynamic array cables that can connect floating turbines to substations for power export.

In the medium term, there is research and commercialisation activity in support of new superconducting cable systems, which offer a potential route for the transmission of larger amounts of power using smaller cable

diameters and have low resistance – thus avoiding overheating or electromagnetic interference. Cable company Nexans is installing superconductive cables at Paris's Montparnasse station in partnership with French rail company SNCF, helping to accelerate learning from this technology. In offshore wind, companies like Supernode are seeking to apply superconductivity to meshed offshore wind grid systems. At a European level, the SCARLET project has secured EU Horizon funding to look at superconductivity.

Without addressing bottlenecks in the supply of cable technology and grid connection availability, the growth of offshore wind risks significant delay. Longer term, we can expect to see higher specification cables, as well as a shift to power-to-X that can move offshore wind to market via other means. But the fundamental building block of offshore wind is a reliable grid system. Mature markets are showing what happens when grid systems cannot keep pace with offshore wind aspirations. New offshore wind markets have an opportunity to get ahead of this future problem and ensure that the onshore/offshore grid system is in place for green electrons to flow.

# Gearing up for green hydrogen and power-to-X

The ongoing energy crisis has forced many countries to couple energy security and decarbonisation goals, with green hydrogen emerging as one of the most promising candidates for enabling the energy transition. Green hydrogen does not emit CO<sub>2</sub> during

especially for far-from-shore projects in deep waters.

However, developing a hydrogen-based energy system is not without its challenges. Despite increasing political momentum and renewable hydrogen targets being announced

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**The economic viability of generating hydrogen from renewable energy through electrolysis will improve over time, despite the existing challenges of inadequate infrastructure and high costs**

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production, hence it is ideally suited to supporting the intermittency challenges of other renewable energy sources.

As offshore wind power generation increases, a proportion of the energy generated may not reach the power grid due to cost or technical constraints. Locating electrolyzers near offshore wind farms would enable the production of green hydrogen – an attractive proposition

in markets across the globe, several technical, policy and investment steps are still needed to evolve the green hydrogen industry alongside the continued rapid growth of offshore wind.

Experts predict that the economic viability of generating hydrogen from renewable energy through electrolysis will improve over time, despite the existing challenges of inadequate infrastructure and high

costs. Although the necessary raw materials for the sector's expansion have been expensive in recent years, it is expected that cost reductions will occur as the adoption of green hydrogen increases. The IEA and IRENA predict that green hydrogen presents the greatest opportunity for cost reduction through 2030, when compared with unabated fossil hydrogen or blue hydrogen.<sup>22</sup> These cost cuts will enhance the economic feasibility of further development and facilitate the integration of this technology into the energy mix.

In countries such as Australia, Spain, India, Germany and the US, it is anticipated that potential supply chain bottlenecks like high CAPEX requirements will start to ease, and that green hydrogen will become an important energy source for reaching net zero by 2050.

## **Power-to-X applications**

Green hydrogen is produced via electrolysis, fed by renewable energy sourced from an adjacent asset or the grid. Wind-to-green hydrogen can be compressed and stored in a tank system for offloading when needed. Through an offshore hydrogenation platform, liquid hydrogen can be converted to

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22. IEA, IRENA and UN Climate Change High-Level Champions, Breakthrough Agenda Report, 2022.

synthetic natural gas (SNG), better known as methane, before being shipped to end users.

Offshore wind energy can also power electrolyzers located on offshore oil and gas platforms to produce green hydrogen using seawater. The green hydrogen is blended into the gas and transported to land via the existing infrastructure. It is estimated that up to 20% of hydrogen by volume can be mixed into existing gas pipeline flows.<sup>23</sup>

Stored electricity can also be combined with captured CO<sub>2</sub> to make carbon-neutral liquid fuels or generate heat through heat pumps or electric boilers (power-to-heat), or it can be contained in underground formations such as salt domes and fed back to the grid when needed (power-to-power). Each sector will require targeted approaches, especially given the varying costs and conversion efficiency rates attached to each application.

Power-to-X is particularly capable of providing solutions, feedstock and green fuels for hard-to-electrify sectors such as heavy road transport, shipping and aviation, as well as steel and cement production and chemicals manufacturing.

23. GWEC, Global Offshore Wind Report 2022.



While different types of hydrogen can bolster energy security by reducing import dependence, mitigating exposure to fossil fuel price fluctuations and boosting system flexibility, green hydrogen is naturally best suited to support the journey to net zero.

### A global green hydrogen race

Russia's invasion of Ukraine has raised concerns about energy security, prompting a global increase

in green hydrogen targets and proposed projects. Governments and the private sector are capitalising on the opportunities provided by green stimulus policies and packages. It is widely acknowledged that the demand for renewable exports is expected to soar as interest in energy transition technologies grows. Those who take early action may have the advantage of dominating the emerging green hydrogen market.

Green hydrogen initiatives utilising electrolyzers powered by renewable sources are currently being planned on all continents, with Europe and Australia spotlighted below, leading the way with their large-scale project portfolios in the gigawatt range.

### European Union

The EU established the European Hydrogen Bank (EHB) last year, allocating a budget of €3 billion for its ambitious REPowerEU target,



### Case Study: Bass Offshore Wind Energy (BOWE)

Equinor has announced its support for a potential multi-GW offshore wind project off the coast of Tasmania. The project, known as Bass Offshore Wind Energy (BOWE), aims to harness the exceptional wind resource in the Bass Strait, located approximately 30 km off the northeastern coast of Tasmania and in one of the designated offshore wind zones proposed by the Australian government.

The primary objective of the project is to provide significant renewable energy capacity that can be utilised for powering a large-scale green hydrogen production initiative in Tasmania. The partners of the fixed-bottom wind energy project, including Equinor and local developer Nexsphere, have not provided a specific timescale for its completion. However, there are ambitions to commence operations as early as 2026, pending approval from local authorities. The project has the potential for multiple stages of development and could scale up to encompass multiple GWs of installed capacity,

which aims to produce 10 million tonnes per annum (tpa) of green hydrogen. Additionally, the EU plans to import 10 million tpa of green hydrogen.

In March 2023, the European Commission announced that the first part of the support package, a €800 million funding initiative to subsidise green hydrogen production, is set to launch by the end of 2023.

Furthermore, several EU member nations including Denmark, Germany, Portugal and the Netherlands have implemented national tenders to encourage development within the region.

#### Denmark's landmark tender

Denmark launched a power-to-X tender in April 2023 to support the production of green hydrogen. The Danish Energy Agency has allocated a total budget of DKK 1.25 billion (\$182.4 million) with the aim of encouraging the development of approximately 100-200 MW of electrolyser capacity. Successful applicants will be granted fixed premiums on a ten-year contract, with a maximum bid price of DKK 120/GJ hydrogen (equivalent to approximately \$2.1/kg hydrogen).

To ensure that the supported amount of hydrogen remains within budget

limitations, a 'budget controlling ceiling' of DKK 70/GJ (\$1.2/kg hydrogen) has been set. If any winning bid exceeds this threshold, the DKK 1.25 billion funding will be divided into two rounds of DKK 750 million and DKK 500 million, respectively. Another important aspect of the tender is that the support provided only covers up to 5,500 operational hours per year.

Assuming bids are equal to the budget control ceiling of \$1.2/kg, the tender would promote a total electrolyser capacity of 144 MW (equivalent to 14,900 tpa of hydrogen). If bids are even lower, both hydrogen production and the added electrolyser capacity would increase, contributing to Denmark's goal of achieving 4–6 GW of electrolyser capacity by 2030. Based on the current pipeline for green hydrogen supply in Denmark, it is expected that electrolyser capacity will reach 7.2 GW by 2030, spread across 30 different projects.

#### Asia

In Asia, hydrogen roadmaps are driven by demand creation. Both Japan and Korea are exploring the production and export of hydrogen and the establishment of international supply chains, with a particular focus on the transport sector.

China is already the world's largest producer and consumer of hydrogen. The Chinese government has laid out a medium- and long-term development plan for hydrogen, for the period 2021–2035. Hydrogen is also featured in plans formulated by provincial authorities.<sup>24</sup> Currently, China's hydrogen production relies on fossil fuels and involves state-owned and state-backed companies such as SPIC, Beijing Jingneng and CNOOC. However, these entities have initiated projects aimed at green hydrogen production. The government's Hydrogen Industry Development Plan targets green hydrogen production using renewable feedstock resources to reach 100,000–200,000 tonnes per year by 2025. Besides transport, the plan envisages the use of clean hydrogen in other sectors including energy storage, electricity generation and industry.

### Australia

The Australian government has set high ambitions for hydrogen exports, with grants available at both the state and federal level. In May 2023, it unveiled a significant renewable hydrogen package worth AUD\$2 billion (\$1,275 billion) in its annual budget, marking a major step towards

the country's energy transition.

The funding will be dedicated to scaling up Australia's initial large-scale green hydrogen projects. It will be distributed through a scheme called 'Hydrogen Headstart', which follows a contract for difference auction model. Under this scheme, developers will receive government contracts that provide long-term subsidies and stable pricing. Additionally, AUD\$2 million will be allocated to projects that support indigenous communities.

The budget includes substantial funding commitments for solar and wind energy projects and a comprehensive review of the status of Australia's energy transition. Furthermore, ministers have confirmed over AUD\$1.6 billion in funding to facilitate energy efficiency upgrades for homes and small businesses.

Australia has agreements with South Korea and Japan to begin establishing an international hydrogen supply chain. In June 2023, five companies signed an agreement on the initial design of a project to produce and liquify green hydrogen in Queensland, Australia for export to Japan.

<sup>24</sup>. Hydrogen Industry Development Plan (2021–2035), International Energy Agency, last updated 13 January 2023



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# MARKET STATUS 2022



# Annual Installations

8.8 GW of new offshore wind was fed into the grid last year. The new additions are 58% lower than the bumper year of 2021 but still make 2022 the second highest year in offshore wind history.

- China continued to lead global

offshore wind development, although new installations in 2022 were 70% lower than in 2021 – a record year driven by the end of the feed-in tariff (FiT). Starting from 1 January 2022, China's offshore wind market has also entered the era of 'grid parity' with the end of

national FiTs. Although financial support at the provincial level is still available in Guangdong, Jiangsu and Shandong, the incentive is much lower than the FiT previously offered by the central government.

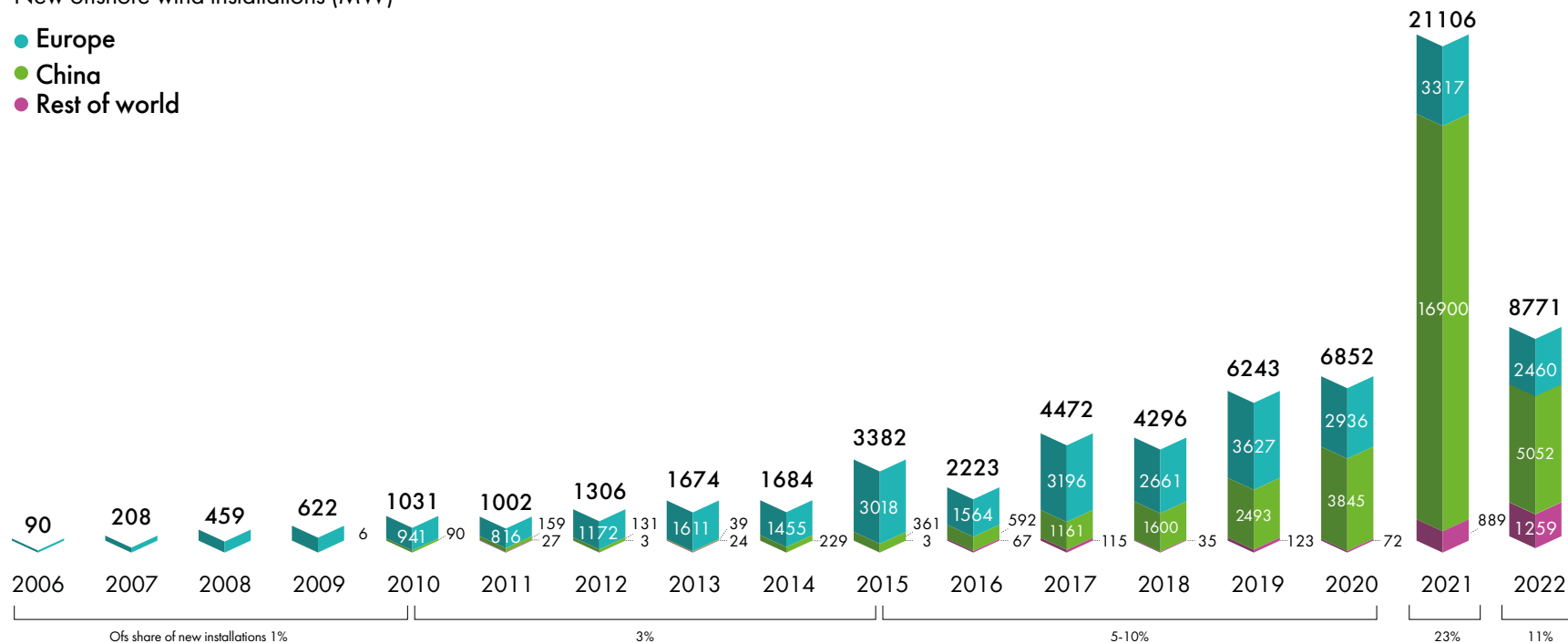
Commissioning more than 5 GW of new offshore wind in 2022 demonstrates the resilience of China's offshore wind industry.

- With 2.5 GW offshore wind capacity across six countries connected to the grid in 2022, Europe accounted for the majority of the remaining new capacity, as in the previous year.

- The UK has further consolidated its leading position in the European offshore wind market in 2022. In addition to bringing the remaining

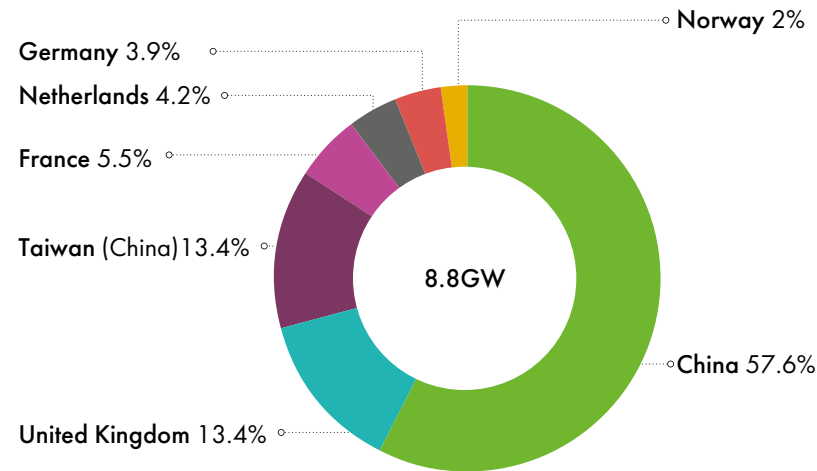
New offshore wind installations (MW)

- Europe
- China
- Rest of world

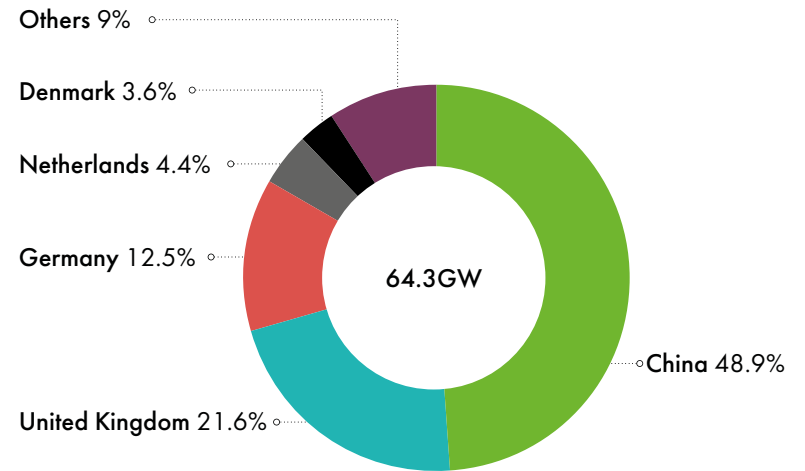


\*Compound Annual Growth Rate.  
Source: GWEC Market Intelligence

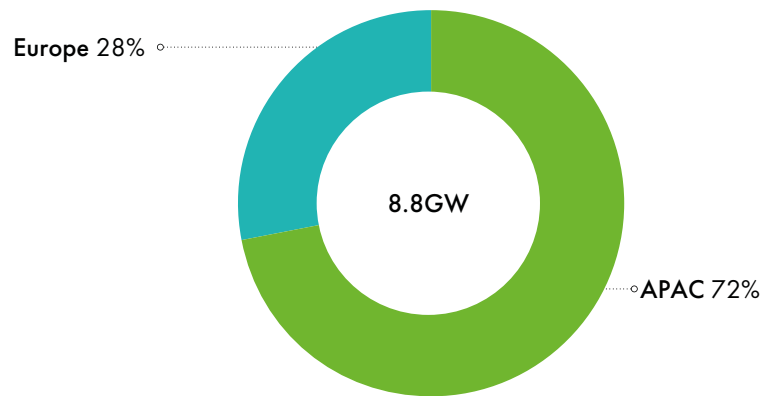
New offshore wind installations by market



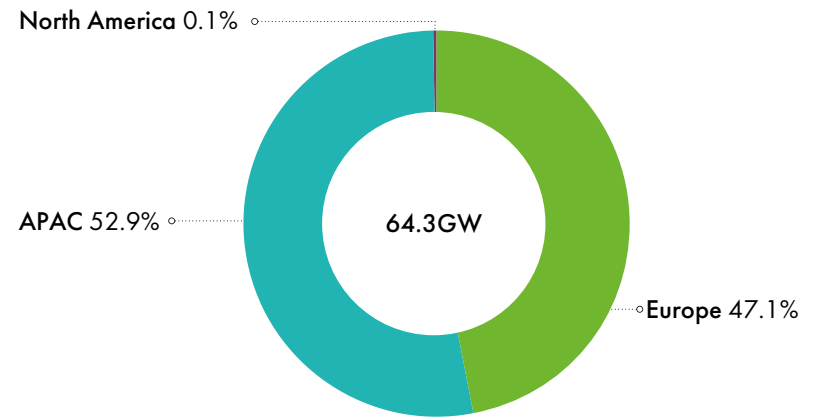
Total offshore wind installations by market



New offshore wind installations by region



Total offshore wind installations by region



Source: GWEC Market Intelligence, June 2023



wind turbines (924 MW) online at the 1.4 GW Hornsea Project 2, which is now the world's biggest single operational offshore wind farm, the UK has connected to the grid 27 units of wind turbines (255 MW) at the 1.1 GW Seagreen project.

- France got its first commercial offshore wind project, the 480 MW Saint-Nazaire wind farm, fully commissioned last November, making it the second largest European offshore wind market in 2022, followed by the Netherlands (369 MW) and Germany (342 MW).
- Italy also commissioned its first commercial offshore wind project last year. The 30 MW Beleolico offshore wind farm, which features ten MySE3.0-135 wind turbines from Mingyang, not only represents the first installation of Chinese wind turbines in European waters but also the first offshore wind project commissioned at the Mediterranean Sea.
- In Norway, the 94.6 MW Hywind Tampen floating wind project, featuring 11 units of SG-8.6 MW-167 wind turbines from Siemens Gamesa and a concrete SPAR-type floating foundation, was initially scheduled to be completed by the end of 2022, but due to supply chain

issues only seven wind turbines (60.2 MW) have come into operation. Together with one 6.2 MW floating wind turbine supplied by Chinese CSSC Haizhuang, which was installed on a floater prototype called 'Fuyao' in China, a total of 66.4 MW floating wind capacity was commissioned in 2022.

- Outside of China and Europe, two other markets reported new offshore wind installations in 2022: Chinese Taiwan (1,175 MW) and Japan (84 MW). In February 2022, the local Bureau of Energy predicted a total of 2,016 MW offshore wind capacity would be added in Taiwan in 2022. However, only 145 offshore wind turbines across four projects were connected last year. This is due in part to the COVID-19 pandemic and typhoon-related disruptions. In Japan, the 140 MW Akita Noshiro Port wind farm achieved full commissioning in early 2023.
- No intertidal offshore wind project in Vietnam reached commercial operation last year, although more than 300 MW of intertidal project capacity missed their COD deadline in 2021 and more turbines were installed at a few intertidal projects in 2022. This is because the ceiling price used by

Vietnam Electricity (EVN) as the cap to negotiate PPAs with investors for their renewable energy projects was missing until January 2023.

- The US is the only market with offshore wind in operation in the Americas, but no offshore turbine or project was commissioned in 2022, as in the previous year. The situation is expected to change with the first power to be generated at the 806 MW Vineyard Wind 1 project in October this year and the 132 MW South Fork offshore wind project coming into operation by the end of 2023.

### Cumulative installations

The global offshore market grew on average by 21 % each year in the past decade, bringing total installations to 64.3 GW, which accounted for 7.1% of total global wind capacity as of the end of 2022.

- In terms of cumulative installations, China overtook the UK as the top

market in 2021, and further consolidated its market share in 2022. The other four markets that make up the global top-five are: the UK (13.9 GW), Germany (8.1 GW), the Netherlands (2.8 GW) and Denmark (2.3 GW).

- The total offshore wind installations in Europe passed 30 GW by the end of 2022, making up 47% of the global total offshore. However, Europe lost its title as the largest offshore wind regional market to Asia, as the total offshore wind installations in China alone exceeded 30 GW by the end of last year.
- In addition to China, other large offshore wind markets in Asia include Chinese Taiwan (1.4 GW), Vietnam (0.8 GW), South Korea (0.1 GW) and Japan (0.1 GW).
- Outside Europe and Asia, North America had 42 MW of offshore wind in operation at the end of last year, with all installations located in the US.

### Floating wind

- 66.4 MW floating wind was installed in 2022, of which 60.2 MW is from Norway and 6.2 MW from China.
- As of 2022, a total of 187.8 MW net floating

wind was installed globally, of which 78 MW is in the UK, 66.1 MW in Norway, 25 MW in Portugal, 11.7 MW in China, 5 MW in Japan and 2 MW in France.



# Ocean Energy Pathway (OEP)

The Ocean Energy Pathway (OEP) is a large-scale, multi-year programme for contributing to the acceleration of the global energy transition. OEP aims to ramp up the delivery of offshore wind through collaboration between industry and civil society to unlock the potential of ocean-based renewable energy in new and underdeveloped markets.

The OEP's fundamental tenet is that sustainable scaling up of the sector will only come from high-quality, locally appropriate policy and regulation that encourages nature-positive outcomes, delivers for local communities, and enables wider economic development.

## **A trusted partner for all stakeholders**

Being independent of industry, the OEP is a trusted partner that works with governments, investors, communities and NGOs to build a competitive and sustainable offshore wind sector. Its key aim is to proactively address the major challenges offshore wind faces through three thematic pillars: market design and supply chains, limited government capacity, and providing benefits for nature and community.

