Offshore Infrastructure Regulator

Offshore wind energy
December 2023

The Offshore Infrastructure Regulator has responsibility for overseeing work health and safety, infrastructure integrity and environmental management for offshore infrastructure activities in the Commonwealth offshore area.

Winds of change

The global offshore wind sector has undergone rapid expansion in recent years with major advances in technology and cost reductions, making offshore wind an increasingly competitive option for large scale energy generation.

Europe has traditionally been the global leader in offshore wind from a technology and generation capacity perspective, however the Asia-Pacific region has surged forward recently, with China leading the world in new installed capacity since 2019[1].

In addition to China, Australia's regional neighbours Vietnam, Taiwan, Japan and South Korea are rapidly adopting offshore wind technologies as the global move to a lower carbon energy future gathers pace (Figure 1).

Global interest in Australia's offshore wind potential is increasing with a number of highly prospective sites for offshore wind energy generation around the continent.

A site is considered to be suitable for an offshore wind project if it has high and relatively consistent wind speeds, water depths are appropriate, and the site is either able to be connected to an electricity grid or is in a suitable location for the generation of energy export products such as hydrogen and ammonia.

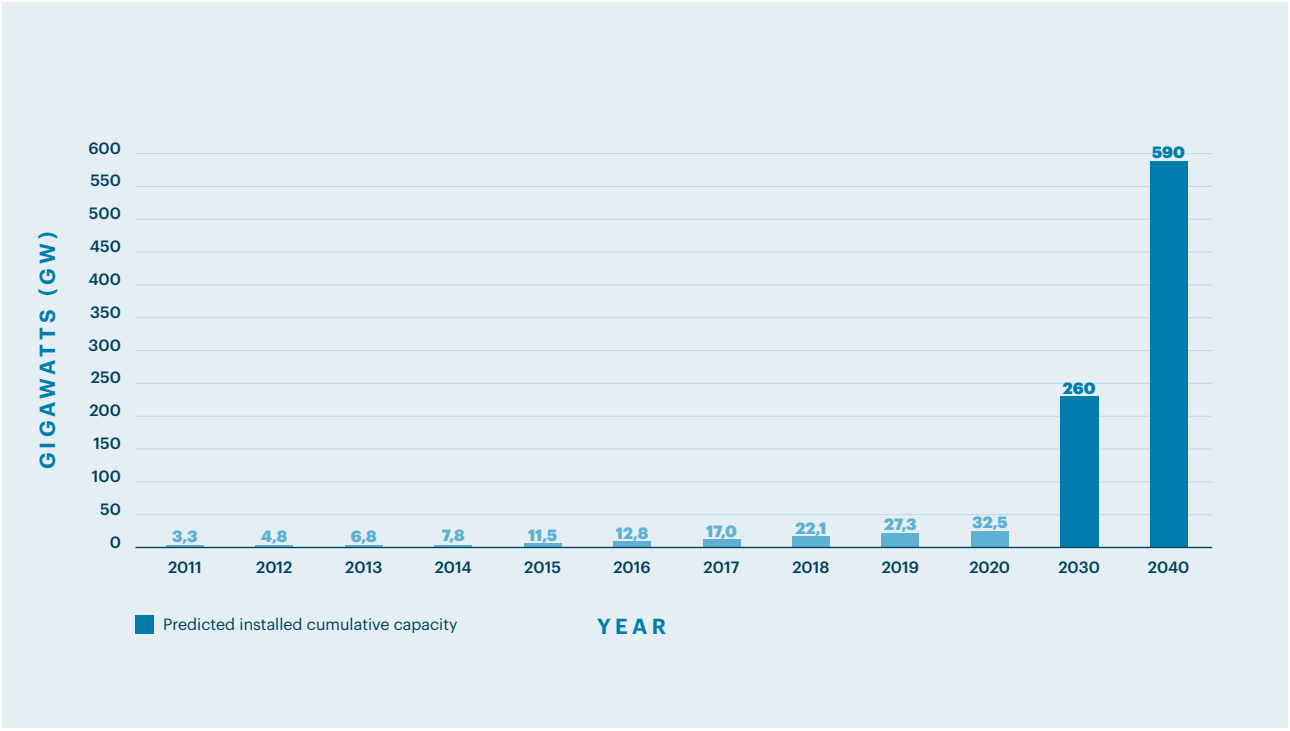


Figure 1. Global cumulative installed offshore wind generation capacity in operation and future predictions[2]

[1] Global Wind Energy Council (GWEC) – Global Offshore Wind Report 2023 GWEC.net.

[2] Sources: World Forum Offshore Wind (2021), International Renewable Energy Agency, Future of Wind Paper (2019), 4C Offshore 2022a and BloombergNEF 2021a.

Offshore wind technologies

The wind industry has experienced significant technological advancements over the past few decades in terms of the size and generation capacity of wind turbines.

In the 1980's wind turbines were approximately 17 metres tall with a capacity of around 75 kilowatts (or .75 megawatts (MW)).

The latest generation of offshore wind turbines are up to 250 metres tall and have a generation capacity of up to 15,000 kilowatts (or 15 MW). To put that in perspective one of these turbines can produce enough electricity in a year to power approximately 20,000 households and save around 38,000 tonnes of carbon dioxide emissions. That's the equivalent of removing about 25,000 passenger cars from the road every year[3].

Technology continues to advance at pace with floating offshore turbine technologies allowing access to a far greater range of suitable offshore locations for energy generation.