## **Market design: how policy drives investment**

The development of domestic supply chains – a trend increasingly arising from political necessity – can also become a limiting factor for the rapid expansion of offshore wind in new countries. Governments and local industry must work together on new policy instruments and strategic

bureaucracies and an even greater one for countries that lack the regulatory and institutional underpinnings to build delivery frameworks. This adds uncertainty and stretches out wait times for developers.

New offshore wind markets need a huge amount of locally appropriate and fully aligned policy and

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## **The wind industry needs confidence in policy measures to drive increased investment in manufacturing, infrastructure and talent**

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support in developing their own supply chains in a way that does not hinder offshore wind development.

The wind industry needs confidence in policy measures to drive increased investment in manufacturing, infrastructure and talent. Unless the correct industrial policy choices are made, success for offshore wind will be severely constrained.

## **Government capacity: why appropriate regulation matters**

Delivering offshore wind is a complex policy design challenge for developed

regulation if the sector is to scale up to meet its targets.

## **Dealing with socio-political and ecosystem impacts**

Socio-political challenges increasingly threaten project viability. Offshore wind operates in a complex, multi-stakeholder landscape where the technology is often poorly understood, engendering conflict that causes additional costs and delays.

Offshore wind competes with existing ocean users – sectors that

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## Accelerating ocean-based renewable energy requires new approaches to deployment, including a sustainable approach to ocean stewardship.

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may feel their prospects are threatened by ocean-energy technologies. The ecosystem impacts of offshore wind projects are also poorly understood, especially in new markets, leading to 'green-on-green conflict' where conservation NGOs push back against wind projects.

Accelerating ocean-based renewable energy requires new approaches to deployment, including a sustainable approach to ocean stewardship, to avoid the industry being caught in the crossfire of wider conversations around ocean management. In new markets especially, the offshore wind industry needs to establish early partnerships with conservation groups and local communities to shape emerging regulations and political narratives.

### **How to accelerate deployment**

In the medium to long term, the wind industry and investors may be able to continue to singlehandedly bring offshore wind to scale in several markets. But given the huge

role offshore wind must play in displacing fossil fuels and getting us on track for a 1.5C world, we cannot wait for the market alone to act.

The OEP knows that while there are common elements to building a successful offshore wind sector, it is essential that we work within the unique economic and political contexts of each country. For this reason, it focuses on a number of actions that are crucial to successful project delivery.

### **Expertise and networking**

Because the wind industry has so far deployed and invested in the vast majority of offshore wind projects, the OEP occupies a unique position to convene and support all stakeholders in this area. It aims to leverage its experience and connections to support and complement the work of other organisations including the World Bank and the International Renewable Energy Agency (IRENA), as well as partner governments and





the offshore sector itself.

The OEP will create a network of regional experts that can work with governments and stakeholders to build knowledge on offshore wind. Serving as a catalyst for longer-term systematic change, the OEP intends to provide experts who can sit alongside officials in governments, rather than work remotely from within large consultancies. This will allow us to support learning inside new country markets and accelerate growth in expertise.

The OEP will also make an ongoing effort to create and/or invest in local networks to facilitate dialogue and shared working between ocean and nature NGOs, community groups, industry groups and government stakeholders.

The OEP's strategic approach is to focus on countries with significant carbon footprints, at risk of fossil fuel lock-in and with significant wind resources while also responding pragmatically to country-specific ambitions, evolving politics and economics. Priority countries include Vietnam, Indonesia, the Philippines, Thailand, India, South Korea, Taiwan, Colombia, Brazil, Japan and South Africa.

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# MARKETS TO WATCH



## Asia Pacific

Since the end of 2020, we've seen the concept of net zero being embraced by Asian nations as a key national strategy for delivery by mid-century. The region has embraced the need for an energy transition into a new system with a high share of renewable energy. Offshore wind, due to its high technical potential, high energy output and huge cost reduction potential, has become a top choice for some Asian countries when it comes to planning a successful energy transition.

Several markets in APAC have high offshore wind targets. Japan has a target of 10 GW by 2030 and 30–45GW by 2040; Korea 14.2GW by 2030; Vietnam 6 GW by 2030. The Philippines, despite not having a technology-specific target, is also likely to emerge as a major GW-size market for offshore wind by the end of the decade.

Despite the high ambitions, there are many challenges ahead. How well these issues can be tackled will determine how successfully ambitions can be delivered in the future.

- Many markets lack a route-to-market strategy, involving clear guidance from governments on

policy, including marine spatial planning, leasing and the permitting policy process, as well as the process to determine the project offtaker and offtake price. In most APAC countries, the route to market for offshore wind is in the early stages of development. Due to the complexity of offshore wind projects, governments around the region also suffer from a poor understanding of the different processes involved and the interactions between them, which often causes further delays or policy confusion. GWEC hopes that effective route-to-market policies and processes can be introduced in each market soon.

- The next challenge after a route to market is an industrial policy that facilitates offshore wind development. This fundamentally breaks down into plans and policies that relate to three areas: supply chain, infrastructure and workforce.
- Supply chain challenges have the potential to become a major bottleneck for the delivery of offshore wind targets in each country. Because it takes years for a supply chain to get started, and the APAC markets are developing rapidly, the pressure on the

supply chain can be huge. This calls for a more coordinated approach. In some of the markets, policies such as prescriptive local content requirements will definitely add further strain to supply chain crunches.

- An ever-present challenge for renewable energy development, the grid will present similar challenges in the offshore wind sector, which requires both policy and planning efforts from the government. Ports and other infrastructure are new challenges that can further slow offshore wind development in all markets.
- The offshore wind sector has huge demands in terms of workforce, which is both a challenge and an opportunity. It is an opportunity for job creation, and for a just transition from jobs that are becoming redundant. However, it poses the challenge of requiring large amounts of skilled labour in the region at around the same time.

Overcoming these challenges and grasping the opportunities will require a collaborative effort from governments, industry and third parties, including associations and academics.

# Australia

The Australian government has committed to a 43% reduction in the country's emissions by 2030 and to net zero by 2050. The establishment of an offshore wind sector in Australia will play an important role in decarbonisation of the energy sector. In August 2022, the federal government announced the establishment of several offshore wind zones around the country (Gippsland, Hunter Valley, Illawarra, Portland, Northern Tasmania, Perth and Bunbury). The industry has been encouraging the federal government to set national targets for offshore wind, but as yet there have been no volume targets attached to the zones.

The Victorian state government decided to provide some business case certainty to investors when it set an ambitious target of 2 GW of offshore generation by 2032, 4 GW of offshore wind capacity by 2035 and 9 GW by 2040. Industry has responded positively to the targets, with the initial feasibility licence application for Gippsland attracting 37 applications for the zone. Victoria has also set up Offshore Wind Energy Victoria (OWEV) to act as a one-stop-shop for offshore wind.



OWEV has already released two of three implementation statements to provide clarity to industry around procurement, transmission, ports, policy, workforce development, legislation and reform. The third statement is due for release before year's end.

In New South Wales, the state is still considering the introduction of state-based targets for its Hunter Valley and Illawarra zones. Since coming to power in March 2023, the newly elected state Labor administration has hinted that it intends to introduce targets, but as yet there are no targets defined. This is despite the fact that, in July 2023,

the federal government declared the Hunter Valley zone open for feasibility licence applications, with the process due to close at the end of August.

## Committed to adopting best practice

Although being relatively new to the offshore wind space, Australia has proved itself to have supportive, forward-looking regulations. The Offshore Electricity Infrastructure Act 2021 (OEI Act) provides the legal framework for offshore renewable energy projects and activities in Commonwealth waters. It entered force on 2 June 2022 and enables the full life cycle for the construction,

implementation, and decommissioning of offshore renewable energy infrastructure. The OEI Act prohibits people from undertaking offshore infrastructure activities without a licence.

The framework is not limited to offshore wind projects. It has been designed to be flexible, so that it can adapt to new emerging offshore renewable energy technologies that may come through over time, allowing industry to drive how it develops in Australia.

## The licence process

In 2022 there were some big political moments for offshore wind in

Australia. The government introduced the first stage of regulations to support the establishment of offshore wind and help decarbonise the economy: Offshore Electricity Infrastructure Regulations 2022, Offshore Electricity Infrastructure (Regulatory Levies) Regulations 2022 and Cost Recovery Implementation Statement (CRIS).

Australia introduced a feasibility licence as part of its leasing process. The licence area of a feasibility licence cannot overlap with the licence area of another feasibility or commercial licence.

The granting of feasibility licences is a competitive process. The minister will grant a feasibility licence based on merit, including whether the applicant has the financial and technical capabilities to undertake the proposed project. In circumstances where licence applications overlap and are similarly meritorious, the minister may invite financial offers to separate the proposals.

### **Australia commits to Global Offshore Wind Alliance**

At COP27 in November 2022, GWEC actively engaged with the Minister for Industry, Energy and Emissions Reduction of Australia –

Chris Bowen. With efforts from GWEC, Denmark and IRENA, Minister Chris Bowen committed to the Global Offshore Wind Alliance (GOWA), resulting in Australia becoming a member of GOWA together with 12 other countries at the time.

### **Increasing activity in 2023**

Following the success of the first consultation for Gippsland in 2022, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) launched two other consultations in the Hunter and Southern Ocean Region in February 2023 and June 2023, respectively. The industry expects more good news from the government in the coming months, with Perth and Bunbury actively looking to put forward cases for Western Australia to be considered in the next tranche of consultations.

### **Unlocking potential**

While the first feasibility licences are expected to be awarded in Gippsland before the end of 2023, there are a number of challenges that Australia needs to consider before these projects can be realised. Common offshore wind challenges like grid connection, port infrastructure, access to vessels, workforce development (including

skills training) and supply chain capacity are not unique to Australia or other emerging markets, but they will need to be dealt with over the next two years to ensure delivery timeframes can be met.

In terms of supply chain, Australia's share of manufacturing and supply chain activity in most renewable energy sectors is low, although several recent reports have documented opportunities in the market. Investing in infrastructure to strengthen the domestic supply chain is vital to help Australia reduce costs for offshore wind and ensure job creation.<sup>25</sup>

Governments at both the federal and state level have been ramping up their capacity to deal with the rapid rollout and huge interest in the market. Lessons learned from the first feasibility licence process are helping to shape the rollout of future licences. While no market is ever perfect, Australia's commitment to iterative learning and constant improvement in processes and regulations around offshore wind are causing other markets to look to emulate the country's initial success in building a market.

25. Briggs, C., M. Heimer, P. Howard, R. Langdon, P. Marsh, S. Teske and D. Carrascosa (2021). Offshore Wind Energy in Australia: Blue Economy Cooperative Research Centre, Launceston, TAS. 92p.



# New Zealand

While neighbouring Australia has progressed rapidly in the last decade thanks to a combination of federal and state activity, interest in offshore wind energy had not crossed the Tasman Sea to New Zealand until recently. Thanks to longstanding hydro generation infrastructure capable of supplying over half of the country's electricity needs, New Zealand has traditionally been seen as a nation already in control of its power sector decarbonisation. However, raised climate ambition, coupled with growing concerns over the impacts of climate change on hydropower<sup>1</sup> and the realisation that the global shift towards electrification will mean increasing power generation, has put a spotlight on development of offshore wind.

## Technical potential much greater than power needs

The country has a technical potential of 2,252 GW,<sup>27</sup> against current generation capacity of 11 GW.<sup>28</sup> Government modelling indicates that electricity demand could increase by between 18% and 78% dependent on economic growth, technology choices and policy. Despite the wide range on growth projections, this

highlights the need to support new renewable electricity projects as part of New Zealand's commitment to meeting 50% of its energy needs with renewable sources by 2035.

With a technical resource many times its current and future power needs, only a fraction of this resource needs to be developed to meet New Zealand's power needs, though opportunities may arise from power-To-X markets and the export of low-carbon fuels.

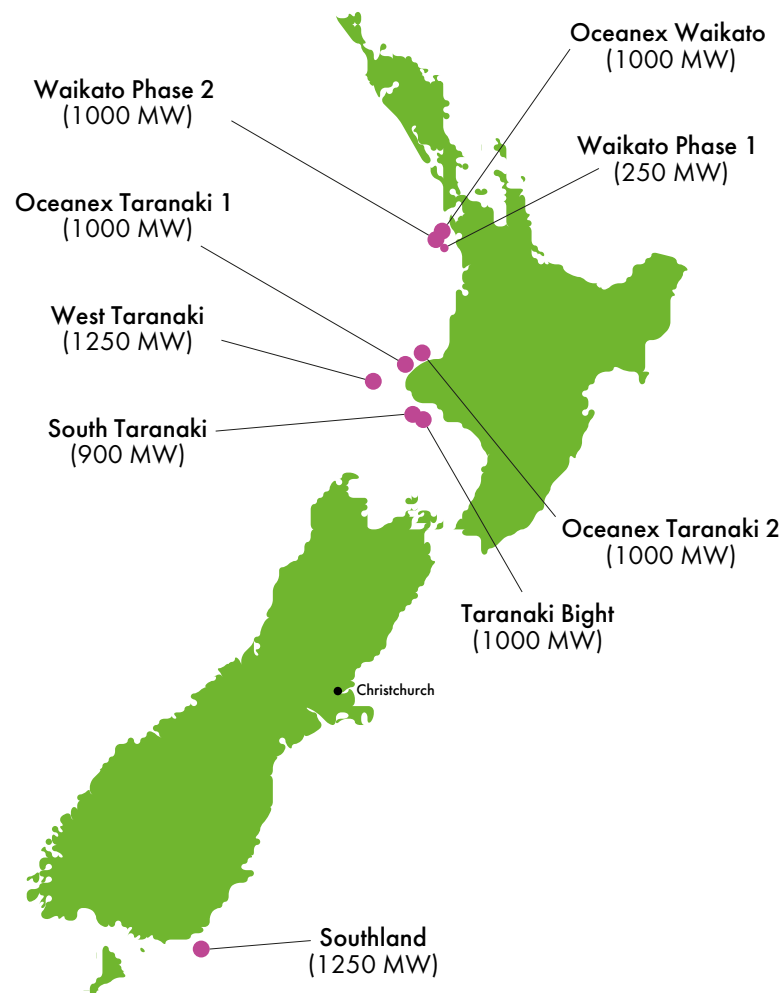
## A predominantly floating offshore wind market

While New Zealand's technical resource is primarily floating, its fixed resource of 148 GW still provides plenty of scope for development. But the emerging market is focused on floating or mixed foundation offshore projects. Almost 9 GW of projects are at the early development stage and all are either floating, mixed or set to be developed as phases of fixed and then floating offshore wind. Almost all activity is currently focused on the west side of the North Island in

26. Te Mana Hiko – NZ Electrical Authority (2023) (<https://www.ea.govt.nz/news/eye-on-electricity/the-impact-of-our-climate-on-hydro-generation/>)

27. OREAC (2020) (<https://gwec.net/oreac/>)

28. Ember (2023) Global Electricity Review 2022 (<https://ember-climate.org/insights/research/global-electricity-review-2022/>)



Source: RUK



the Waikato and Taranaki regions, close to demand centres. This would also help reduce the North Island's dependence on the hydropower generation assets concentrated on the South Island, though there is an interest in offshore wind around the South Island as well.

Floating specialist BlueFloat Energy, in partnership with Energy Estate and Elemental Group, has plans to develop 5 GW of offshore wind capacity through four projects in Waikato, Taranaki and Southland at the southeastern tip of the South Island. The first phase of its Waikato project will be 250 MW of fixed offshore wind, with a second phase of 1,150 MW using solely floating technologies. Its 1,250 MW Taranaki and 1,250 MW Southland projects will also be floating. Adjacent to its Taranaki project, CIP and the NZ Super Fund are proposing a 1 GW floating project at Taranaki Bight, and recently deployed floating lidar to commence site measurements.

Australian company Oceanex – led by the original backers of Australia's Star of the South project – has two projects in development: the 2 GW in Taranaki, to be developed as two 1 GW phases, and the 1 GW in

Waikato. Both these projects are expected to use a mix of fixed and floating technology.

### **Establishing the correct regulatory framework and build cooperation within industry**

While development activity is ongoing, efforts are also underway to put in place the correct regulatory framework to support offshore wind growth. The Ministry of Business, Innovation and Employment (MBIE) is currently reviewing responses from its December 2022 to April 2023 consultation process on what approach it should take to identifying suitable areas for developing offshore renewable energy and managing feasibility activities in the short term.<sup>29</sup>

MBIE set out proposals to cover what enabling activities are needed to support offshore renewable energy projects and plans to consult later in 2023 on issues such as construction, operation and decommissioning. It has committed to putting the necessary regulatory framework in place by 2024.

Alongside work by the NZ Government, Te Waihanga – the

New Zealand Infrastructure Commission – is looking at the infrastructure requirements for supporting growth of offshore wind and other renewable technologies. It estimates that the country needs to add an average of 494 MW of low-emission electricity generation capacity every year for the next 30 years to meet electricity's contribution to achieving New Zealand's net zero carbon target.<sup>30</sup>

Meanwhile, the industry is seeking to build cooperation. The New Zealand Wind Energy Association is working in support of offshore wind, while regional development agency Venture Taranaki is working to hold offshore wind events bringing together offshore wind developers and local partners.

With growing developer ambitions, much will depend on how the government decides to regulate offshore wind and where it sets its level of ambition for new offshore wind capacity. The country certainly has the potential and the opportunity to use offshore wind to grow its economy and bring wider benefit to indigenous stakeholders and local communities.

29. See <https://www.mbie.govt.nz/have-your-say/enabling-investment-in-offshore-renewable-energy/>

30. Te Waihanga (2022) *Leveraging our energy resources to reduce global emissions and increase our living standards* (<https://www.tewaihanga.govt.nz/assets/Uploads/Leveraging-our-energy-resources.pdf>)

# Japan

With Japan's first commercial-scale offshore wind farm achieving commercial operations at the beginning of 2023, the 140 MW Akita Noshiro Offshore Wind project marks a new milestone for the Japanese wind industry and signals the start of a rapid scale-up of Japan's offshore wind capacity.

The current cumulative offshore installed capacity stands at 136 MW at the end of 2022, leaving a big gap to fill if Japan wants to achieve its target of 10 GW installed capacity by 2030, as outlined in the Vision for the Offshore Wind Power Industry (1st).

Although the rate of offshore deployment is far from ideal, Japan is a huge offshore wind market that is too important to miss. Japan has the sixth-longest coastline in the world with massive uncaptured floating wind resources. It also has a long

history of heavy industry manufacturing capability and expertise that can effectively be built upon to position the country as the regional offshore wind hub.

The government has taken proactive steps in recent months to explore the possibility of developing offshore wind within the Exclusive Economic Zone (EEZ) and to unlock the industrialisation opportunity offered by floating offshore wind.

## Round 2: Offshore wind development within territorial waters

On 28 December 2022, the government launched the second round of public tenders for offshore wind development within territorial waters under the 'Promotion of Use of Marine Areas for Development of Marine Renewable Energy Generation Facilities Act'.

Four promotion zones are included in the Round 2 public tenders,

contributing more than 1.8 GW of new installation capacity. Bids were submitted by 30 June 2023 – it is unclear how many, due to revised guidelines preventing companies from disclosing their intention to participate. The winners will be announced as soon as December this year or March 2024 latest.

In view of concerns related to the bidding requirements and procedures for Round 1, the government introduced a number of revisions to the Round 2 tender process and guidelines. A revised 'Guideline for the Operation of Public Tenders for Occupancy of General Water' was released in October 2022, specifying that bidders should be evaluated on a scale of 240 points, with an equal allocation of 120 points for bid price and project feasibility.

Revisions include the introduction of a cap on the maximum project allocation volume for each company

### Projects auctioned in Japan Round 2 Tender

No	Sea Area (ha)	Output (MW)	Sea Area	PPA upper limit	Base Port
1	Happou-cho/Noshiro-city, Akita Pref.	3239.4	285 - 356 MW	19 JPY/kWh (14 euro/MWh)	Akita Port or Noshiro Port
2	Oga-city/Katagami-city/Akita-city, Akita Pref.	5515.3	269 - 336 MW	19 JPY/kWh (14 euro/MWh)	Akita Port or Noshiro Port
3	Murakami-city/Tainai-city, Niigata Pref.	9188.1	282 - 700 MW	19 JPY/kWh (14 euro/MWh)	Niigata Port
4	Enoshima Saikai-city, Nagasaki Pref.	3983.8	99 - 300 MW	29 JPY/kWh (21 euro/MWh)	Kitakyushu Port



## Markets to Watch

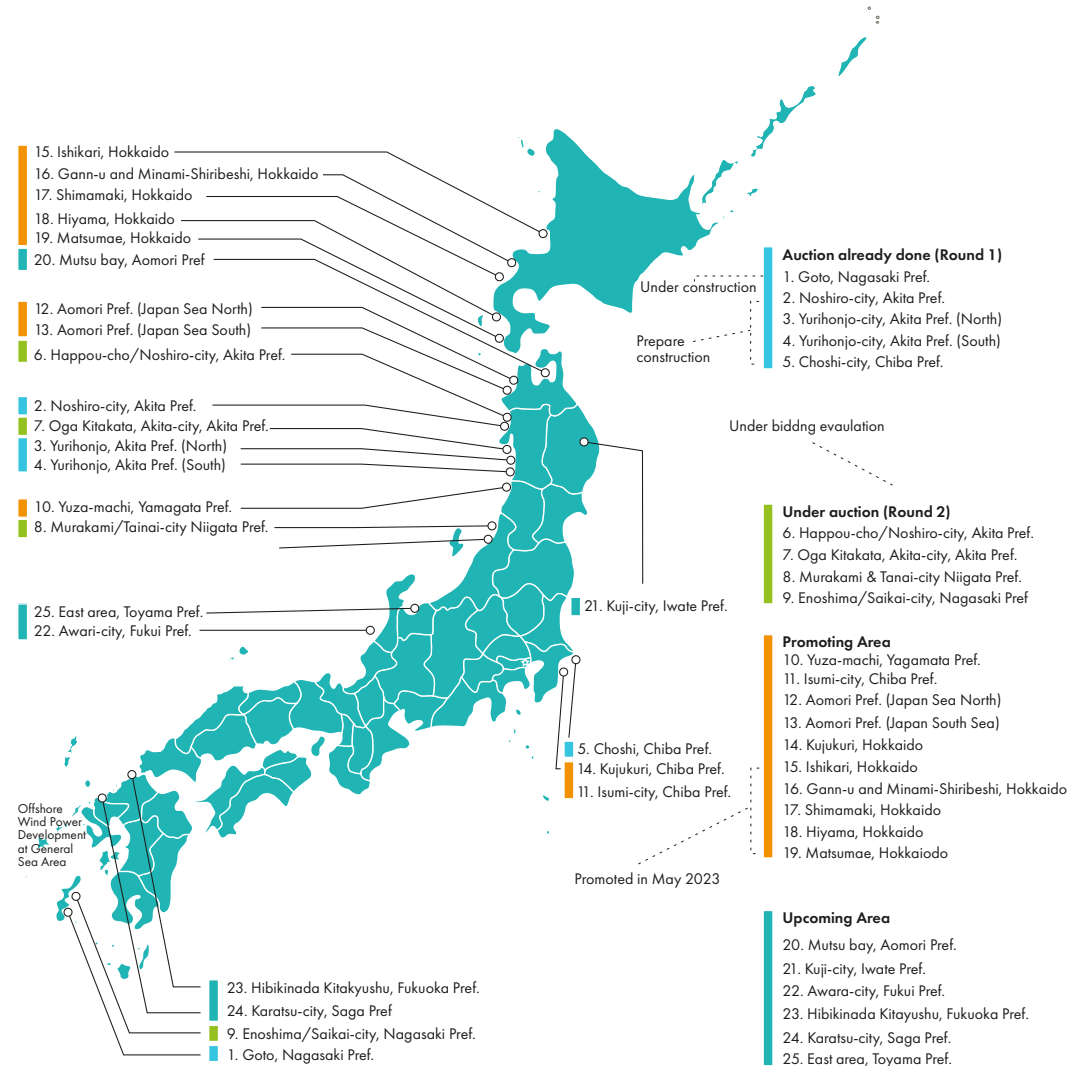
or consortium, the replacement of the feed-in tariff (FiT) with a new feed-in premium (FiP) and various evaluation methods for project feasibility.

The bidder with the highest overall score for feasibility in a particular promotion zone will now receive a full score of 120 to ensure a 1:1 weighting ratio on price and project feasibility. Furthermore, a speed factor has been introduced that rewards with a maximum of 20 points bids with the earliest reasonable Commercial Operation Date (COD) and imposes a penalty of 13,000 JPY/kW (\$90/kW) if the project is not delivered by the proposed date.

Although the government has attempted to address various concerns and challenges related to Round 1 and apply the lessons learned to Round 2, major challenges related to the current tender system remain. There is still a lack of transparency related to bid evaluation as it is unclear how project feasibility can be fairly evaluated and measured with a clear guiding principle.

The introduction of the FiP requires bidders to arrange their own power purchase agreements (PPAs) and many companies have

## Japan Offshore Wind Development Areas within the Territory Water



Source: JWPA, July 2023

experienced significant challenges arranging these deals at the current FiP price.

The outcome of the Round 2 tender will once again impact the timeline of the following tender round and send a signal to existing and potential developers about benefits and costs of continuing to participate in, entering or leaving Japan's offshore wind market.

The current tender process and rules are not perfect and future revisions to the existing rules will be needed to speed up site identification, streamline permitting and consenting processes and accelerate offshore wind development, to establish a visible

project pipeline that provides market confidence and attracts more foreign direct investment into Japan.

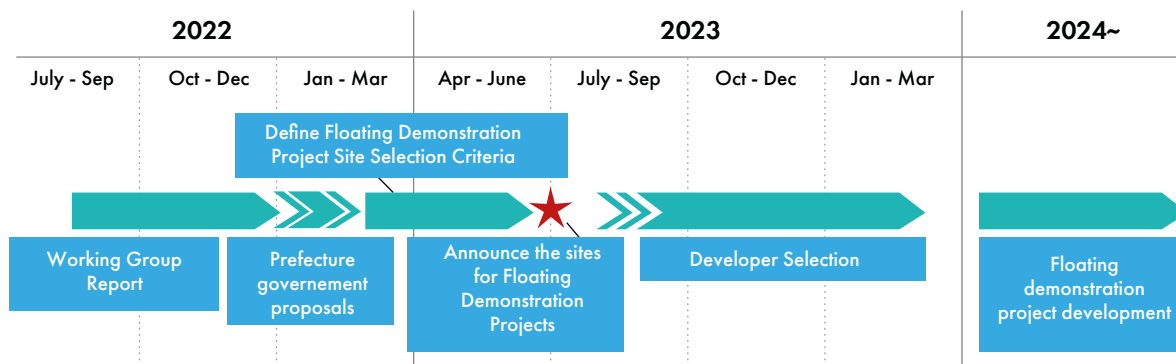
**Capturing offshore wind potential in the Exclusive Economic Zone (EEZ)**

Japan has 236 GW of floating offshore wind technical potential, compared with 156 GW for the fixed-bottom type. The majority of its floating wind potential lies beyond territorial waters and within the EEZ (12nm from shore). According to GWEC's members, EEZ areas entail are less prone to stakeholder conflicts, which will effectively streamline site allocation, consenting and permitting processes.<sup>31</sup>

In October 2022, the Cabinet Office formed a study group and held five meetings to discuss the possibility of developing offshore wind in the EEZ. There are currently no laws governing the use of EEZ waters but the 4th Basic Plan on Ocean Policy adopted via a Cabinet Decision on 28 April this year solidified the government's plan to actively deploy offshore wind in the EEZ. It stated that offshore wind power generation is the key renewable energy for Japan to achieve carbon neutrality and, on this basis, the government will develop laws and regulations to

31. Assessing the potential areas for developing offshore wind energy in Japanese territorial waters considering national zoning and possible social conflicts (Hideaki Obane, 2021) - <https://www.researchgate.net/publication/350705524>

**Floating Offshore Wind Demonstration Project Implementation Timeline**



Source: METI, 2022



facilitate the deployment of offshore wind power in the EEZ.<sup>32</sup>

### The race to become the leading floating offshore wind hub

While Europe is currently leading the way, floating offshore wind is rapidly emerging as a significant opportunity for APAC countries.<sup>33</sup> With only 187.8 MW of floating offshore wind installed globally and less than half in APAC, there is no clear floating offshore wind leader in sight for the region.

As the only East Asian country with 5 MW of floating offshore wind installed – at the Goto floating project in 2019 – Japan is in an ideal position to strengthen its footprint and lead the regional conversation on floating offshore wind.<sup>34</sup>

In the past few months, with various progress made by the government (METI), we are seeing great momentum surrounding floating offshore wind in Japan. The Basic Plan for the Green Transformation (GX) Policy – a ten-year decarbonisation roadmap – although largely centred on the reactivation of nuclear power, reflects the government's increasing commitment to expanding grid and infrastructure to facilitate the uptake of renewable energy including floating offshore wind.<sup>34</sup>

Notably, the government has set aside an JPY85 billion (\$58 million) subsidy to support two large-scale floating demonstration projects to be tendered by March 2024. The proposed demonstration sites will be released between July and September this year, and the Akita Prefectural government has proposed Yurihonjo offshore sea area as potential sites for consideration.<sup>36</sup>

A dedicated Floating Offshore Wind Industry Strategy Working Group<sup>37</sup> was formed in June 2023 by the Public-Private Dialogue Council with the goal of introducing a separate floating offshore wind target and developing an industrialisation plan to deliver the target by the end of this year.

GWEC and the Japan Wind Power Association (JWPA) are committed to working closely with government and industry to draw lessons from international best practices and apply them to the Japanese context. An ambitious floating target supported by a clear and robust development framework is the key to starting Japan's floating wind development on the right note and is fundamental to the long-term success of its offshore wind industrialisation strategy.

With a long development timeline of seven to eight years from project allocation to COD, the IEA expects that only 0.5 GW of new capacity is likely to be commissioned in Japan between 2022 and 2027, meaning that the 2030 offshore wind target is only achievable if the main bulk of the capacity can be delivered within three years between 2027 and 2030.<sup>38</sup> GWEC's analysis also shows that, for Japan to achieve its 2040 offshore wind targets, it will have to increase its annual tender allocation from an average of 1 GW to more than 4 GW from 2026.

Offshore wind resources within Japan's EEZ offer significant opportunities and are readily available for Japan to meet its target and achieve its 2050 decarbonisation goal. Japan must rapidly deploy offshore wind projects in parallel within territorial waters and EEZ waters.

32. Japan: Outline Of The Fourth Master Plan On Ocean Policy (Anderson Mori & Tomotsune, 2023)

33. Floating Offshore Wind - A Global Opportunity (GWEC, 2022)

34. [https://www.enecho.meti.go.jp/en/category/special/article/detail\\_178.html](https://www.enecho.meti.go.jp/en/category/special/article/detail_178.html)

35. [https://www.meti.go.jp/shingikai/enecho/denryoku\\_gas/saisei\\_kano/yojo\\_furyoku/pdf/015\\_s01\\_00.pdf](https://www.meti.go.jp/shingikai/enecho/denryoku_gas/saisei_kano/yojo_furyoku/pdf/015_s01_00.pdf)

36. <https://www3.nhk.or.jp/news/akita/20230620/6010017898.html>

37. <https://www.meti.go.jp/pre/ss/2023/06/20230623003/20230623003.html>

38. Renewables 2022 Analysis and forecast to 2027 (IEA, 2023)

## South Korea

South Korea has emerged as a promising player in the APAC offshore wind industry, boosting substantial potential for growth with a 2030 deployment target of 14.3 GW. The country's existing manufacturing competitiveness is also a positive sign for establishing a resilient offshore wind supply chain, as evidenced by significant investments from Vestas and CIP in 2023.

The country has a staggering floating offshore wind power potential capacity of 277 GW<sup>39</sup> and 6.7 GW of floating offshore wind projects in the permitting pipeline, making Korea's floating offshore wind pipeline one of the biggest in the world.<sup>40</sup>

### The key to realising South Korea's offshore wind potential

Despite these promising developments, South Korea's current installed capacity stands at a mere 124.5 MW. While the total offshore wind capacity of granted electric business licences (EBL) reached an impressive 20.8 GW as of December 2022, many projects faced bottlenecks and lengthy permitting processes due to a lack of policy support and regulatory clarity. To



A government-led approach would offer greater clarity and certainty to offshore wind manufacturers while ensuring robust development of the supply chain based on a visible project pipeline.

fully realise South Korea's offshore wind potential and accelerate deployment, crucial attention is required to address the following key issues:

#### 1. Expedite the introduction of a government-led site selection and tender system

To facilitate the expansion of South Korea's offshore wind market, the introduction of a government-led site

selection and auction is paramount. A government-led approach would offer greater clarity and certainty to offshore wind manufacturers while ensuring robust development of the supply chain based on a visible project pipeline.

Currently, offshore wind development in South Korea follows an open-door approach, which led to an inefficient permitting process that

reviews sites only after obtaining EBLs, hence generating a high level of uncertainty.

A new scheme is expected to introduce a 'dual-track' system for offshore wind development in

39. 2050 Climate Neutrality Roadmap for Korea - K-Map Scenario: Implementing an ambitious decarbonization pathway for the benefit of future generations and the Korean economy (Access: <https://gesi.kr/forum/view/202264>)

40. <https://www.powerinfotoday.com/wind-energy/south-korea-to-spend-40-billion-on-worlds-biggest-floating-wind-farm/>

## Markets to Watch



Korea. New projects would be subject to a government-led site selection and auction process while existing projects with EBLs would be given the option to continue development under the EBL track. However, the EBL track involves a more complex and cumbersome permitting process, as explained in the next section. An offshore wind bill to introduce such a dual-track system had been pending in the Korean National Assembly for more than two years as of July 2023.

### 2. Streamline the licensing process for existing Electricity Business License (EBL) track projects

As South Korea continues to deliberate on the introduction of the offshore wind bill, the challenge lies in supporting the 20.8 GW of EBL

**Table 2: Laws and permits relevant to the development of offshore wind in South Korea**

No.	Relevant law	Details of permits and consultations
1	National Land Planning and Utilisation Act	Decision on urban or Gun management plans, authorisation of development activities, designation of business entities performing urban or Gun planned projects, approval of implementation plans
2	Urban Development Act	Approval of actions within urban development zones
3	Road Act	Approval of performance of roadworks, approval of permission to occupy and use roads
4	Private Road Act	Approval of building permits for private roads
5	River Act	Approval of performance of river works, approval of permission to occupy and use rivers, approval of permission to use river water
6	Public Waters Management and Reclamation Act	Permission to use and occupy public waters, authorisation or report of implementation plans, reclamation licence of public waters, consultation or approval of reclamation by the government, etc., approval of implementation plan for reclamation of shared waters
7	Water Supply and Waterworks Installation Act	Approval of installation of exclusive waterworks, approval of installation of exclusive industrial waterworks
8	Natural Parks Act	Approval of actions within park areas
9	Farmland Act	Change and cancellation of agricultural promotion areas, approval and consultation of permission to divert farmland, report on diversion of farmland, permission to temporarily use farmland for other purposes
10	Mountainous Districts Management Act	Approval of conversion of mountainous districts, report on conversion of mountainous districts, permission and report to temporarily use mountainous districts, approval of gathering earth or stones
11	Creation and Management of Forest Resources Act	Approval and report of standing timber, etc.
12	State Forest Administration and Management Act	Approval of lease and use of state forests
13	Erosion Control Work Act	Approval of lumbering, etc., cancellation of designation as land for erosion control
14	Protection of Military Bases and Installations Act	Consultation on approval of administrative agencies, etc.
15	Grassland Act	Approval of change of form and quality of grassland, approval of the conversion of the use of grassland
16	Harbor Act	Approval of implementation of harbour development projects, approval of harbour development project implementation plan
17	Act on Funeral Services	Approval of reburial
18	Mining Industry Act	Disposition of non-permission, cancellation of mining rights, or reduction of mining areas
19	Countermeasures Against Natural Disasters Act	Consultation on disaster impact assessment, etc.
20	Electric Utility Act	Approval of electric utility business
21	Natural Environment Conservation Act	Consultation on the impact on natural scenery
22	Act on Protection and Inspection of Buried Cultural Heritage	Consultation on the results of ground surface inspection for cultural heritage
23	Cultural Heritage Protection Act	Permission of acts on state-designated cultural heritage
24	Agricultural and Fishing Villages Improvement Act	Permission to use agricultural infrastructure
25	Maritime Safety Act	Maritime traffic safety examination
26	Act on the Maintenance and Improvement of Road Networks in Agricultural and Fishing Villages	Permission to use and occupy roads
27	Landscape Act	Deliberation on landscapes of development projects, deliberation on landscapes of buildings
28	Wetlands Conservation Act	Permission of acts within wetland protection areas
29	Aids to Navigation Act	Approval of establishment and management of aids to navigation, establishment and management of aids to navigation marking construction zones, report of establishment and management of wreck markings

Source: SFOC Up in the Air report, 2023



projects already in the pipeline to meet the 2030 target of 14.1 GW (56 projects) of fixed-bottom and 6.7 GW (13 projects) of floating.

The permitting process for EBL projects involves obtaining a maximum of 29 licences from ten different ministries (see Table 2), resulting in lengthy and costly procedures. This complex process makes it harder to secure financing, generating uncertainty for project developers. To overcome these challenges, institutional support is crucial to streamline the licensing process.

The government can achieve this by focusing on capacity-building and awareness-raising initiatives for offshore wind development. Building capacity for permitting organisations at all levels, from central to municipal, will allow efficient review and rejection of unsuitable projects while fast-tracking viable projects in appropriate locations for rapid deployment.

### 3. Review and assess socio-economic effects and stakeholder engagement

Opposition by fishermen poses a primary challenge to expanding offshore wind in South Korea, given the country's high fish consumption

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## Effective communication and engagement by the wind industry with municipal authorities, the fishing community and the general population are essential

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and large fishing fleet. Currently, fishermen's opposition prolongs the permitting process, leading to project delays. In 2020, all projects failing to gain approval from the EBL review committee were primarily due to insufficient acceptance levels. To overcome these challenges, it is essential to establish effective communication protocols and actively engage with fishermen throughout the development process, to prevent conflicts and build trust.

Additionally, providing a comprehensive assessment of offshore wind's socio-economic impact can promote better understanding and social sustainability. The socio-economic benefits of the offshore wind industry to coastal regions and local communities are not fully perceived and understood by municipal governments in Korea, which have a crucial say on a few licences in the existing EBL track.

Effective communication and engagement by the wind industry with municipal authorities, the fishing community and the general population are essential to bridge the gaps of understanding and ensure strong support from all.

### Build on momentum and develop readiness

Despite the challenges, South Korea possesses immense offshore wind potential with a high degree of offshore wind market readiness that attracts overseas investors due to significant capacity potential and favourable geographical advantages. To fully unlock this potential, South Korea must address the three key challenges through effective policy support, actively develop its port and infrastructure and build a robust supply chain. By doing so, the country can achieve its offshore wind goals and play a vital role in the global transition toward sustainable energy sources.



# Vietnam

Following a successful year for the wind industry in 2021, when Vietnam had almost 4 GW of onshore and intertidal wind projects (779 MW intertidal) with CODs in time for the FiT deadline, the government of Vietnam did not release any follow-up policy for the wind industry in 2022. This resulted in no wind projects being grid connected in 2022, even though nearly 4GW of onshore wind projects already had PPAs but missed the FiT deadline.

Many of these projects, which are called transitional projects by the government, are in construction or have already finished installation.

## Power Development Plan VIII (PDP8)

The Vietnamese government finally approved its PDP8 in May 2023. The target for onshore wind is 21.8 GW by 2030, which is very ambitious yet achievable. Around 4 GW of these projects are already built, and another 4GW of 'transitional projects' are in the process of PPA negotiation with EVN. The government will need

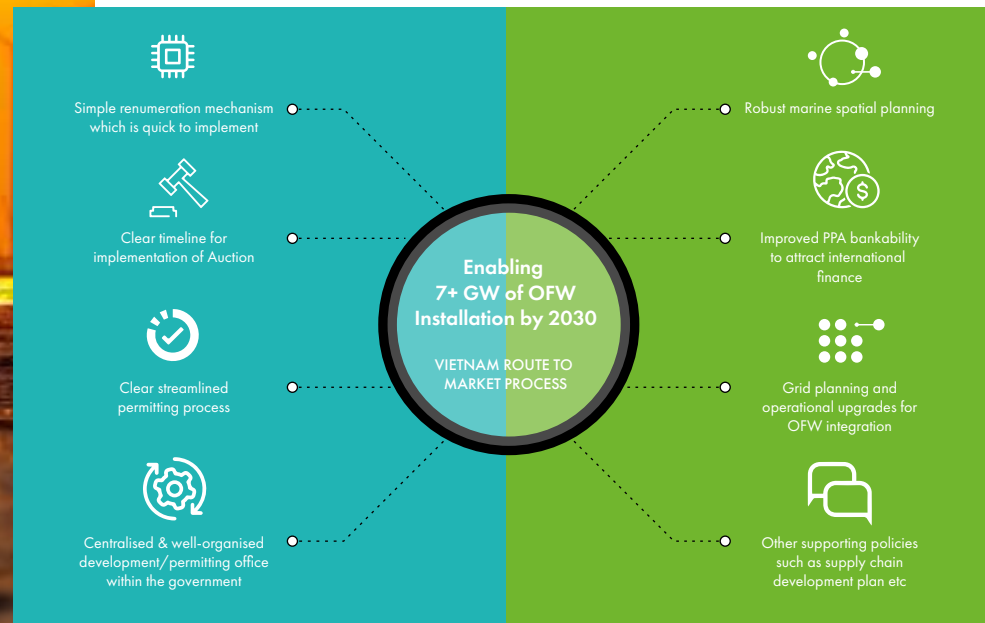
to issue a new regulatory framework for the developers to build the remaining 13.8 GW. These new projects will be put through a competitive auction process for price discovery.

The target for offshore wind is 6 GW by 2030, with a rapid increase to 91 GW by 2050. Out of the 6 GW, 3 GW are to be developed in the north and 3 GW in the south. These regional targets could potentially create different regional policies since the wind resources in the north are not as good as the resources in the South. The PDP8 also mentions Vietnam's intention to build offshore wind projects for export. These projects will not be a part of the 6 GW target until 2030. Singapore is the most likely potential buyer of the electricity from these projects.

The ambitious target for offshore wind set in the PDP8 reflects Vietnam's commitment to achieve net zero by 2050, under a pledge made by the country's prime minister at COP26. The next step for the country is to have an implementation plan and a detailed regulatory framework to turn these targets into real projects.

## The way forward

Vietnam lacks a holistic regulatory



framework for offshore wind. Projects typically require 6–8 years from project development to construction after all of the permitting hurdles have been cleared. In order to have the first batch of projects connected by 2030, the discussion on policy and regulatory frameworks has to begin today. The key components that are needed are:

- A simple remuneration mechanism that is quick to implement
- A clear timeline for auction implementation
- A clear streamlined permitting process
- A robust marine spatial planning regime
- Improved PPA bankability to attract international finance
- Grid planning and operational upgrades for offshore wind integration
- Other supporting policies such as a supply chain development plan

Developing legal frameworks to solve these issues will take time. Potentially, new laws are needed, which will take at least two or three years to implement. This could result in Vietnam missing its 2030 target. Therefore, some form of fast-track mechanisms should be applied for the first projects to kickstart the necessary development work as soon as possible.

The government has signalled its intention to launch a pilot scheme to allow developers to start projects sooner, but it is unclear how it will be done. Overall, the industry is supportive of a fast-track pilot scheme.

Vietnam and the International Partners Group (IPG) have signed a Just Energy Transition Partnership (JETP) to commit \$15.5 billion to support Vietnam's energy transition. Offshore wind is one of the key focus areas of this programme. A JETP secretariat established in July 2023 and led by the Ministry of Natural Resources and the Environment (MONRE) gathers members from multiple ministries and government departments. A resource mobilisation plan is expected in 2023. International communities are supporting Vietnam in this process, with organisations like the Vietnam Energy Partnership Group (of which GWEC is a member) working with the government to form policies that can attract investment into offshore wind.

Grid infrastructure is a critical challenge in a market where the significant upgrades are required for the current grid to accommodate new offshore wind projects. According to the PDP8, Vietnam



needs approximately \$3 billion of investment into the grid annually until 2030.

In addition, capacity building is needed for the government to better manage a grid with high penetration of renewable energy. The government is reluctant to build long transmission lines and instead encourages building energy projects closer to demand centres, which could lead to higher electricity prices since renewable energy resources are normally in remote areas.

Globally and in the region, the offshore wind supply chain is highly

constrained as the result of increasing demand and high prices for key components. With an established oil and gas industry that can quickly be transitioned to offshore wind, Vietnam is in a position to attract investment and enjoy first-mover advantage to gain priority access to the supply chain, lower prices and eventually become a supply chain hub for offshore wind in the region, if it can deploy supporting policy in time to keep up the momentum. Failure to do this will turn investors and suppliers away from the market and could lead to more expensive prices, and even power shortages, in the future.



# India

Globally, India ranks third in total energy consumption and fourth in wind and renewable energy installed capacity.<sup>41</sup> The country had installed 43.2 GW onshore wind and no offshore wind capacity as of May 2023.<sup>42</sup> India's share of global primary energy consumption is likely to increase to about 9.8% by 2050 under stated policies from the current share of 6.1%.<sup>43</sup> To meet growing demand, India has committed at COP26 to install 30 GW offshore wind and a total 500 GW of non-fossil fuel power by 2030.

## First 5 GW seabed leasing tender

Offshore wind could be a pivotal source for India's round-the-clock (RTC) clean power requirements and socioeconomic growth. As the share of clean energy in the grid increases, grid balancing and resilience become even more important. Offshore wind is perceived to be available for more months than onshore wind at many sites and hence it is often considered a commercially attractive option for

RTC power. India's central government and the state governments of Gujarat and Tamil Nadu are keen to harness the offshore wind potential.

In April 2023, the Ministry of New and Renewable Energy (MNRE) and National Institute of Wind Energy (NIWE) shared a revised strategy paper and draft Request for Selection (RfS) tender documents with stakeholders:

A revised strategy paper for the 'Establishment of Offshore Wind

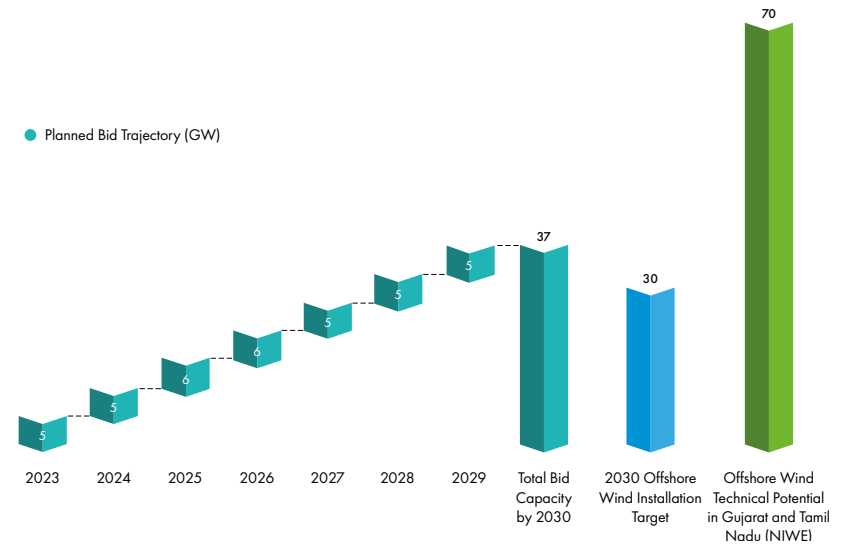
Energy Projects' provides an auction trajectory for 2023–2030 (see Figure below). It identifies offshore wind zones totalling 37 GW in capacity along the Tamil Nadu and Gujarat coasts to be auctioned through four proposed models:

**Model 1:** 1 GW for Zone B3 in Gujarat

**Model 2:** 2 GW with viability gap funding (VGF) for offshore wind sites identified by NIWE for which detailed studies/surveys have not been conducted

**Model 3:** 12 GW for sites identified and notified by NIWE and without VGF

Revised Offshore wind planned bid trajectory vs installation target vs earmarked potential, June 2023



41. <https://pib.gov.in/PressReleasePage.aspx?PRID=1885147>  
 42. [https://cea.nic.in/wp-content/uploads/installed/2023/05/IC\\_May\\_2023.pdf](https://cea.nic.in/wp-content/uploads/installed/2023/05/IC_May_2023.pdf)  
 43. <https://pib.gov.in/PressReleasePage.aspx?PRID=1809204>

**Model 4:** 22 GW for any offshore wind sites within the Exclusive Economic Zone excluding the sites considered under Models 1, 2 and 3.

A draft RfS tender document for the 'allocation of seabed lease rights for offshore wind power projects' for zone B off the Tamil Nadu coast, published in November 2022 and revised in April 2023. GWEC

made on various aspects ahead of the final tender release is remarkable.

- **Policy incentives:** A 25-year waiver on inter-state transmission system (ISTS) charges would be granted for offshore wind projects commissioned before the end of 2032, with graded transmission charges applicable thereafter for

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Following consultation with industry, state governments and other key stakeholders on the revised draft RfS, the final RfS tender is expected later this year.

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presented industry feedback on grid evacuation infrastructure, inclusion of de-risking measures and incentives.

Following consultation with industry, state governments and other key stakeholders on the revised draft RfS, the final RfS tender is expected later this year. Although the revised strategy paper calls for auctions awarding 37 GW of capacity by 2030, it is not yet clear how much of the capacity allocated through bids would be installed by that date and against the target of 30 GW by the end of this decade. The progress

projects commissioned between 2033 and 2037.<sup>44</sup> No additional surcharge would be paid for offshore wind projects commissioned by December 2032 and supplying generated power to Open Access Consumers.

- **Maritime spatial planning and port studies** for the states of Gujarat and Tamil Nadu were published in November 2022, under the Centre of Excellence for Offshore Wind and Renewable

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<sup>44</sup> Ministry of Power notification





Energy, jointly set up by the Danish Energy Agency and the MNRE. It showed the favourable offshore wind zones which can be prioritised for the bidding. Rapid EIA studies for ports in Tamil Nadu are being discussed.

- **Logistics:** Under its 'Shipbuilding Financial Assistance Policy', the government will offer subsidies to build specialised offshore wind vessels in India. The Ministry of Ports, Shipping and Waterways has included in the list of 'specialised vessels' wind turbine installation vessels (WTIVs); self-propelled semi-submersible heavy lift and heavy transport vessels; windfarm service and maintenance vessels and cable laying vessels.

- **VGF:** In December 2022, the central government notified that a concept note for the VGF scheme of Rs 14,283 crore (\$1.74 billion) for the initial 3 GW of offshore wind energy projects be sent for 'in-principle' approval to the Department of Expenditure, Ministry of Finance. Further, the states of Gujarat and Tamil Nadu have agreed to offtake the first few GWs of offshore wind capacity at a tariff of INR 4/unit.

- **Supply chain:** It is likely that for the first few GWs of projects, offshore wind turbine generators will have to be imported. Given the scale of the auction pipeline up to 2030, there is an urgent need to create a domestic supply chain in order to gradually reduce LCOE. A study

funded by UKRI India and launched in March 2023 will assess the capability of India's offshore wind supply chain. In July 2023, GWEC commissioned work to explore potential opportunities in offshore wind manufacturing in Tamil Nadu.

- **Power evacuation:** There is a plan in place for laying a 10 GW (5 GW each in Gujarat and Tamil Nadu) ISTS grid infrastructure for offshore wind power evacuation by December 2030.<sup>45</sup>

- **Coordination between central and state authorities:** Regular dialogue between authorities and agencies at central and state level is to be facilitated and coordinated by the MNRE to accelerate progress on offshore wind. This is also vital for timely permits, clearances and positive engagement with the fishing community.

### De-risk the process to accelerate offshore wind deployment

While the progressive steps described above set a firm foundation to start the bidding process, it is important to adopt measures that de-risk the entire process in order to achieve offshore wind targets. In March 2023, a white paper titled 'An ocean of potential: Recommendations for offshore wind

development in India', published by GWEC India and the UK government, emphasised Contracts for Difference as a useful instrument to mitigate investor risk. The white paper outlined best practices and advocated seizing offshore wind-led opportunities in India.<sup>46</sup>

In May 2023, as part of the third meeting of the G20 Energy Transition Working Group, the MNRE, with support from GWEC and NIWE, convened a side event on how to harness offshore wind to accelerate the energy transition. Financing and Capacity Building for offshore wind was deliberated.<sup>47</sup>

For a successful venture into offshore wind, investment planning for port readiness and an upgrade of grid infrastructure are essential for driving the interest of offshore wind stakeholders in the Indian market, alongside effective implementation of a single-window clearance system for projects, offshore wind tailored standards and guidelines, attractive financial incentives and support for power offtake.

45. [https://cea.nic.in/wp-content/uploads/notification/2022/12/CEA\\_Tx\\_Plan\\_for\\_500GW\\_Non\\_fossil\\_capacity\\_by\\_2030.pdf](https://cea.nic.in/wp-content/uploads/notification/2022/12/CEA_Tx_Plan_for_500GW_Non_fossil_capacity_by_2030.pdf)

46. <https://gwec.net/an-ocean-of-potential-white-paper-download/>

47. G20 side event - Harnessing Offshore Wind for Accelerating Energy Transition - Global Wind Energy Council

## North America

Last year saw significant strides in North American offshore wind with advancements and incentives introduced at federal and state level in the US, along with Canada announcing its first offshore wind target and auction.

Autumn 2022 saw the Canadian Province of Nova Scotia set a target to auction off 5 GW of offshore wind energy by 2030. This is the first move towards planned offshore wind development in a country that

wind. A leap in governmental support and investment, along with ambitious plans for nationwide leases, means the industry is getting ready to unleash its true potential. However, to reach its promise of 30 GW by 2030 and lead the energy transition, the offshore community must gather to overcome the cost crisis, political instability, transmission and permitting limitations to deploy projects at scale.

The US Inflation Reduction Act (IRA), which came into effect in August 2022, is aimed at alleviating some of these concerns by supercharging domestic energy investment and production,

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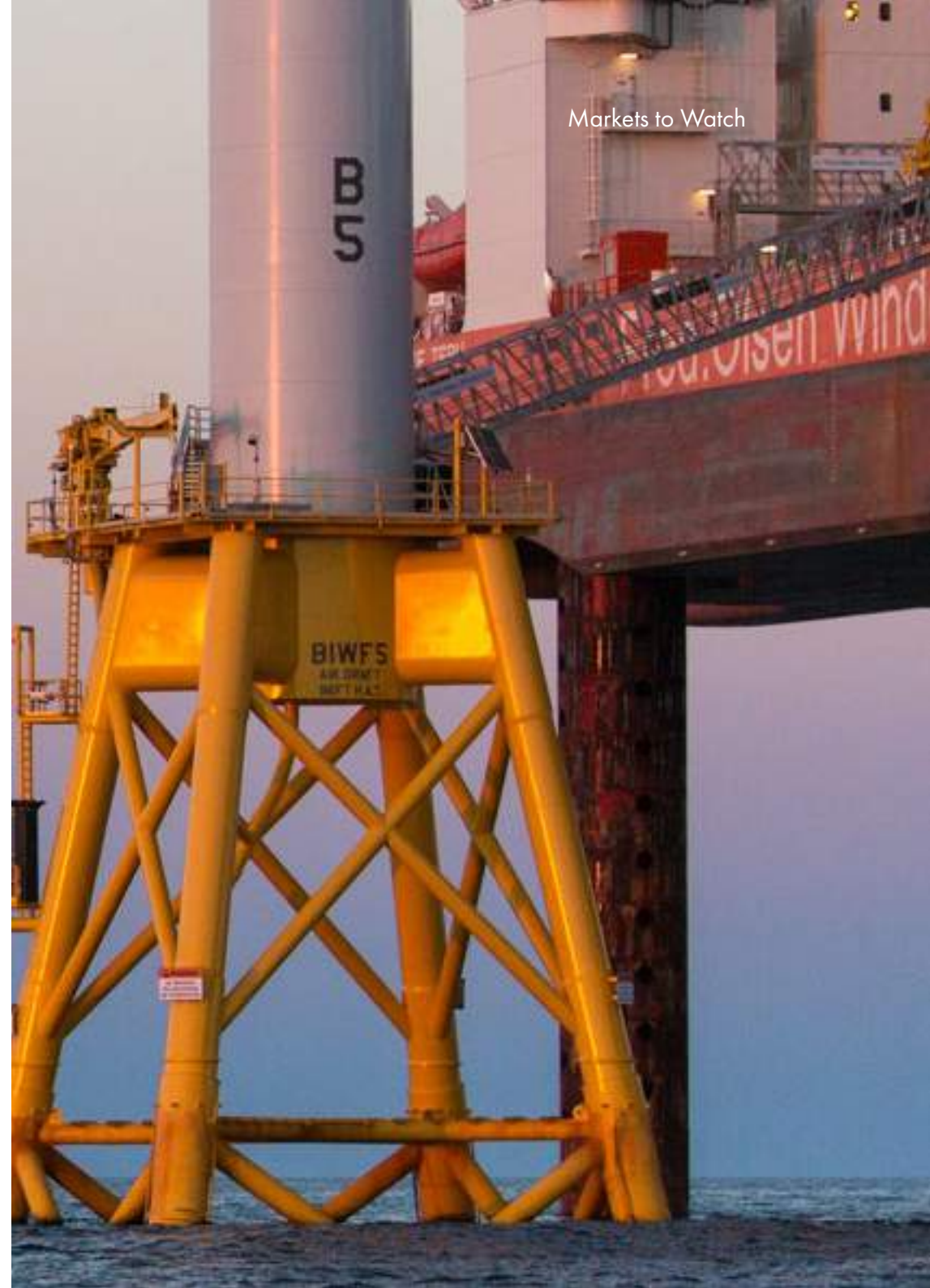
**However, to reach its promise of 30 GW by 2030 and lead the energy transition, the offshore community must gather to overcome the cost crisis, political instability, transmission and permitting limitations to deploy projects at scale.**

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has seen significant activity in the marine energy sector (tidal and wave energy) over the past several years, as well as an offshore wind moratorium that led to legal actions from affected developers.

At the same time, the US is on the verge of rapid expansion for offshore

and ultimately changing the path for clean energy in the US. Alongside the Department of Interior's (DOI) \$300 million investment, the act marked a leap in political support for offshore wind and a turning point for the United States's journey to meeting the Biden administration's goal of 30 GW by 2030.





## USA

Whilst only 42 MW of installed wind capacity in operation, the US boosts one of the most ambitious project pipelines at over 50 GW with 32 leases in active development. Most of this capacity is in early development but more than 15 GW is in advanced development.

New York State has the largest capacity – almost 4 GW – in the pipeline. The 132 MW South Fork project is currently under construction. The Bureau of Ocean Energy Management (BOEM) convened two large lease auctions in 2022, one on the East Coast and the first on the West Coast generating nearly \$5.4 billion in federal revenue from winning bids.

In the New York Bight, BOEM's auction of six leases lasted three days, drawing winning bids totalling nearly \$4.4 billion. Further south, an auction for two leases in Carolina Long Bay generated \$315 million. Finally, a much-anticipated sale of five leases off the coast of central and northern California drew winning bids totalling \$757 million.

Sale prices ranged from a low of

\$6,147/acre to as much as \$9,933/acre, averaging \$8,313/acre across six leases. High lease prices in the New York Bight can be explained by increased demand for offshore wind from two nearby states, New York and New Jersey, and well-defined offshore wind goals and procurement schedules. The lease auctions in Carolina Long Bay and California saw lower prices: \$2,657/acre on average in the former and just \$1,910/acre off California. In 2018, the auction of three leases off the coasts of Massachusetts and Rhode Island yielded lease prices ranging from \$1,021/acre to \$1,060/acre.

### Federal initiatives - Inflation Reduction Act

The US took a significant step forward in supporting the energy transition with the passage of the IRA last year. This comprehensive legislation aims to make clean energy more affordable and attractive, it also includes a range of measures to achieve this goal. The package provides tax incentives, grants and loans that prioritise US manufacturing and clean job creation.

One of the major highlights of the IRA is its impact on the US offshore wind industry. Recognising the need

for a robust domestic supply chain, the bill allocates \$386 billion in funding to reduce greenhouse gas emissions and invest in clean energy. This investment is crucial, as the US currently lacks the necessary infrastructure to meet its federal offshore wind target of 30 GW by 2030. Additionally, the global supply chain for offshore wind components and construction is expected to face constraints.

To address these challenges, the IRA includes several tax credits specifically aimed at offshore wind manufacturing and infrastructure. These credits promote the development of offshore wind facilities within the US. They encompass \$100 million for offshore wind transmission planning, a new advanced manufacturing tax credit for offshore wind components, and an extension of the investment tax credit for vessel construction and offshore wind manufacturing facilities that produce essential components like blades, nacelles, towers and foundations.

In addition to supporting domestic manufacturing, the IRA opens up new areas for offshore wind development in the country. It lifts the previous ban on offshore wind projects in the Southern Atlantic and



Eastern Gulf of Mexico, allowing for their development. Furthermore, the bill enables the development of offshore wind off US territories.

The IRA not only focuses on financial incentives and expanding development areas but also aims to streamline the planning, permitting and execution of offshore wind projects. It provides increased funding for staffing at the BOEM and the National Oceanic and Atmospheric Administration (NOAA). Furthermore, the bill includes an agreement to pass comprehensive permitting reform legislation, which will expedite the approval process for major offshore wind projects. Additionally, it stipulates that an offshore wind lease can only be finalised if an offshore oil and gas leasing sale has occurred in the previous year.

Overall, the IRA plays a vital role in establishing the necessary foundations for the realisation of offshore wind energy in the US. By supporting domestic manufacturing, expanding development areas and streamlining project execution, this landmark legislation demonstrates the country's commitment to clean energy and sets the stage for significant progress in the offshore wind sector.



### Planning and permitting reform

As we have seen across markets looking to ramp up offshore wind deployment, slow permitting still remains a huge challenge in the US, for renewable projects and also for grid infrastructure.

Attempts by Senator Joe Manchin to change the way big infrastructure projects that involve federal funds are approved by enacting permitting reform legislation alongside the IRA was rejected. It was a personal loss for Manchin but a potentially bigger one for a key Democratic priority: building out a clean energy infrastructure, and fast. Whilst the outlook for doing so is now bleaker,

## The IRA plays a vital role in establishing the necessary foundations for the realisation of offshore wind energy in the US

there remain hopes of cross-party consensus on some sort of permitting reform at a federal level, although it would likely benefit approvals for gas infrastructure as well as any clean energy projects.

The defeat of federal permitting reform takes place in the shadow of the passage of the IRA, perhaps Congress's signature achievement.

But as it stands, the IRA will be hard-pressed to accomplish its stated goals, primarily due to the 50-year-old law National Environmental Policy Act (NEPA). NEPA mandates that all federal agencies consider environmental factors in their decision-making and involve the communities where projects are taking place. The act covers not only public infrastructure but extends to

## Markets to Watch

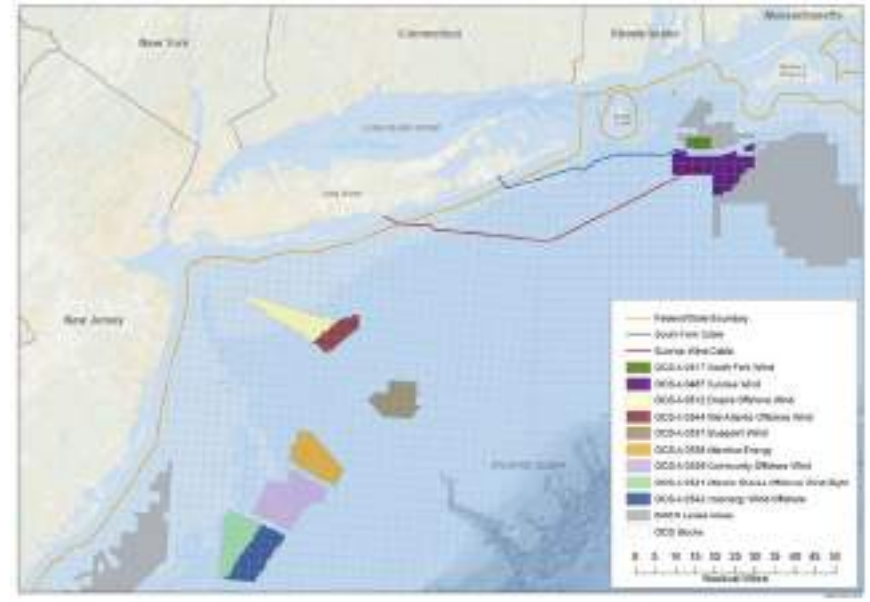
any project that requires a permit from the federal government or receives federal funding.

Despite the valuable role played by NEPA over the years, there is now a conflict between its objectives and the need to develop clean energy infrastructure. Given the urgency of the climate crisis, a diverse coalition spanning the political spectrum is raising concerns about the necessity of reforming the law.

For offshore wind, the DOI and BOEM have announced reforms to streamline processes that developers will have to navigate. However, considering that offshore development in the US is still in its early stages, only time will reveal the effectiveness of the overall process involving BOEM and state-level authorities.

### Grid access and Investment

In the US, the responsibility for network investment lies primarily at the state level. However, there are federal mechanisms in place to support national infrastructure needs. For instance, the IRA includes funding provisions to assist with transmission projects – \$2 billion in loan funds, covering up to 80% of the construction costs for transmission lines, and \$760 million in grants to



To fully leverage the benefits of the IRA, it has been estimated that there needs to be a doubling in electricity transmission infrastructure across the country

facilitate the siting of transmission lines or promote economic development in communities where such lines are planned.

Despite past instances of increased federal funding, it is important to note that grid issues, often stemming from coordination and planning challenges between Regional Transmission Organizations (RTOs)

and Independent System Operators (ISOs), have not been fully resolved. To fully leverage the benefits of the IRA, it has been estimated that there needs to be a doubling in electricity transmission infrastructure across the country. However, in the last decade, more projects have been cancelled than completed, highlighting the complexities involved in the process.

### BOEM leases

In October 2021, the Secretary of the Department of the Interior, Deb Haaland, announced BOEM's offshore wind leasing 'Path Forward 2021–2025', which paved the way for the offshore wind lease auction held in the NY Bight in February 2022. Following that, the agency held an auction in the Carolina Long Bay region in May 2022 and finished the year with a lease auction for two areas off California in December 2022.

### State Activity New York Bight

BOEM conducted an offshore wind lease sale on 23 February 2022, as part of its Path Forward initiative. This lease sale focused on six areas situated in the New York Bight, which refers to the oceanic area between New York and New Jersey. The auction took place over three days and 64 rounds, concluding on 25 February 2022. Remarkably, the auction attracted considerable attention, resulting in winning bids from six companies that amounted to approximately \$4.37 billion. This lease auction not only set a new record for offshore wind but also underscored the promising opportunities available to developers in the region. Both New York and New Jersey have set ambitious

offshore wind goals and have established detailed procurement schedules to drive the industry's growth. (Note for Designer: Image taken from: [https://www.boem.gov/sites/default/files/images/NY\\_and\\_sunrise.png](https://www.boem.gov/sites/default/files/images/NY_and_sunrise.png))

**Bluepoint Wind - OCS-A 0537, a 71,522-acre lease, was awarded to OW Ocean Winds East, LLC**, a partnership between Ocean Winds (itself a joint venture of EDP Renewables and ENGIE) and Global Infrastructure Partners, for the winning bid of \$765 million. The project is now known as Bluepoint Wind.

**Attentive Energy - OCS-A 0538, an 84,332-acre lease, was awarded to Attentive Energy LLC** for the winning bid of \$795 million. Attentive Energy LLC was jointly owned by TotalEnergies and EnBW. Days later, EnBW announced its decision to exit the US offshore wind market. The company's US assets were acquired by TotalEnergies in March 2022.

**Community Offshore Wind - OCS-A 0539, the largest lease in the auction at 125,964 acres, was awarded to Bight Wind Holdings, LLC** for the winning bid of \$1.1 billion. Bight Wind Holdings, LLC is a joint venture between RWE and

National Grid. The project is now known as Community Offshore Wind. As such, the name Bight Wind Holdings, LLC was changed to Community Offshore Wind, LLC after lease issuance.

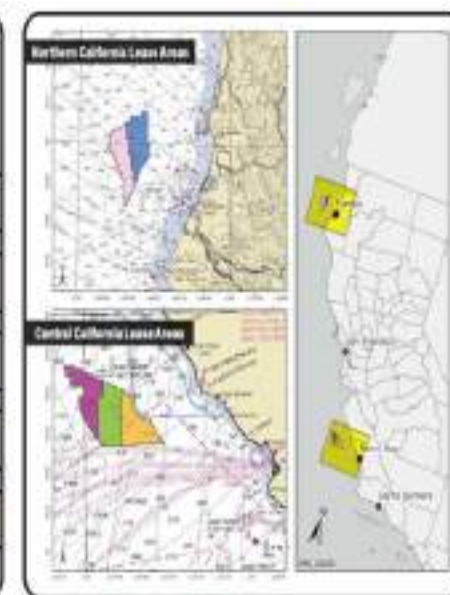
**Atlantic Shores Offshore Wind Bight - OCS-A 0541, a 79,351-acre lease, was awarded to Atlantic Shores Offshore Wind Bight, LLC** a subsidiary of Atlantic Shores Offshore Wind (itself a joint venture between Shell and EDF) for the winning bid of \$780 million.

**Invenergy Wind Offshore - OCS-A**

**0542, an 83,976-acre lease, was awarded to Invenergy Wind Offshore, LLC for the winning bid of \$645 million.** Invenergy Wind Offshore, LLC is sponsored by Invenergy and EnergyRE. Blackstone Infrastructure Partners, CDPQ, FirstLight Power, and Ullico Infrastructure Fund will also provide funding for the project. The project is now known as Leading Light Wind.

**Mid-Atlantic Offshore Wind - OCS-A 0544, the smallest lease at just 43,056 acres, was awarded to Mid-Atlantic Offshore Wind LLC**, for the bid of \$285 million. The name

Winners of the California Lease Areas, \$757,100,000 in High Bids		
OCS-P0561	RWE Offshore Wind Holdings, LLC	\$157,700,000
OCS-P0562	California North Floating LLC	\$173,400,000
OCS-P0563	Equinar Wind US LLC	\$130,000,000
OCS-P0564	Golden State Wind, LLC	\$150,300,000
OCS-P0565	Invenergy California Offshore LLC	\$145,300,000



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## BOEM intends to conduct lease auctions in the Gulf of Mexico (2023), Central Atlantic (2023), Oregon (2023) and the Gulf of Maine (2024) as part of the Path Forward initiative.

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Mid-Atlantic Offshore Wind LLC was changed to Vineyard Mid-Atlantic LLC after lease issuance. Vineyard Mid-Atlantic LLC is owned by Copenhagen Infrastructure Partners.

### Carolina Long Bay lease sale

In its second lease sale of the year, BOEM held an offshore wind auction for two lease areas in the Carolina Long Bay on 11 May 2022. The 18-round auction lasted one day and resulted in winning bids totalling \$315 million. Combined, the leases total 110,091 acres.

**Lease OCS-A 0545**, in the western part of the Carolina Long Bay lease area, was awarded to TotalEnergies Renewables USA, LLC for the final bid of \$160 million. TotalEnergies Renewables USA, LLC is wholly owned by TotalEnergies. This lease represents a total of 54,937 acres.

**Lease OCS-A 0546**, to the east, was awarded to Duke Energy Renewables Wind, LLC for a final bid of \$155 million. Duke Energy

Renewables Wind LLC is wholly owned by Duke Energy. This lease represents a total of 55,154 acres.

### California lease sale

In its third and final lease sale of the year, BOEM held an offshore wind auction for five lease areas off California on 6 December 2022. The auction included two leases off the coast of northern California, near Humboldt Bay, and three leases off the Central Coast, near Morro Bay. The auction lasted two days and resulted in winning bids totalling \$757 million. The leases total 373,268 acres. Deep waters in these lease areas necessitate the use of floating offshore wind technology.

**OCS-P 0561, a 63,338-acre lease off Humboldt, was awarded to RWE Offshore Wind Holding, LLC** for a final bid of \$157.7 million. RWE Offshore Wind Holding, LLC is wholly owned by RWE.

**OCS-P 0562, a 69,031-acre lease**

**also off Humboldt, was awarded to California North Floating LLC** for a final bid of \$173.8 million. California North Floating LLC is wholly owned by Copenhagen Infrastructure Partners.

**OCS-P 0563, an 80,062-acre lease off Morro Bay was awarded to Equinor Wind US LLC** for a final bid of \$130 million. Equinor Wind US LLC is wholly owned by Equinor.

**OCS-P 0564, an 80,418-acre lease off Morro Bay was awarded to Central California Offshore Wind LLC** for a final bid of \$150.3 million. Central California Offshore Wind LLC is owned by a joint venture of Ocean Winds (itself a joint venture between EDP Renewables and ENGIE) and the Canadian Pension Plan Investment Board.

**OCS-P 0565, an 80,418-acre lease off Morro Bay was awarded to Invenergy California Offshore LLC** for a final bid of \$145.3 million. Invenergy California Offshore LLC is wholly owned by Invenergy.

BOEM intends to conduct lease auctions in the Gulf of Mexico (2023), Central Atlantic (2023), Oregon (2023) and the Gulf of Maine (2024) as part of the Path Forward initiative. However, these dates could change due to possible delays.

# Canada

Canada has a massive offshore wind technical potential of around 9.3 TW.<sup>48</sup> Canada's power grid benefits from significant amounts of clean electricity – primarily hydropower – while oil and natural gas energy sources dominate the total energy supply mix.

In the medium to long term, harnessing the huge wealth of offshore wind energy offers significant opportunities for the country to not only achieve its own target of net zero electricity grid by 2035 and a net zero emissions economy by 2050 but can also support neighbouring countries in their clean energy goals through electricity exports. As per an NREL 2021 study, Canada would need 150 GW of wind power capacity for net zero, against a current total of 15.26 GW installed onshore wind and zero offshore.<sup>49</sup>

## Clean electricity export and hydrogen hub

Offshore wind projects could potentially stretch along Canada's Atlantic and Pacific Coasts as well as the Great Lakes, since Canada has the longest coastline in the world.<sup>50</sup> Most sites are suitable for floating

offshore wind, with the province of Nova Scotia enjoying the world's most competitive offshore wind resource of 10.3 m/s at 100m water depth. Other potential areas are Newfoundland and Labrador, New Brunswick, the Gulf of Saint Lawrence, and offshore British Columbia in western Canada.

Nova Scotia has made strides to kickstart offshore wind and a green hydrogen industry. In 2022, it announced it would offer 5 GW of

roadmap will address supply chain development and version 3 will address the concerns of indigenous communities, the fishing industry and other interested parties are expected in 2024 and 2025, respectively.

As well as having a wealth of experience in the oil and gas industry, Nova Scotia has offshore wind resources that are ideal for floating and fixed wind. It also enjoys international shipping infrastructure across its coastline with an

## Offshore wind projects could potentially stretch along Canada's Atlantic and Pacific Coasts as well as the Great Lakes, since Canada has the longest coastline in the world

offshore wind seabed leases through a competitive bidding process between 2025 and 2030 to support green hydrogen production. Offshore wind bids will be based on market opportunities after 2030.

The draft Nova Scotia offshore wind roadmap module 1<sup>52</sup>, released in May 2023, plans a 'request for information' for offshore wind project developers in 2023 followed by a 'request for proposals' for seabed leases in 2024. Version 2 of the

experienced and competitive marine service and supply chain, research expertise in clean technology and labour availability. For all these reasons, Nova Scotia is

48. [https://gwec.net/wp-content/uploads/2021/06/Canada\\_Offshore-Wind-Technical-Potential\\_GWEC-OREAC.pdf](https://gwec.net/wp-content/uploads/2021/06/Canada_Offshore-Wind-Technical-Potential_GWEC-OREAC.pdf)

49. <https://renewablesassociation.ca/statement-naris/>  
50. <https://www150.statcan.gc.ca/n1/pub/11-402-x/2012000/chap/geo/geo-eng.htm>

51. A report say it has changed to 2024 instead of original plan starting from 2025.

52. <https://docs.google.com/document/d/1Vtk98J1xiF418DnttE8DOcfr7AdBvEfe7rmOypZJhHy8/edit>



## Markets to Watch



a sought-after location for large-scale green hydrogen production and export. It aims to release a green hydrogen action plan in 2023.

In Newfoundland and Labrador, the Canadian government awarded funding in 2021 to a project using floating wind turbines to power oil and gas assets, with the aim of reducing their carbon footprint. For informed offshore wind planning and decision-making, the governments of Canada, Newfoundland and Labrador and Nova Scotia have now initiated the Regional Assessment of Offshore Wind Development to assess future impacts.<sup>54</sup>

The Minister of Natural Resources' Bill C-49 over Atlantic Accords Acts<sup>55</sup> has been introduced in the House of Commons to create a regulatory framework for offshore wind, hydrogen and green ammonia development in Atlantic Canada. Under this bill, the Offshore Petroleum Board for Nova Scotia and Newfoundland and Labrador would additionally act as the regulatory body for offshore wind.

To prioritise offshore wind and green hydrogen production commercially, Canada introduced a suite of investment tax credits in its March 2023 budget<sup>56</sup>, to offset the US IRA

and similarly competitive European support mechanisms. The budget includes investments made by Canada Infrastructure Bank and Canada Growth Fund. Atlantic Investment Tax Credit is another addition to support new energy generation.

These are important and promising first steps to kickstart Canada's offshore wind industry. However, an increasingly competitive global environment for private investment means that the federal and provincial governments will have to step up and accelerate efforts to support the sector and the local supply chain.

This includes identifying potential sites through offshore wind resource measurements, setting a national offshore wind target that includes commitments from all potential provinces, followed by offshore wind auctions/seabed leases pipelines. Additionally, it will be necessary to create permitting, policy and regulatory frameworks, analyse grid and port infrastructure readiness, introduce incentives to gradually reduce the higher cost of offshore wind, and finally promote coordination and collaboration between provinces, the fishing sector and offshore wind industry players.

53. <https://www.offshorewind.biz/2021/05/11/canada-backs-project-powering-oil-gas-assets-with-floating-wind/>

54. <https://www.google.com/url?q=https://iaac-aeic.gc.ca/050/evaluations/proj/84343?%26culture%3Den-CA&sa=D&source=docs&ust=1692606734829477&usq=AOvVaw1SdouXxr96AH0txRYNyHub>

55. It regulates Atlantic Accords Acts implement agreements between Canada and the respective provinces on the joint management of offshore petroleum resources

56. <https://www.budget.canada.ca/2023/report-rapport/chap3-en.html>

# Latin America - Brazil

## Offshore wind: a strategic element in industrial policy

Climate emergency, energy transition, low carbon, renewable energy – today, it is practically impossible to talk about the competitiveness of any world economy without these concepts being at the centre of discussions. The global engagement in favour of decarbonisation is undeniable. Motivated by the Paris Agreement, 128 countries representing 88% of global greenhouse gas emissions and accounting for 92% of global GDP have adopted decarbonisation policies. Many countries are putting together post-COVID-19 pandemic economic recovery packages that fully embrace green industrial policies. It is in this context that offshore wind excels only as a tool for decarbonising the economy but also as a strategic part of a green industrial policy and a driver of economic and social development.

According to the 'Roadmap Eólica Offshore Brasil', published by Empresa de Pesquisa Energética, Brazil has a huge offshore wind potential of approximately 700 GW on sites with a depth of up to 50 metres.

Brazil has an urgent need to design a legal framework for the sector and, as a first step, it needs to define the rules for the right to use the sea so that it can turn this vast potential into reality.

Brazil has made some progress with different aspects of the regulatory debate and the value chain. A recent study on the value chain in offshore wind,<sup>57</sup> sponsored by ABEEólica and with the technical coordination of

For Decree No. 10,946, the Ministry of Mines and Energy (MME) opened two public consultations (CP 134/22 and 135/22) on the draft of the ordinance. Ordinances Normative 52°/2022 MME and Interministerial n° 3/2022 MME/MM deal with guidelines and complementary rules for assigning sites and natural resources in offshore areas to generate electricity, and to create a portal for the management of

## Brazil has an urgent need to design a legal framework for the sector and, as a first step, it needs to define the rules for the right to use the sea

Petrobras' energy transition director, Maurício Tolmasquim, outlines the main pathways for the development of the offshore wind energy value chain.

### Regulatory advances and important milestones

The regulation of offshore wind in Brazil has been addressed on two fronts, with the main objective of providing transparency and legal certainty to investors: Decree 10,946/2022 and PL 576/2021 issued in 2022.

offshore areas. Currently, investors interested in exploring offshore wind energy seek their guidance through Decree 10,946, which deals with the procedures for granting contracts for allocating the use of offshore areas.

PL 576/2021, by former senator and current Petrobras CEO, Jean-Paul Prateshas been approved by the Infrastructure Commission of the

57. <https://abeeolica.org.br/wp-content/uploads/2023/02/Executive-Summary.pdf>





Federal Senate and is currently going through the Chamber of Deputies. PL 576/21 regulates all types of energy exploration in the ocean, lagoons, lakes and other bodies of water. The proposal is that the federal government grant the right to use these areas (when there is competition) or authorize it by grant (when there is no competition).

Both legislative instruments are

needed to streamline and structure regulation in the national context. For offshore wind projects and the ordinances to move forward, the government needs to be aligned with the planning bodies. The offshore wind industry must be seen in a strategic context, with the right regulatory and institutional environment enabling the creation of a leasing auction for offshore wind energy to unlock the potential of the

sector. It is expected that the offshore wind legislation will be published by November.

### **Next steps for offshore wind**

When we envision the future of offshore wind in Brazil, there are two guiding pillars: one is offshore wind as an accelerator of economic and social development, through new industrial policies; the second is its connection with green hydrogen and power-to-X, as offshore wind could

play a central role in meeting the demand for hydrogen, considering its intense use of water and ability to enable exports.

Brazilian institutions such as Aneel, which included offshore wind for the first time in its 'Regulatory Agenda for the Biennium' – a document that lists 15 strategic topics to be addressed – are showing signs of a willingness to act on offshore wind regulation.



# Colombia

Colombia is primed to launch the first tender to allocate seabed areas for offshore wind energy exploration, taking an early lead as a first mover in Latin America and the Caribbean.

A just energy transition is a priority for the government of President Gustavo Petro, based on the need to approach the transition by integrating social and technical principles supported by technologies such as offshore wind energy.

In support of this agenda, the government commissioned a roadmap

for offshore wind development, which identifies the potential of more than 50 GW and targets between 3 GW and 9 GW of installed capacity between 2030 and 2050 off the country's Atlantic Ocean coast.

A pipeline of 11 projects with a total of 5 GW of capacity has already been registered by developers with the energy planning body UPME.

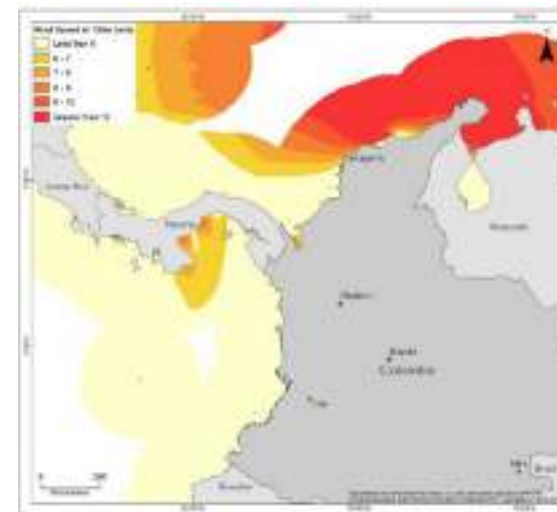
Through Resolution 40284 of 2022 issued by the Ministry of Mines and Energy in conjunction with the General Maritime Directorate, the government has regulated the procedure for the allocation of sites for project development in the

seabed areas already identified for this purpose.

The Ministry of Mines and Energy announced the rules for a first competitive tender round to be enacted in the second semester of 2023. It will target the Atlantic area for the allocation of temporary maritime permits for offshore wind development.

Regulatory activity is expected in the short and medium term to streamline the permitting process for project development according to the timelines outlined in the resolution to grant definitive concessions for the seabed areas to be allocated in the tender.

Map of Colombia's offshore wind potential



Map of the seabed areas included in the annex of the Resolution 40284 of 2022 issued by the Ministry of Mines and Energy



Table 3: Projects in the pipeline

No.	Project Name	Capacity (MW)	Location	Developer	Estimated Finishing Date
1	OWF Astrolabio	825	Uribia, La Guajira	OWF Astrolabio SAS ESP	2032/08/02
2	OWF Barlovento	825	Uribia, La Guajira	OWF Barlovento SAS ESP	2032/08/02
3	OWF Bergantín	825	Santa Marta, Magdalena	OWF Bergantín SAS ESP	2032/08/06
4	OWF Galeón	825	Barranquilla, Atlántico	OWF Galeón SAS ESP	2032/08/06
5	Goleta OWF	825	Santa Marta, Magdalena	OWF Goleta	2032/08/02
6	OWF Bitácora	510	Cartagena, Bolívar	OWF Bitácora SAS ESP	2032/08/06
7	Vientos Alisios	200	Santa Catalina, Bolívar	Parque Eólico Offshore Alisios SAS	2025/08/12
8	OWF Barlovento I	50	Uribia, La Guajira	OWF Barlovento SAS ESP	2034/12/31
9	OWF Barlovento II	50	Uribia, La Guajira	OWF Barlovento SAS ESP	2034/12/31
10	OWF Barlovento III	50	Uribia, La Guajira	OWF Barlovento SAS ESP	2034/12/31
11	OWF Barlovento IV	50	Uribia, La Guajira	OWF Barlovento SAS ESP	2034/12/31



## Africa

The offshore wind energy landscape in Africa holds immense promise as a transformative force in the continent's sustainable energy transition. Countries such as Morocco, Egypt, South Africa and Kenya are leading the charge towards harnessing the

vast renewable potential of their coastal regions.

Morocco's strategic location along the Atlantic Coast offers an ideal setting for offshore wind farms, capitalising on strong and consistent winds. Egypt, endowed with the Mediterranean and Red Sea coasts, has embarked on ambitious plans to diversify its energy

mix, with offshore wind playing a crucial role. South Africa's high demand for energy, advanced infrastructure and progressive policies have positioned it as a key player in the continent's renewable energy scene, with potential for offshore wind projects along its vast coastline.

At present, no offshore wind farms

exist in Africa. However, several countries are exploring the potential to harness offshore wind into their energy mixes. For instance, in South Africa, the Council for Scientific and Industrial Research (CSIR) is exploring whether offshore wind could help inject more energy into areas without the grid constraints currently being experienced in the country.

# South Africa

## Unlocking vast renewable potential

South Africa's coastal waters hold tremendous potential for offshore wind energy generation, offering a viable solution to the country's energy challenges and the need for sustainable power sources.

South Africa's energy landscape has been marred by an ongoing energy supply deficit, resulting in frequent electricity shortages and rising costs. To address these issues and transition to cleaner energy, the country has increasingly turned to renewable sources, including wind energy. The offshore wind sector, in particular, offers significant advantages over its onshore counterpart, such as higher wind speeds and increased capacity factors.

The coastal geography of South Africa presents a wide range of bathymetry, or ocean depth, which is crucial when assessing the country's offshore wind potential.

Shallow waters of up to 60 metres along the coast of South Africa have limited potential for fixed-bottom turbines with the notable

exception of the area between Durban and Richards Bay, along the east coast stands, where average wind speeds exceed 9 m/s. This region offers an appealing location for offshore wind farm development due to its proximity to existing infrastructure, including commercial ports.

Deeper waters off the South African coast demonstrate great potential for floating turbines. Noteworthy areas include the west coast near the Northern Cape, the south-west coast near the Western Cape, the east coast near the Eastern Cape, and the north-east coast near KwaZulu-Natal. These regions also benefit from their proximity to commercial harbours, which reduces logistical barriers to entry.

Offshore wind farms in these regions have the potential to significantly contribute to South Africa's renewable energy mix. Even after considering losses and other technical factors, estimates suggest that fixed-bottom turbines could yield approximately 64 GW of installed power capacity, while floating turbines could offer a substantial 764 GW. By the end of 2022, South Africa's total installed wind capacity (onshore) was 54 GW, meaning that offshore wind potential can add significant capacity to the grid.

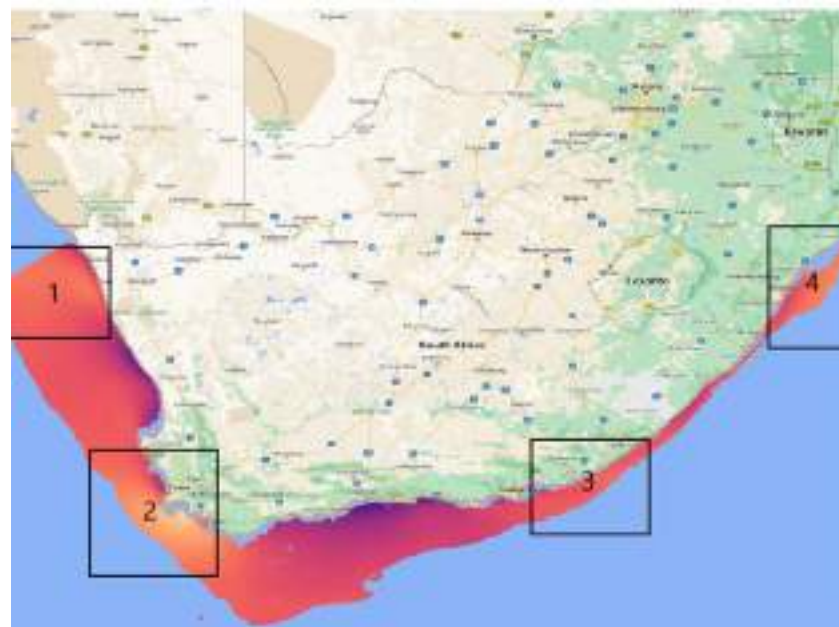
However, offshore wind development is not without challenges, including biodiversity concerns, policy frameworks and shipping restrictions. All These elements need to be carefully considered during the planning and implementation stages of offshore wind projects.

To fully realise South Africa's offshore wind potential, government entities must work

together with renewable energy developers and other stakeholders at the same time as providing policy support, investment incentives and streamlined regulatory processes.

Offshore wind power can provide a stable and reliable source of electricity for South Africa at the same time as creating job opportunities and stimulating economic growth.

### Regions showing great potential for offshore wind.



Source: Energies 2023, 16(9), 3668; <https://doi.org/10.3390/en16093668>

A landscape photograph featuring several wind turbines. The scene is hazy, with a soft, diffused light that creates a dreamy atmosphere. The sky is a pale, hazy blue, and the ground is obscured by a thick layer of mist or fog. The wind turbines are scattered across the frame, with one prominent in the foreground on the left and others receding into the distance. The overall color palette is muted and soft, dominated by blues, greys, and whites.

# MARKET OUTLOOK 2023-2032

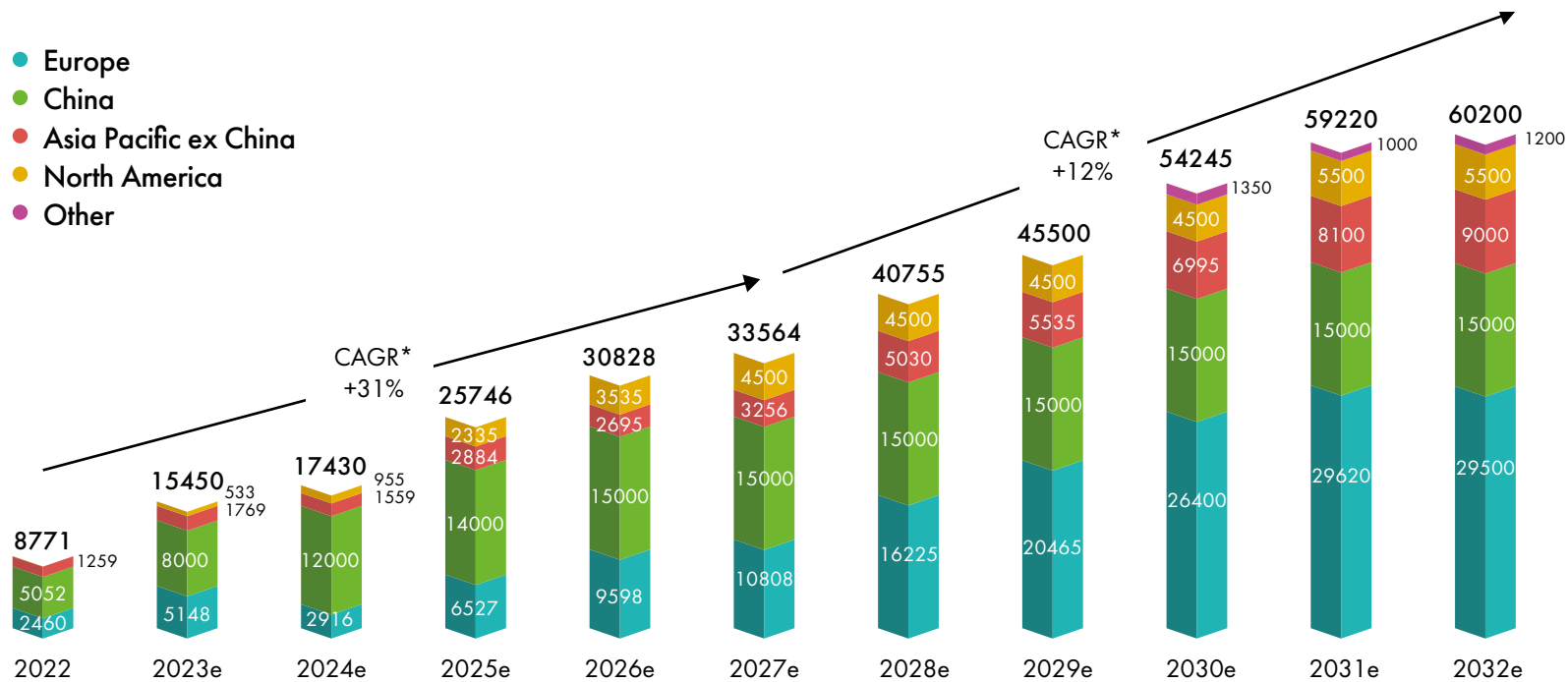
# Global Offshore Market Outlook to 2032

Russia's invasion of Ukraine has permanently reshaped the global energy market and amplified the call for an accelerated energy transition. The urgency of ensuring secure and affordable energy supplies while meeting climate

targets has propelled wind power development into a new phase of even faster growth. Challenges such as inflation, increased capital cost and a supply chain crunch have created uncertainty, forcing developers to review the viability of

their projects and in some cases even to terminate their offtake contracts and stop developing projects due for construction in the next five years (2023–2027). Despite all of this, the global offshore wind market outlook in the medium and

New offshore wind installations, global (MW)



\* Compound Annual Growth Rate.  
Source: GWEC Market Intelligence, July 2023



long term, from 2028 onward still looks promising.

With a compound average annual growth rate of 31% until 2027 and 12% up to the beginning of the next decade, new installations are expected to sail past the milestones of 30 GW in 2026 and 50 GW by 2030.

GWEC Market Intelligence expects more than 380 GW of new offshore wind capacity to be added over the next decade (2023–2032), bringing total offshore wind capacity to 447 GW by the end of 2032. However, only one-third of this projected new volume will be added in the first half (2023–2027) due to near-term challenges. Annual offshore wind installations capacity is expected to quadruple in 2028 from 8.8 GW in 2022 and pass 60 GW in 2032, bringing its share of global new installations from 11% in 2022 to 30% by 2032.

For decades Europe has been the world's largest regional offshore wind market in terms of cumulative offshore wind installation. However, it lost the title to Asia Pacific in 2022 as a result of strong growth in China in the past five years. APAC's leading position in total offshore wind installations is unlikely to be challenged in the next decade (2023–2032), but Europe is likely

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## GWEC Market Intelligence expects more than 380 GW of new offshore wind capacity to be added over the next decade

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to become the largest market for new installations from 2030. The dual objective of achieving energy independence from Russian oil and gas while fighting climate change is likely to push Europe's annual offshore wind installations beyond the 10 GW milestone in 2027 and 25 GW in 2030. North America will remain the third largest offshore wind market by 2032, followed by Latin America. No offshore wind installations are expected in Africa and Middle East region during the forecast period.

In the near term (2023–2024), all of the expected growth outside of Europe will come from APAC, primarily from Mainland China and Chinese Taiwan. Due to expected delays in project execution off the US Eastern Coast, meaningful capacity contributions from North America will not be available until 2025 when the multi-GW level of annual installations is likely to be achieved. Despite a project pipeline of more than 170 GW in Brazil and some progress in Colombia, no

sizable volume is likely to emerge from Latin America until the end of this decade.

Our near-term offshore wind market outlook (2023–2027) was built using a bottom-up approach and is based on GWEC Market Intelligence's global offshore wind project database, which covers projects currently under construction, global auction results and announced offshore wind tenders worldwide. For the medium-term market outlook (2028–2032), aside from existing project pipelines, a top-down approach was also used, which takes into account existing policy and medium/long-term national and regional level offshore wind targets.

Since our medium-term outlook reflects current declared national and regional targets, it is highly likely that it will increase further as these targets increase. On the other hand, there is currently an implementation gap between declared targets and the rate of annual installations.

# Europe

The offshore wind industry started in Europe in 1991, when the world's first offshore wind project was installed in Denmark. Through three decades of development, fixed-bottom offshore wind technology has matured, with supply chains becoming established and tens of thousands of jobs being created in countries neighbouring the North and Baltic Seas.

In 2009, Norway commissioned the world's first MW-scale floating offshore wind turbine, making Europe the birthplace for floating wind. As the technology hub for floating wind turbines and foundations, Europe remained the world's largest market for floating wind in 2022.

While Europe lost its leading position to APAC in cumulative installations last year and is unlikely to recapture this title in the next ten years, annual installations in the Old Continent are expected to surpass APAC's from 2030. Our growth projection for Europe is based on several elements:

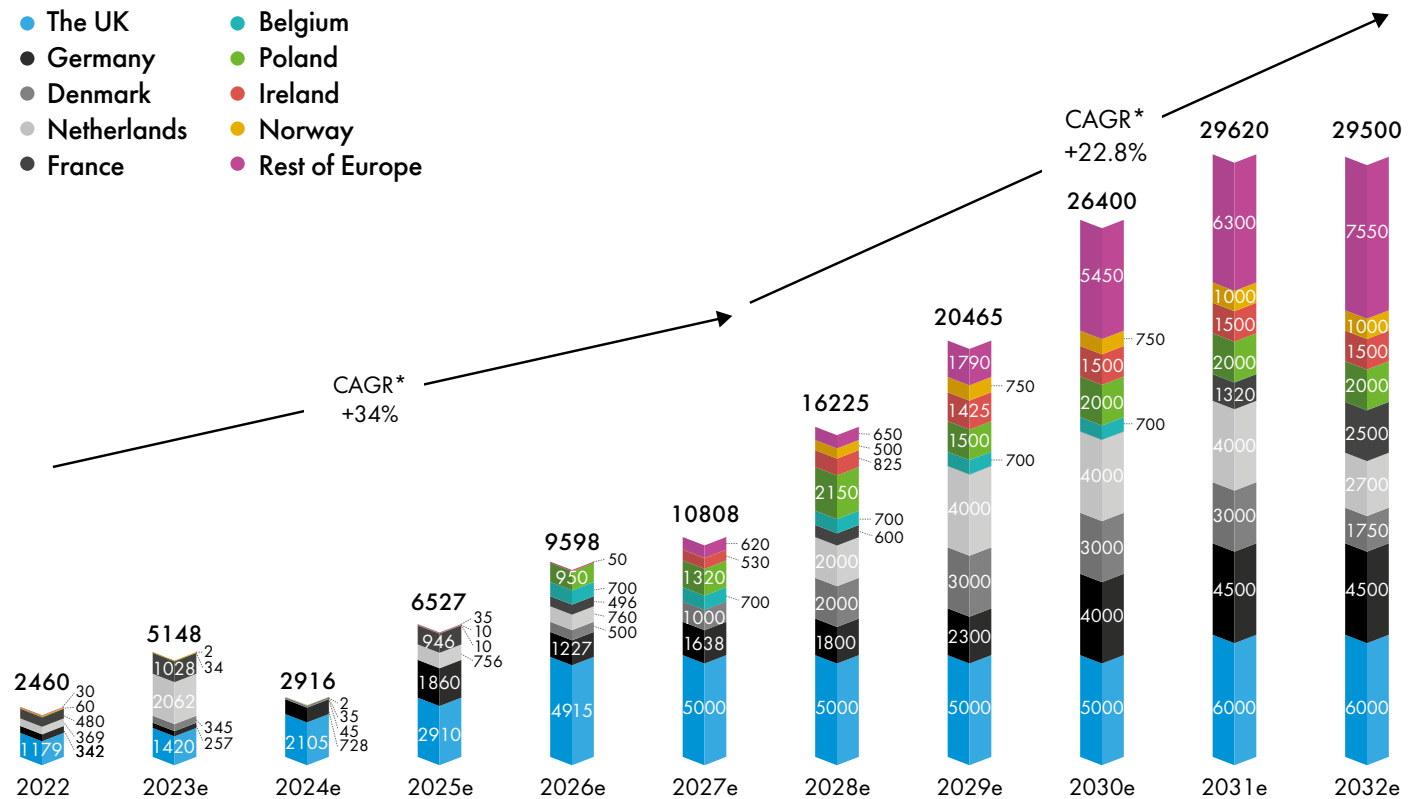
1) Fixed-bottom offshore wind has become the most competitive

electricity generation technology after onshore wind and solar PV, but with considerable advantages in terms of being able to deploy at scale.

2) The commercialisation of floating wind will unlock the potential in deep waters in the North Sea, Mediterranean Sea and Atlantic Ocean.

3) The EU's new energy security strategy, REPowerEU, will accelerate offshore wind and renewable hydrogen deployment on the back of Europe's urgency to replace fossil

New offshore wind installations, Europe (MW)



\*Compound Annual Growth Rate.  
Source: GWEC Market Intelligence, July 2023

fuels with renewables to achieve energy security in the aftermath of the Russian invasion of Ukraine.

4) The EU's net zero commitments, which rely on an offshore wind target of 300 GW by 2050 as part of the EU Green Deal.

5) The EU's Green Deal Industrial Plan to strengthen Europe's clean energy industries.

GWEC Market Intelligence predicts a double-digit growth rate for Europe in this decade, but explosive market growth in Europe is unlikely to happen until 2026. Offshore wind additions in the near term (2022–2025) are expected to be relatively slow, with average annual installations staying at the 4.8 GW level due to lower activity levels in established North Sea markets including Germany, Denmark and Belgium as well as the impact of current challenging market conditions on offshore wind project development.

However, with multi-GW wind projects from Round 3 and 4 auctions in the UK coming into operation and utility-scale projects becoming connected in new markets like Poland and Ireland, new installations in Europe are likely to pass the 10 GW milestone in 2027.

If more projects materialise from the announced auction plans in mature markets such as Denmark and Netherlands, and from the Baltic Sea, annual growth in Europe can potentially reach 20 GW in 2029 and close to 30 GW in 2030 – assuming the supply chain and infrastructure can cope. Around 78% of the total volume predicted to be added in Europe in the next ten years will be

built in the second half of this period (2028–2032).

**The UK**

The UK is the largest offshore wind market in Europe. As of the end of May 2023, nearly 10 GW of offshore wind projects were under construction and more than 100 GW of projects were at different stages of development, which is only second to China worldwide.

In July 2022, almost 7 GW of new offshore wind projects won the Round 4 CfD auction. In the same month, the Crown Estate identified five areas for a 4 GW floating wind auction in the Celtic Sea. In August, the Crown Estate opened the Innovation and Targeted Oil and Gas (INTOG) offshore wind leasing process and awarded three more floating wind projects under the ScotWind seabed leasing.

**The latest offshore wind targets in Europe**

Unit: GW	2027	2030	2035	2040	2045	2050
EU		≥60				≥300
UK		50				
Germany		30	40		≥70	
Netherlands		22.2		50		70
Denmark		12.9				
Belgium		5.7				
France			18			40
Poland	10.9*					
Norway				30		
Ireland		7				30
Spain		3				
Greece		2				
Portugal		10**				
Esbjerg Declaration***		≥65				≥150
Marienburg Declaration****		19.6				
Ostend Declaration*****		120				300

\* Either in operation or under development by 2027 \*\* Capacity to be awarded through auctions  
 \*\*\* North Sea countries have set a joint target through the Esbjerg Declaration (Germany, Denmark, Belgium and the Netherlands)  
 \*\*\*\* Baltic Sea counties have set a joint target through the Marieborg Declaration (Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden)  
 \*\*\*\*\* North Sea counties have set a joint target through the Ostend Declaration (Belgium, Denmark, Germany, Netherlands, France, Ireland, Luxembourg, Norway and the United Kingdom)  
 Source: GWEC Market Intelligence, July 2023



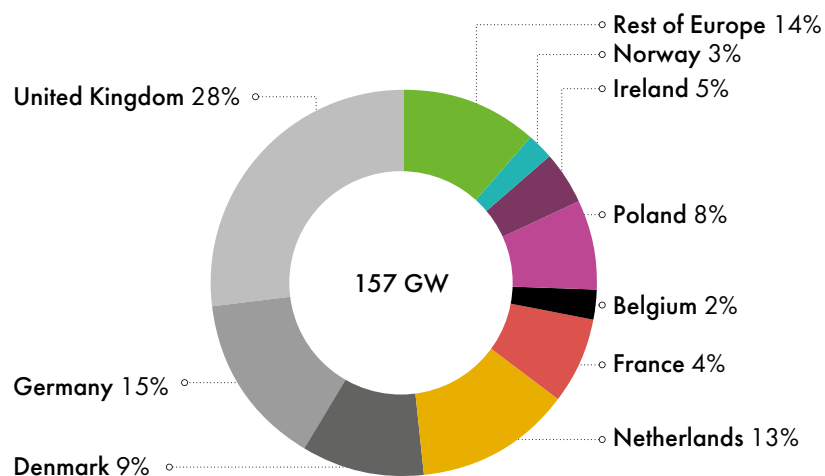
Entering 2023, the UK government confirmed the budget for the Round 5 CfD auction. Although fixed-bottom offshore wind will now be competing alongside other established technologies, floating wind will compete for the budget available for emerging technologies. In March, 13 offshore wind projects totalling 5.5 GW won the INTOG leasing round, making it the world's first leasing round designed to enable offshore wind energy to directly supply offshore oil and gas platforms.

To boost the UK's energy security, in April 2022, the government increased the 2030 offshore wind target from 40 GW to 50 GW, 5 GW of which is targeted for floating wind.

### Germany

The second largest offshore wind market in Europe, Germany has only connected three small projects in the past three years, due to unfavourable market conditions and a lack of mid-term visibility. However, encouraging offshore wind legislation has been released since 2022. The new German government amended its offshore wind legislation in April 2022 through the 'Easter Package' requiring 30 GW of operational offshore wind by 2030, 40 GW by 2035 and at least 70 GW by 2045.

Total offshore wind added between 2022 and 2032



Source: GWEC Market Intelligence, July 2023

In July, the government amended the Offshore Wind Act (WindSeeG) to introduce two-track auction systems, one with sites centrally developed by state authorities and another with sites not pre-developed and allowed for 'negative bidding'. In addition, this new Act will procure offshore wind power for green hydrogen production through six annual tenders, each with 500 MW capacity, from 2023.

To cut its reliance on Russian fossil fuels, Germany signed a cooperation agreement on offshore wind

development and green hydrogen with three North Sea countries through the Esbjerg Declaration, eight Baltic Sea countries through the Marienberg Declaration and eight North Sea countries through the North Seas Energy Cooperation and Ostend Declaration.

To support the country's offshore wind target, in January 2023, Germany's Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, or BSH) released an offshore wind area development





plan for the North Sea and the Baltic Sea, which maps out a total of 36.5 GW of offshore wind buildout by 2030.

### **Denmark**

As well as being the birthplace of offshore wind in Europe, Denmark remains the hub for offshore wind technology. To secure its energy independence from Russia's oil and gas while supporting the EU's new energy security strategy, the country hosted three North Sea countries and eight Baltic Sea countries in May and August 2022 to sign the Esbjerg declaration and Marienborg Declaration, respectively.

At the beginning of this year, the government announced a plan to put 9 GW of new offshore wind capacity out for tendering by the

end of the year, which can be increased to 14 GW after the 'overplanting' option was agreed by most parties through a political agreement signed in May 2023.

The government, however, suspended the processing of offshore wind farm projects under the open-door scheme in February 2023 for fear the scheme may be in breach of EU law. Although nine projects totalling 3.6 GW were released and can continue with the development, 24 out of the 33 offshore wind projects proposed under the scheme have been cancelled.

### **Netherlands**

The Netherlands is the third largest offshore wind market in Europe with 1.5 GW of offshore wind capacity

currently under construction. To meet the EU's CO2 emissions reduction target, the country increased its 2030 offshore wind target from 11.5 GW to 22.2 GW in November 2022.

Last summer, the government disclosed the tendering timelines and locations for nine offshore wind projects with a combined capacity of up to 13.4 GW. The projects, ranging from 700 MW to 2 GW in individual capacity, are scheduled to be put out to tender between the second quarter of 2025 and the end of 2027.

Following the recently announced 50 GW by 2040 and 70 GW by 2050 offshore wind targets, the Dutch Ministry of Economic Affairs and Climate Policy (EZK) is now identifying further offshore wind

areas with a draft roadmap expected to be released by the end of 2023.

### **Belgium**

Belgium is Europe's fifth largest offshore wind market in total offshore wind installations, but the country has run out of its project pipeline since the 487 MW Seamade and 219 MW Northwester 2 projects came online in 2020. It is unlikely to connect any new capacity until 2026.

In October 2021, Belgium's Council of Ministers approved a proposal to increase the capacity to be offered at the upcoming tenders for the Princess Elisabeth offshore wind zone from the initially planned 2.25 GW to up to 3.5 GW. It also approved connecting the wind farms in this zone to an energy island. Belgian transmission system operator (TSO)

Elia received an EU grant last December, under the Recovery and Resilience Facility (RRF), for the energy island. Foundation work is expected to start in 2024. Once the Princess Elisabeth offshore wind zone is fully connected by 2030, Belgium's total offshore wind capacity will reach 5.76 GW.

### France

By the end of 2022, France had installed 482 MW of offshore wind capacity. Eight projects totalling 2.5 GW are under construction, of which three are demonstration floating wind projects.

According to the Multiannual Energy Programme (Programmation pluriannuelle de l'énergie, PPE) released by the French government in 2020, 8.75 GW of offshore wind capacity will be put out to tender by 2028. As of today, three fixed-bottom and three floating wind projects, for a total of 4.3 GW, have been floated for auction, with the 1 GW AO4 project awarded in March 2023.

To reach its 2050 net zero target, the French government has signed an offshore sector deal with France's wind industry, aiming to achieve 40 GW of offshore wind by 2050 spread over 50 wind farms.

### Poland

In late 2020, Poland's Council of Ministers adopted a draft bill supporting the development of offshore wind energy in the Baltic Sea. The draft bill, which was signed into law by the President in January 2021, allows for 10.9 GW of offshore wind capacity to be either operational or under development by 2027.

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## It now plans to hold four auctions with a combined capacity of 12 GW in the second phase of offshore wind expansion,

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By the end of June 2021, the Polish Energy Regulatory Office (ERO) had awarded a CfD to seven offshore wind projects totalling 5.9 GW. According to the Polish Offshore Wind Act, the second phase of development will include two auctions, the first in 2025 and the second in 2027, each with 2.5 GW of capacity.

In April 2023, the government announced a more ambitious target. It now plans to hold four auctions with a combined capacity of 12 GW in the second phase of offshore wind expansion, which will allow the

country to have 18 GW of offshore wind capacity at different stages of development by the end of this decade.

### Norway

There are three floating offshore wind sites currently in operation in Norway, making the country the second largest floating market in terms of total installations.

In March 2023, the government officially opened the application window for Norway's first offshore wind auction. The rights to develop the 1.5 GW Sørlige Nordsjø II Phase 1 project and the 1.5 GW Utsira Nord floating wind project will be awarded by the end of 2023. Considering the higher risk profile, the Norwegian government has proposed that the floating sites in the Utsira Nord lease area be selected based on qualitative criteria, rather than through an auction.

In May 2022, the newly elected government launched a large-scale





green investment plan aimed at allocating sea areas to develop 30 GW of offshore wind capacity by 2040, with the next round of licence awards for offshore wind in the new areas expected to launch in 2025.

### **Ireland**

According to Ireland's Climate Action Plan, the country aims to have 5 GW offshore wind by 2030 with a long-term plan to tap into its floating wind potential of at least 30 GW in deeper waters.

In July 2022, the Irish Government increased the country's offshore wind target for 2030 to 7 GW. Last December, the Irish Government issued Maritime Area Consents (MACs) for the first phase of seven offshore wind projects, which enables phase-one projects to participate in the ORESS 1, the first auction for offshore wind under the Renewable Electricity Support Scheme (RESS).

In May 2023, four projects with a combined capacity of nearly 3,100 MW were awarded under ORESS 1. Early this summer, the Irish government opened the consultation process for ORESS 2 with the first auction, ORESS 2.1 for 900 MW, planned for the end of 2023 or early next year.

Additionally, the government plans to have 2 GW of floating wind capacity in development by 2030.

### **Portugal**

Portugal only has the 25 MW WindFloat Atlantic (WFA) floating wind farm in operation at present. The country planned to put 3–4 GW of floating wind capacity up for auction last summer. Although its first offshore wind auction was postponed to 2023, the planned capacity for the first auction has been upgraded twice to 10 GW.

In January 2023, the government released draft areas for 10 GW of offshore wind, but this summer the inter-ministerial working group proposed putting the areas out to tender in phases, with three areas totalling 3.5 GW to be offered this year through one or more competitive procedures, and the remaining capacity to be allocated in subsequent phases until 2030.

### **Spain**

Spain has 10 MW offshore wind capacity installed, but the Roadmap for the Development of Offshore Wind and Marine Energy approved in December 2021 by Spain's Council of Ministers sees the country reaching up to 3 GW of (floating) offshore wind by 2030.

# Asia Pacific

The first offshore wind project was built in Japan 20 years ago, but

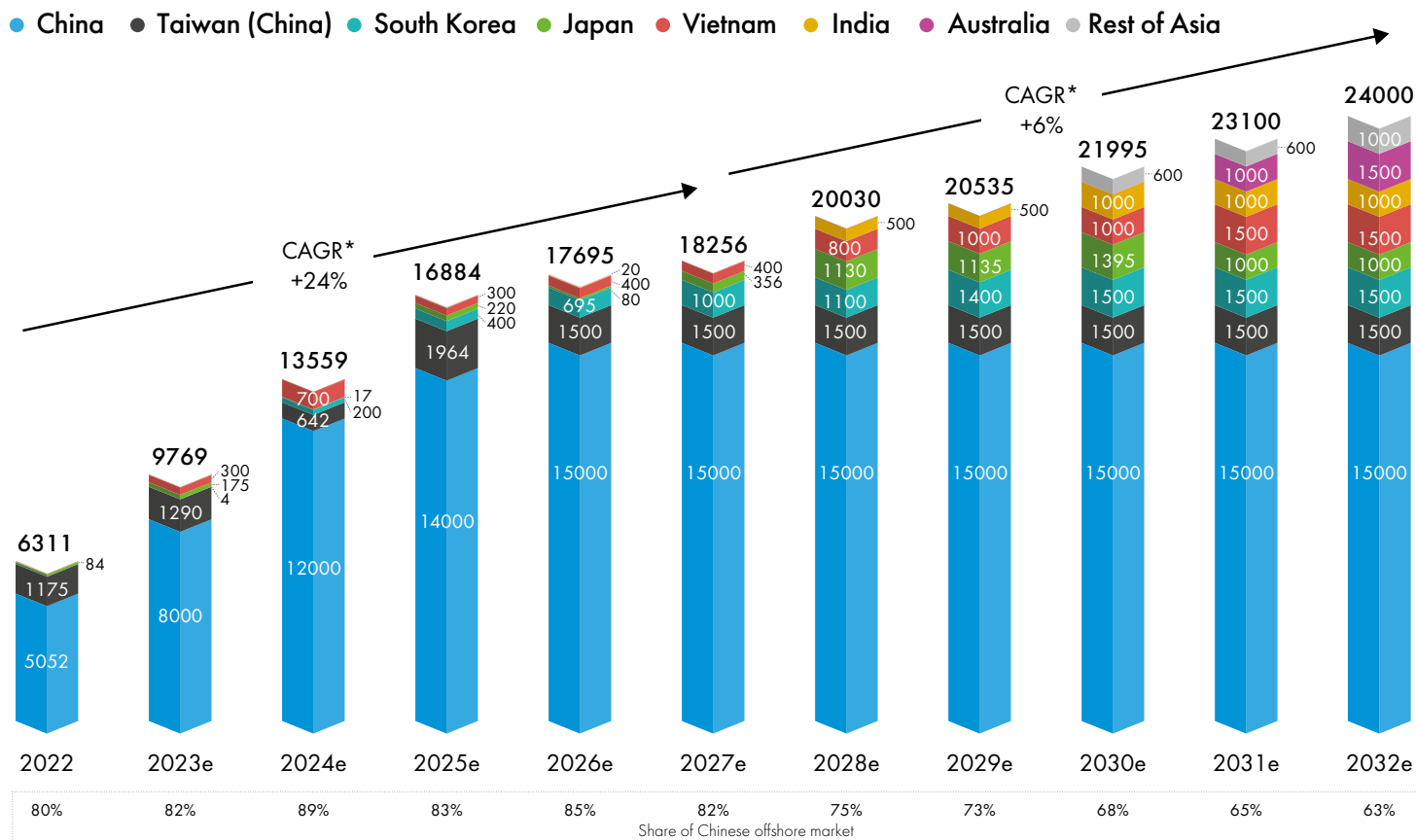
there was limited progress in the region until annual installations in China passed the 1 GW milestone in 2017 and the country replaced the UK as the world's top market in

new installations a year later. APAC replaced Europe as the leading regional offshore wind market in new installations in 2020 and in cumulative installations in 2022,

primarily driven by strong growth in China.

GWEC Market Intelligence's latest market outlook shows that China will

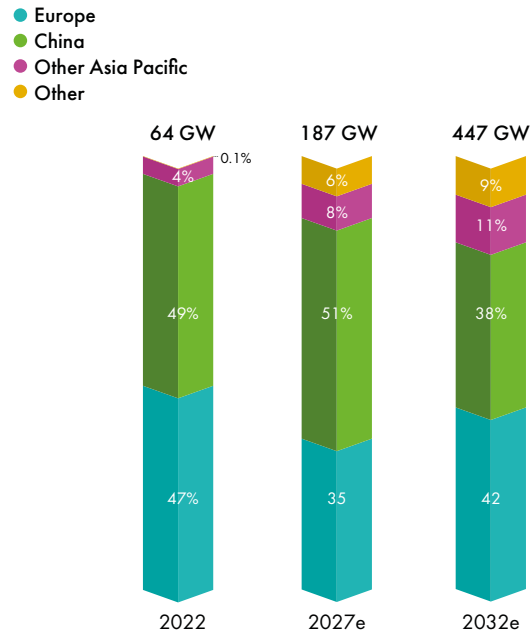
Offshore wind growth to 2032 in Asia Pacific (MW)



\*Compound Annual Growth Rate.  
Source: GWEC Market Intelligence, June 2023

## Market Outlook 2023 - 2032

### Total added between 2023 and 2032



Source: GWEC Market Intelligence, July 2023

continue to be the dominant market in the region for the next five years (2023–2027), with a market share of more than 80%.

However, China's market share is expected to drop to 68% in 2030 and 63% in 2032. We expect the market to become more diversified in the second half of this forecast period as more utility-scale offshore wind projects are expected to come

online in Japan, South Korea and Vietnam from 2027. The first batch of offshore wind project development is likely to take place in new markets such as India, the Philippines and Australia towards the end of this decade.

In total, 41% of the predicted offshore wind additions for this region will be built in 2023–2027, with the remainder to be installed in the second half of the forecast period. With strong growth returning to China in 2025, it is likely that new installations in APAC in 2026 will exceed the 2021 record. The top five markets in total new APAC additions in the next ten years will be China, Chinese Taiwan, South Korea, Vietnam and Japan.

China is currently the most mature offshore wind market outside Europe. Driven by the installation rush starting from the second half of 2019, the domestic offshore wind supply chain and infrastructure were built quickly along China's east and southeast coast. As of today, large offshore wind manufacturing bases and ports can be found in Shandong, Jiangsu, Zhejiang, Fujian and Guangdong provinces, and more bases are expected in Hebei, Guangxi and Hainan provinces in the next couple of years.

While supply chain capacity building activities have continued in the area of Chinese Taiwan in the past three years, the other markets are still at early stages of development with most of them facing the challenge of developing a local supply chain while building the necessary skills and workforce.

Based on the investment plans and partnerships recently announced by European players in South Korea and Japan, similar success is likely to be duplicated in these two markets. To unlock the offshore wind potential and further bring down the cost of offshore wind energy in APAC, however, regional cooperation in supply chain and infrastructure is essential.

### China

China entered the offshore wind sector relatively late compared with European countries: its first commercial offshore wind project was not fully commissioned until 2010. Offshore wind development started gaining momentum from the beginning of the 13th five-years plan period (2016–2020) and accelerated after the government announced its feed-in tariff (FiT) phaseout plan in 2019.

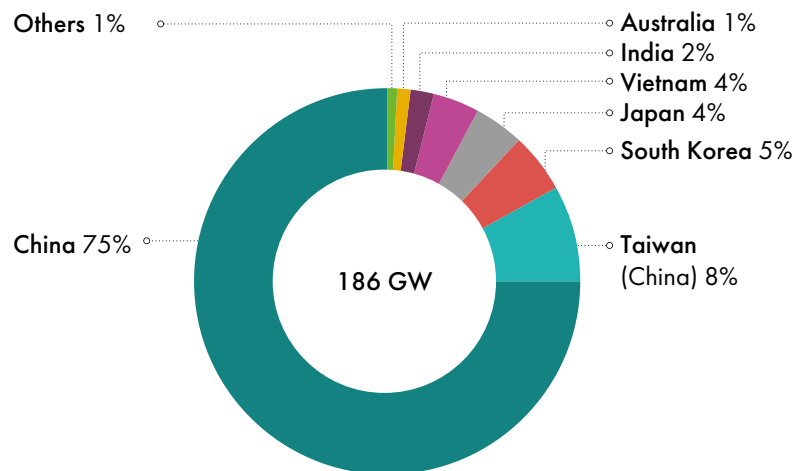
After an astonishing level of growth

in 2021 driven by the cut-off date for the FiT, new installations dropped significantly last year. Connecting 5 GW of new offshore wind in 2022 without financial support from central government, however, has demonstrated the resilience of China's offshore wind industry and shown that its capability to maintain stable growth in the new era of 'grid parity', whereby electricity generated from offshore wind will receive the same remuneration as that from coal-fired power plants.

According to the latest statistics from the China Renewable Energy Engineering Institute, six provinces have completed their offshore wind development plans for the 14th five-year plan period (2021–2025). By the end of June 2023, China's National Energy Administration had reviewed and approved 30 GW of nearshore wind and 35 GW of offshore wind capacity in deep waters. More capacity is expected to be approved after another four provinces complete the same process.

Considering that China has the world's largest and most competitive wind supply chain and the market is ready to complete the transition from nearshore to deep water installations by the end of

Total offshore wind added between 2023 and 2032



Source: GWEC Market Intelligence, July 2023

2025, GWEC Market Intelligence predicts that 139 GW of new offshore wind capacity will be built in the coming decade. This progress will further reinforce China's position as a global leader in the offshore wind sector.

**Taiwan (China)**

Despite the challenges of the COVID-19 pandemic and typhoon-related disruptions, more than 1 GW of new offshore wind capacity was connected in Chinese Taiwan last year, making it the second largest market in the region.

More than 2.5 GW of offshore wind capacity is under construction, which marks the half-way point toward achieving its 5.6 GW by 2025 offshore wind target. In August 2021, the government officially announced its Round 3 offshore wind allocation plan for 2026–2035, with seven projects totalling 3 GW allocated through Round 3, phase 1 A, in December 2022. If all anticipated projects from the Round 3 offshore wind auctions are allocated and come online on time, Taiwan is likely to maintain its current position within the APAC region.

**South Korea**

South Korea only has 142 MW of offshore wind capacity in operation but an ambitious target to bring 14.3 GW of offshore wind online by 2030. As of Q4 2022, 69 offshore wind farm projects with a combined capacity of more than 20 GW had received licences from the Electricity Regulatory Commission under the Ministry of Trade, Industry and Energy.

Offshore wind – particularly floating wind – has attracted significant interest from domestic and international renewables companies after the Korean government signed the Green New Deal in 2020 and committed to net zero a year later. However, permitting progress in the past 12 months has been slow due to opposition from local residents, fishermen and, in some cases, even the Ministry of Defence.

GWEC Market Intelligence, therefore, maintains its previous year's forecast and predicts that only half of the country's 2030 offshore wind target will materialise by the end of this decade.

**Japan**

Although Japan was the first country to build an offshore wind project in





the region, it did not have an offshore wind target until late 2020, when the Japanese government approved the 'Vision for Offshore Wind Industry' with the aim of achieving 10 GW of offshore wind by 2030 and 30–45 GW by 2040.

The country's first floating tender (16.8 MW) and first fixed-bottom offshore wind auction (1.7 GW) have been completed and the second fixed-bottom auction with a combined capacity of 1.8 GW across four sites was launched last November, with the results to be announced in March 2024.

In April 2023, the government released a plan to allow offshore wind projects to be built in its exclusive economic zone (EEZ), to support offshore wind deployment – including floating wind. In May it upgraded five sites from the 'Preparatory Stage' to the 'Promising Stage' and in June it started the nomination process for floating wind demonstration sites.

Based on the existing project pipeline and auction plans, we believe that 6.5 GW of new capacity is likely to be added in the next ten years, of which more than 85% will come between 2028 and 2032.

### **Vietnam**

Vietnam is the third largest market in the APAC region in cumulative offshore wind installations. However, offshore wind growth in the country collapsed after the installation rush that took place in 2021.

By the end of 2022, around 500 MW of installed offshore wind (intertidal) capacity was waiting to go through the PPA negotiation process with Electricity of Vietnam (EVN). However, the country made headlines in the first half of 2023. First, the Ministry of Industry and Trade set a ceiling price for wind power in January, which helps to initiate PPA negotiations for projects that have been installed but have yet to be commissioned. Second, the government formally approved the long-awaited Power Development Plan 8 (PDP 8), which sets a 6 GW offshore wind installation target for 2030 (excluding intertidal).

Although these two updates would increase our forecast, GWEC Market Intelligence believes that growth momentum will not return until route-to-market policies for the next round of offshore wind deployment are in place. We expect 5 GW of offshore wind to be added by 2030 and the GW level of annual installations to be achieved from 2029.



# North America

North America is the only region with offshore wind projects in operation outside of Europe and Asia Pacific. Both installed small-scale offshore projects, the 30 MW Block Island in Rhode Island and the 12 MW

Dominion Virginia demonstration project, are located in the US.

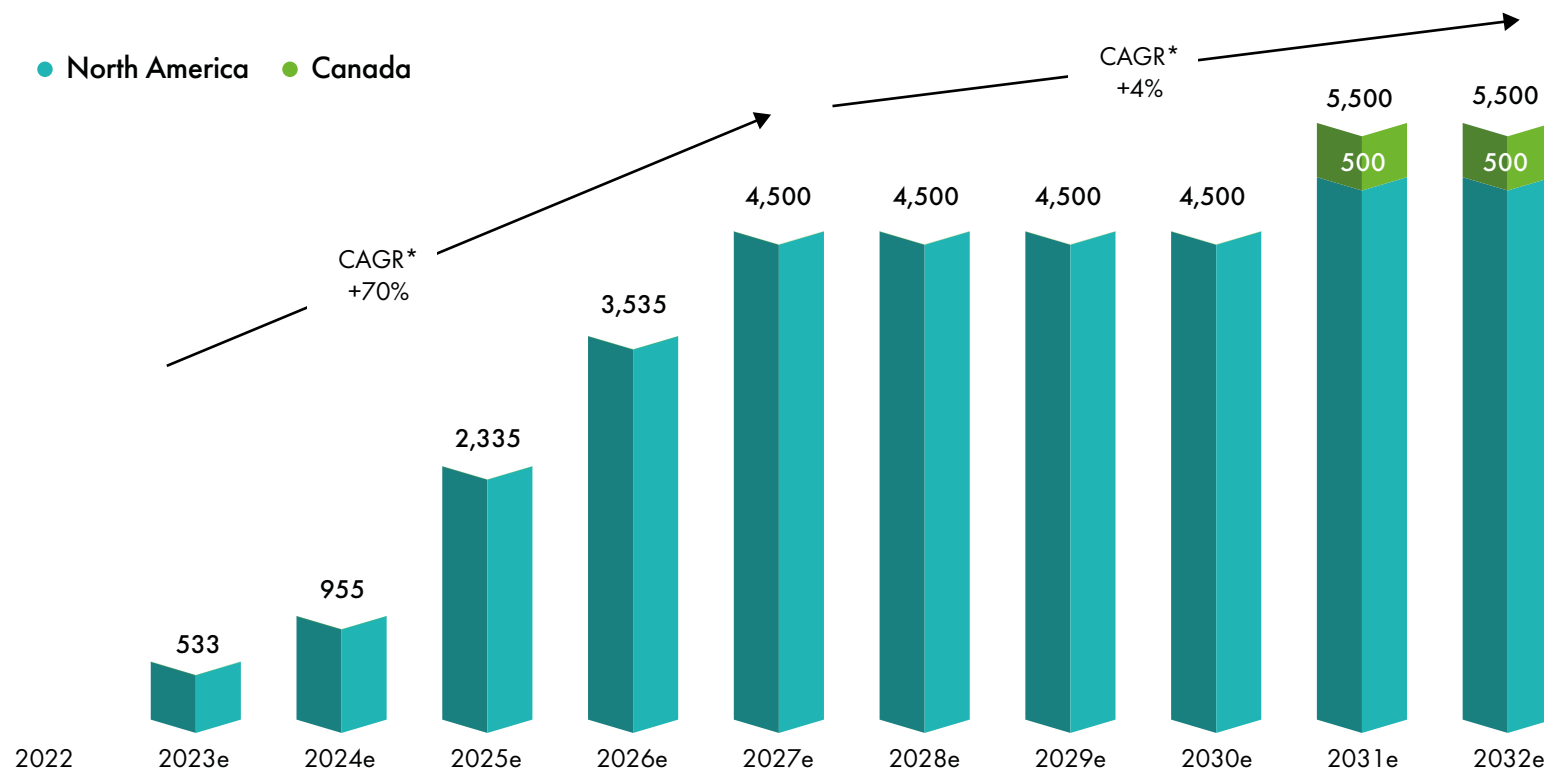
Based on the latest offshore wind project development pipeline, we expect the region's first utility-scale

offshore wind project, the 130 MW South Fork wind farm, to come online by the end of this year. In total, 36.4 GW of offshore wind is predicted to be built in this region in the next ten years (2023–2032), of

which 97% will come from the US and only 1 GW from Canada.

As project installation off the US eastern coast in the next three or four years is likely to be delayed due to

New offshore wind installations, North America (MW)



\*Compound Annual Growth Rate.  
Source: GWEC Market Intelligence, July 20253



PPA renegotiation and termination, only one-third of the projected capacity for the next ten years is likely to be delivered in the first half (2023–2027).

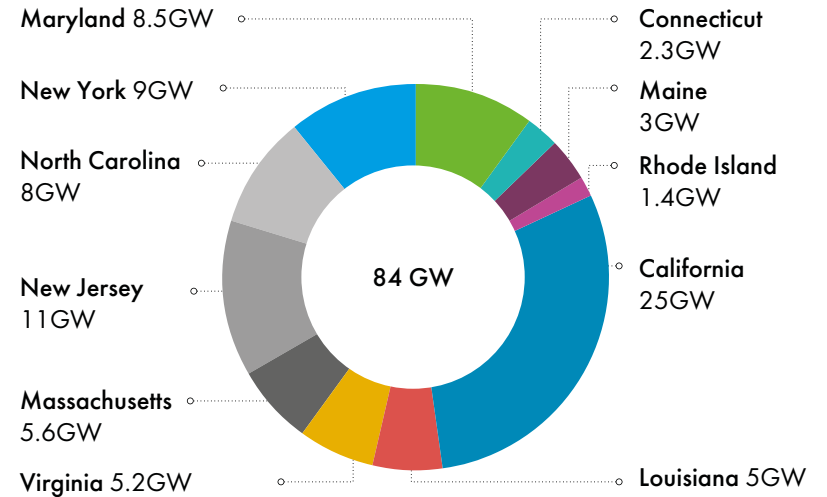
**United States**

The US only has 42 MW of offshore wind capacity in operation but 938 MW of projects under construction, with 17.4 GW in advanced development (with planned commission date already announced) and more than 30 GW in the early stage of development.

To support the offshore wind target of 30 GW by 2030 set by the Biden Administration, as well as the recently announced floating wind target of 15 GW by 2035, the Bureau of Ocean Energy Management (BOEM) held three lease sales in 2022, of which the one off central and northern California is the first-ever offshore wind lease sale on the US West Coast and the first-ever to support floating wind in this country.

In February, BOEM announced its proposal for the first offshore wind lease sale in the Gulf of Mexico with the final sale notices issued in July. In the same month, BOEM issued a Record of Decision (ROD) to Ocean Wind 1. In August, BOEM issued a ROD for the 704 MW Revolution

**US State-level offshore wind development targets**



Wind project, making it the fourth US offshore wind project to have received a final permit.

At the state level, with new offshore wind targets recently announced in Louisiana, California, Maryland and Maine and an upgraded target in New Jersey, combined state-level offshore wind development targets passed 80 GW by June 2023.

Although the US has made great progress in offshore wind capacity building in the past 12 months, challenging market conditions – namely, higher inflation, increased

capital costs and supply chain constraints – have created problems for ten US offshore wind projects totalling 10.3 GW off the eastern coast. Those challenges have forced developers to request a revision of their offtake contracts or to terminate signed PPAs. Rhode Island’s state utility decided not to sign a PPA with developers.

GWEC Market Intelligence is therefore pushing back the commissioning dates and downgrading its 2030 offshore wind outlook for the US by 2.3 GW relative to the previous year’s outlook.

# Floating Offshore Market Outlook to 2032

80% of the world's offshore wind resource potential lies in waters deeper than 60m, but only 188 MW of net floating wind capacity is in operation worldwide, accounting for 0.3 % of total installed offshore wind capacity as of the end of 2022.

Following the installation of the world's first MW-scale floating offshore wind turbine in Norway in 2009, demonstration projects have been installed in both Europe and Asia Pacific. Following more than a decade of testing, in the early 2020s, floating wind passed the demonstration stage and entered the pre-commercial phase.

Since the release of our Global Offshore Wind Report 2022, progress has been made in every region around the world. In Europe, the UK government added three more floating wind projects after Crown Estate Scotland completed the clearing process for the ScotWind seabed leasing round in August 2022, bringing the total floating wind capacity awarded through the ScotWind leasing round to nearly 18 GW.

In March 2023, 13 floating offshore

wind projects with a combined capacity of around 5.5 GW were selected by Crown Estate Scotland in the Innovation and Targeted Oil and Gas (INTOG) leasing round. Additionally, another 4 GW of floating wind capacity is expected to be allocated from the proposed seabed leasing in the Celtic Sea later this year.

In North America, to achieve the US federal government's 15 GW by 2035 floating wind target, BOEM not only held lease sales off central and northern California last December, with more than 4.6 GW of floating wind capacity expected to be built, but also completed a draft environmental assessment for a floating wind research lease in the Gulf of Maine this summer.

In Asia Pacific, China's Renewable Energy Engineering Institute approved the feasibility study for phase one of the 1 GW Wanning floating wind demonstration project in September 2022. The 200 MW capacity from phase one is scheduled to be connected by end of 2025, with the remaining capacity to be added by end of 2027. In addition, the past 12 months saw

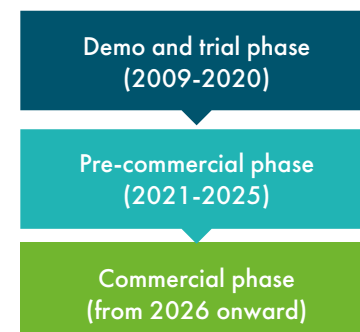
Europe-based developers and oil and gas companies joining forces with developers in South Korea to develop the local floating pipeline, with preferred turbine suppliers already selected for nearly 2 GW of projects.

Although the global floating offshore wind pipeline doubled in the past 12 months and now tops 240 GW, we predict that the commercialisation of floating wind will not be reached until 2026/2027.

Taking into account the higher cost of floating wind compared with fixed-bottom, the impact of the current challenging economic and financial conditions on offshore wind project development, as well as the expected supply chain bottlenecks in floating wind foundations and port facilities, GWEC Market Intelligence has downgraded its global floating wind forecast and predicts 10.9 GW to be built globally by 2030, 42% lower than the previous year's projection.

The UK, Norway, Portugal, China and Japan are the top five markets in total net floating wind installations. By the end of 2030, the UK, South Korea,

## Roadmap of floating offshore wind commercialisation





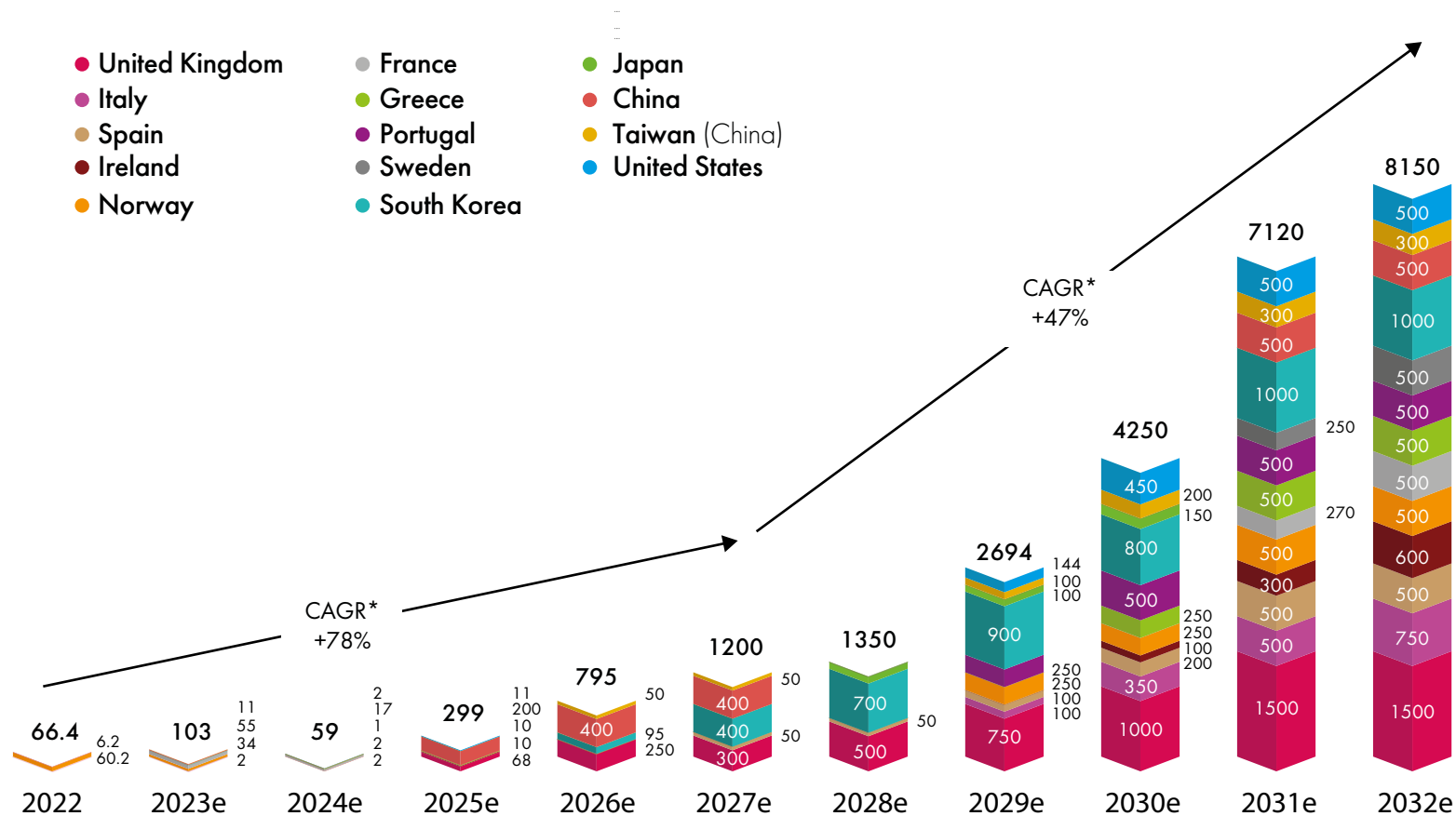
China, Portugal and Norway are likely to be the top five floating markets.

GWEC Market Intelligence predicts floating wind to become fully commercialised towards the end of this decade and multi-GW levels of new installations to be achieved post 2029/2030. Therefore, only 9% (2.5 GW) of the total projected new additions (26 GW) will be installed in the first half of the forecast period.

As for regional distribution, we expect Europe to contribute 66% of total installations added in 2023–2032, followed by APAC (32%) and North America (6%). As of the end of 2032, a total of 26.2 GW of floating wind is likely to be installed worldwide, bringing its contribution to total wind installations from today's 0.3% to 6%.

Our near-term (2023–2027) outlook is primarily based on the existing global floating offshore project pipeline, but a top-down approach has been applied for the medium-term (2028–2032) outlook, which takes into account national floating wind targets, announced auction plans and the project pipelines announced by major offshore wind developers.

New floating wind installations, Global (MW)\*\*



\*Compound Annual Growth Rate, \*\*Note: this floating wind outlook is already included in GWEC's global offshore wind forecast. Source: GWEC Market Intelligence, July 2023

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# APPENDIX



# Global Offshore Wind Report 2023 - Methodology and Terminology

## Data definitions and adjustments

GWEC reports installed and fully commissioned capacity additions and total installations. New installations are gross figures not deducting decommissioned capacity. Total installations are net figures, adjusted for decommissioned capacity.

Historic installation data has been adjusted based on the input GWEC received. GWEC made the adjustments

to both new and cumulative installations over the course of time.

All currency figures in \$ are given in US Dollars.

## Definition of regions

GWEC adjusted its definition of regions for the 2018 Global Wind Report and maintains these in the 2023 edition, specifically for Latin America and Europe.

**Latin America:** South, Central America and Mexico

**Europe:** Geographic Europe including Norway, Russia, Switzerland, Turkey, Ukraine

## Sources for the report

GWEC collects installation data from regional or country wind associations. For the supply side data, GWEC collects directly from wind turbine

OEMs and component suppliers.

## Used terminology

GWEC uses terminology to the best of our knowledge. With the wind industry evolving certain terminology is not yet fixed or can have several connotations. GWEC is continuously adapting and adjusting to these developments.

## Acronyms

<b>Aneel</b>	Agência Nacional de Energia Elétrica (National Electric Energy Agency)	<b>DOI</b>	Department of Interior (US)	<b>IRENA</b>	International Renewable Energy Agency	<b>NT</b>	New Taiwan Dollar (currency)
<b>APAC</b>	Asia Pacific	<b>DP</b>	Democratic Party	<b>ISTS</b>	Inter-State Transmission System	<b>PDP8</b>	Power Development Plan VIII
<b>AUD</b>	Australian Dollar (currency)	<b>EBL</b>	Electricity Business Licences	<b>JETP</b>	Just Energy Transition Partnership	<b>POEM</b>	Spanish acronym for MSP
<b>BOEM</b>	Bureau of Ocean Energy Management (US)	<b>EEZ</b>	Exclusive Economic Zone	<b>JWPA</b>	Japan Wind Power Association	<b>PPA</b>	Power Purchase Agreement
<b>BOWE</b>	Bass Offshore Wind Energy	<b>EHB</b>	European Hydrogen Bank	<b>kWh</b>	Kilowatt-hour	<b>PPP</b>	People's Power Party
<b>BSH</b>	Germany's Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie)	<b>EIA</b>	Environmental Impact Assessment	<b>LCOE</b>	Levelized Cost of Electricity	<b>RfS</b>	Request for Selection
<b>CO2</b>	Carbon Dioxide	<b>ESA</b>	European Space Agency	<b>LCAs</b>	Life Cycle Assessments	<b>ROD</b>	Record of Decision (US)
<b>COP26</b>	26th UN Climate Change Conference of the Parties	<b>ESIA</b>	Environmental and Social Impact Assessment	<b>LCRs</b>	Local Content Requirements	<b>RRF</b>	Recovery and Resilience Facility
<b>COP28</b>	28th Conference of the Parties	<b>EVOS</b>	Energy Virtual One-Stop Shop	<b>MACs</b>	Maritime Area Consents	<b>RTC</b>	Round-the-Clock
<b>CSIR</b>	Council for Scientific and Industrial Research	<b>EZK</b>	Dutch Ministry of Economic Affairs and Climate Policy	<b>MNRE</b>	Ministry of New and Renewable Energy	<b>SNCF</b>	Société Nationale des Chemins de fer Français
<b>CRIS</b>	Cost Recovery Implementation Statement (Australia)	<b>FiT</b>	Feed-in Tariff	<b>MOFCOM</b>	Ministry of Commerce (China)	<b>SPIC</b>	State Power Investment Corporation (China)
<b>DKK</b>	Danish Krone (currency)	<b>GDP</b>	Gross Domestic Product	<b>MW</b>	Megawatts	<b>TSO</b>	Transmission System Operator
<b>DOE</b>	Department of Energy (US)	<b>GOWA</b>	Global Offshore Wind Alliance	<b>NEPA</b>	National Environmental Policy Act	<b>TW</b>	Terawatts
		<b>GWh</b>	Gigawatt-hour	<b>NGO</b>	Non-Governmental Organization	<b>USD</b>	United States Dollar (currency)
		<b>GW</b>	Gigawatts	<b>NOAA</b>	National Oceanic and Atmospheric Administration	<b>UKRI</b>	UK Research and Innovation
		<b>GWEC</b>	Global Wind Energy Council	<b>NREL</b>	National Renewable Energy Laboratory	<b>US</b>	United States
		<b>HK</b>	Hong Kong Dollar (currency)	<b>NRRP</b>	National Recovery and Resilience Plan	<b>VGF</b>	Viability Gap Funding
		<b>HVDC</b>	High-Voltage Direct Current			<b>WFA</b>	WindFloat Atlantic
		<b>INTOG</b>	Targeted Oil and Gas			<b>WTO</b>	World Trade Organization
		<b>IRA</b>	Inflation Reduction Act			<b>WTIVs</b>	Wind Turbine Installation Vessels

# About GWEC Market Intelligence

GWEC Market Intelligence provides a series of insights and data-based analysis on the development of the global wind industry. This includes a market outlook, country profiles, policy updates, deep-dives on the offshore market among many other exclusive insights.

GWEC Market Intelligence derives its insights from its own comprehensive databases, local knowledge and leading industry experts.

The market intelligence team consists of several strong experts with long-standing industry experience across the world.

GWEC Market Intelligence collaborates with regional and national wind associations as well as its corporate members.

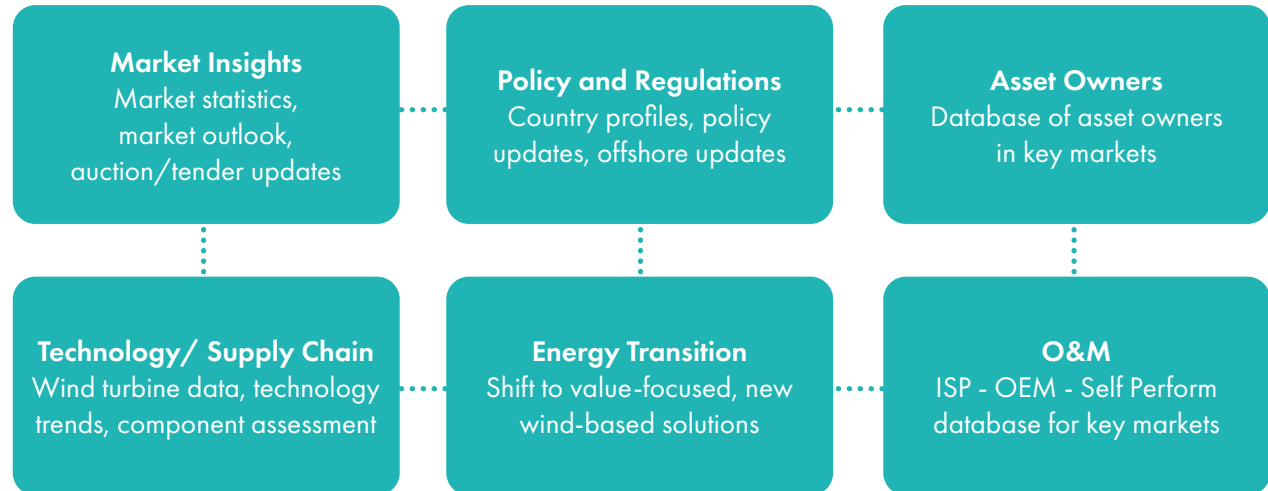
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- Wind energy associations
- Market Intelligence subscription

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## GWEC Market Intelligence Areas



GWEC Market Intelligence created a Member-only area to provide more in-depth market intelligence to GWEC's members and their employees.

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# GWEC Market Intelligence Products in 2023

Product	Frequency
<b>1. Wind Energy Stats/Market Data</b>	
Wind Stats 2022 (historic annual, accumulative, decommission data)	Annual
Global Wind Report 2023	Annual
Wind Energy Statistics (wind energy penetration rate, jobs)	Annual
<b>2. Country Profiles/Policy Updates</b>	
Country Profiles Onshores/Country Profiles Offshore	Annual
Ad-hoc Policy Updates	Ad-hoc
<b>3. Market Outlook</b>	
Global Wind Market Outlook 2023-2027 (Q1 and Q3) Database + Report	Semi-Annual
India Market Outlook Report 2023-2027	Annual
Global Wind Workforce Outlook 2023-2027	Annual
<b>4. Supply Side Data</b>	
Global Wind Turbine Supply Side Data Report 2022 (by OEM, by technology, by turbine ratings, models and drive train, etc)	Annual
<b>5. Auctions/Tenders</b>	
Global Wind Auction Database Annual/Auction Trends and Learnings	Quarterly
<b>6. Offshore Wind Market</b>	
Global Offshore Wind Report 2023 / Market Entry Opportunities Database	Annual/Quarterly
Global Offshore Project Pipeline (database, in operation and under construction)	Annual/Quarterly
Global Offshore Turbine Installation Vessel Database and Report	Annual/Quarterly
<b>7. Components Assessment</b>	
Blade (Q4 2023), Generator (Q4 2021), Gearbox (Q4 2022), followed by other components	Special Report
<b>8. Wind Asset Owners/Operators</b>	
Asset Owners and Operators Database (Onshore & Offshore Ranking)	Annual
Asset Owners and Operators Status Report (including strategical trends)	Annual
<b>9. O&amp;M</b>	
O&M Service Provider Database (ISP - OEM - Self-perform)	Annual
O&M Service Provider Status Report (including regional trends)	Annual
<b>10. Energy transition, Digitalisation, New Technologies</b>	
Position papers / studies - permitting, Corporate PPAs / New solutions, GWEC policy recommendations	Special Report

# GWEC Global Leaders

The Global Wind Energy Council's Global Leaders are an exclusive leadership group of decision-makers and top-tier members who form the basis of the Association's Executive Committee, which drives the work programme and plays a major role in shaping GWEC's priorities for its efforts in the short and long-term strategy.



### Siemens Gamesa

Siemens Gamesa unlocks the power of wind. For more than 40 years, we have been a pioneer and leader of the wind industry, and today our team of more than 26,000 colleagues work at the center of the global energy revolution to tackle the most significant challenge of our generation – the climate crisis. With a leading position in onshore, offshore, and service, we engineer, build and deliver powerful and reliable wind energy solutions in strong partnership with our customers. A global business with local impact, we have installed more than 120 GW and provide access to clean, affordable and sustainable energy that keeps the lights on across the world, while supporting the communities where we operate.



### Shell

Shell is building a global integrated power business spanning electricity generation, trading and supply. Shell entered the

offshore wind business in 2000 as part of a consortium that installed the first offshore wind turbine in UK waters. Today, we have deployed, or are developing, over eight gigawatts (GW) of wind across North America, Europe, the UK, and Asia. We see offshore wind as a critical way of generating renewable electricity for our customers and moving Shell towards its target of being a net-zero emissions energy business by 2050 or sooner, in step with society.



### Ørsted

The Ørsted vision is a world that runs entirely on green energy. Ørsted develops, constructs, and operates offshore and onshore wind farms, solar farms, energy storage facilities, renewable hydrogen and green fuels facilities, and bioenergy plants. Moreover, Ørsted provides energy products to its customers. Ørsted is the only energy company in the world with a science-based net-zero emissions target as validated by the Science Based Targets initiative (SBTi). Ørsted ranks as the world's most sustainable energy company in Corporate Knights' 2022 index of the Global 100 most sustainable corporations



### Mainstream Renewable Power

Mainstream Renewable Power is a leading pure-play renewable energy company, with wind and solar assets across global markets, including in Latin America, Africa, and Asia-Pacific. Mainstream is one of the most successful developers of gigawatt-scale renewables platforms, across onshore wind, offshore wind, and solar power generation. It has successfully delivered 6.5 GW of wind and solar generation assets to financial close-ready. In May 2021, Aker Horizons acquired a 75% equity stake in the company, accelerating its plans to deliver its high-quality pipeline of over 16 gigawatts of clean energy. Mainstream has raised more than EUR3.0bn in project finance to date and employs more than 420 people across five continents.



### GE Renewable Energy

GE Renewable Energy harnesses the earth's most abundant resources – the strength of the wind, the heat of the sun and the force of water; delivering green electrons to power the world's biggest economies and the most remote communities. With an innovative spirit and an entrepreneurial mindset, we engineer

in the world and is recognised on the CDP Climate Change A List as a global leader on climate action.



### Iberdrola

With over 170 years of history behind us, Iberdrola is now a global energy leader, the number one producer of wind power, and one of the world's biggest electricity utilities in terms of market capitalisation. We have brought the energy transition forward two decades to combat climate change and provide a clean, reliable and smart business model, to continue building together each day a healthier, more accessible energy model, based on electricity



### Vestas

Vestas is the energy industry's global partner on sustainable energy solutions. We design, manufacture, install, and service wind turbines across the globe, and with +151 GW of wind turbines in 86 countries, we have installed more wind power than anyone else.

Through our industry-leading smart data capabilities and +129 GW of wind turbines under service, we use data to interpret, forecast, and exploit wind resources and deliver best-in-class wind power solutions. Together with our customers, Vestas' more than 29,000 employees are bringing the world sustainable energy solutions to power a bright future.



### Equinor

We are looking for new ways to utilise our expertise in the energy industry, exploring opportunities in new energy and driving innovation in oil and gas around the world. We know that the future has to be low carbon. Our ambition is to be the world's most carbon-efficient oil and gas producer, as well as driving innovation in offshore wind and renewables. We plan to reach an installed net capacity of 12-16 GW from renewables by 2030, two-thirds of this will be from offshore wind. With five decades of ocean engineering and project management expertise, focus on safe and efficient operations, in depth knowledge of the energy markets, skilled personnel and a network of competent partners and suppliers, Equinor is uniquely positioned to take a leading role in the offshore wind industry. From building the world's first floating wind farm to building the world's biggest offshore wind farm we are well underway to deliver profitable growth in renewables be a leading company in the energy transition.



### Corio

Corio Generation is a specialist offshore wind business dedicated to harnessing renewable energy worldwide. Our 20+ GW development portfolio is one of the largest in the world, spanning established and emerging markets, as well as floating and fixed-bottom technologies.

With our leading industrial expertise and deep access to long-term capital, we work

closely with our partners in the creation and management of projects from origination, development and construction, and into operations.

Corio Generation is a Green Investment Group (GIG) portfolio company, operating on a standalone basis. GIG is a specialist green investor within Macquarie Asset Management, part of Macquarie Group.



### CIP

Founded in 2012, Copenhagen Infrastructure Partners P/S (CIP) today is the world's largest dedicated fund manager within greenfield renewable energy investments and a global leader in offshore wind. The funds managed by CIP focuses on investments in offshore and onshore wind, solar PV, biomass and energy-from-waste, transmission and distribution, reserve capacity, storage, advanced bioenergy, and Power-to-X.

CIP manages ten funds and has to date raised approximately EUR 19 billion for investments in energy and associated infrastructure from more than 140 international institutional investors. CIP has approximately 400 employees and 11 offices around the world



### SSE

SSE Renewables is a leading developer and operator of renewable energy,

headquartered in the UK and Ireland, with a growing presence internationally. Its strategy is to lead the transition to a net zero future through the world-class development, construction and operation of renewable power assets and it is building more offshore wind energy than any other company in the world. Part of the FTSE-listed SSE plc, SSE Renewables is taking action to double its installed renewable energy capacity to 8GW by 2026 as part of its Net Zero Acceleration Programme, and increase renewables output fivefold to over 50TWh annually by 2031.



### ReNew

ReNew is the leading decarbonisation solutions company listed on Nasdaq (Nasdaq: RNW, RNWWW). ReNew's clean energy portfolio of ~13.4 GWs on a gross basis as of December 31, 2022, is one of the largest globally. In addition to being a major independent power producer in India, we provide end-to-end solutions in a just and inclusive manner in the areas of clean energy, green hydrogen, value-added energy offerings through digitalization, storage, and carbon markets that increasingly are integral to addressing climate change.



### Envision

Envision Group is a world-leading green technology company and net zero technology partner. With the mission of "solving the challenges for the sustainable future of humankind". Envision designs,

sells, and operates smart wind turbines, smart storage system and green hydrogen solutions. It continues to promote wind and solar power as the "new coal", batteries and hydrogen fuel as the "new oil", the AIoT network as the "new grid", the net-zero industrial parks to the "new infrastructure", and to promote the construction and cultivation of green "new industry".

Envision Group was ranked among the Top 10 of the 2019 'World's 50 Smartest Companies' by the MIT Technology Review. In October 2021, Envision was ranked second in the world on the Fortune "Change the World" list. Envision Group joined the global 'RE100' initiative and became the first company in mainland China committed to 100% renewable electricity by 2025.

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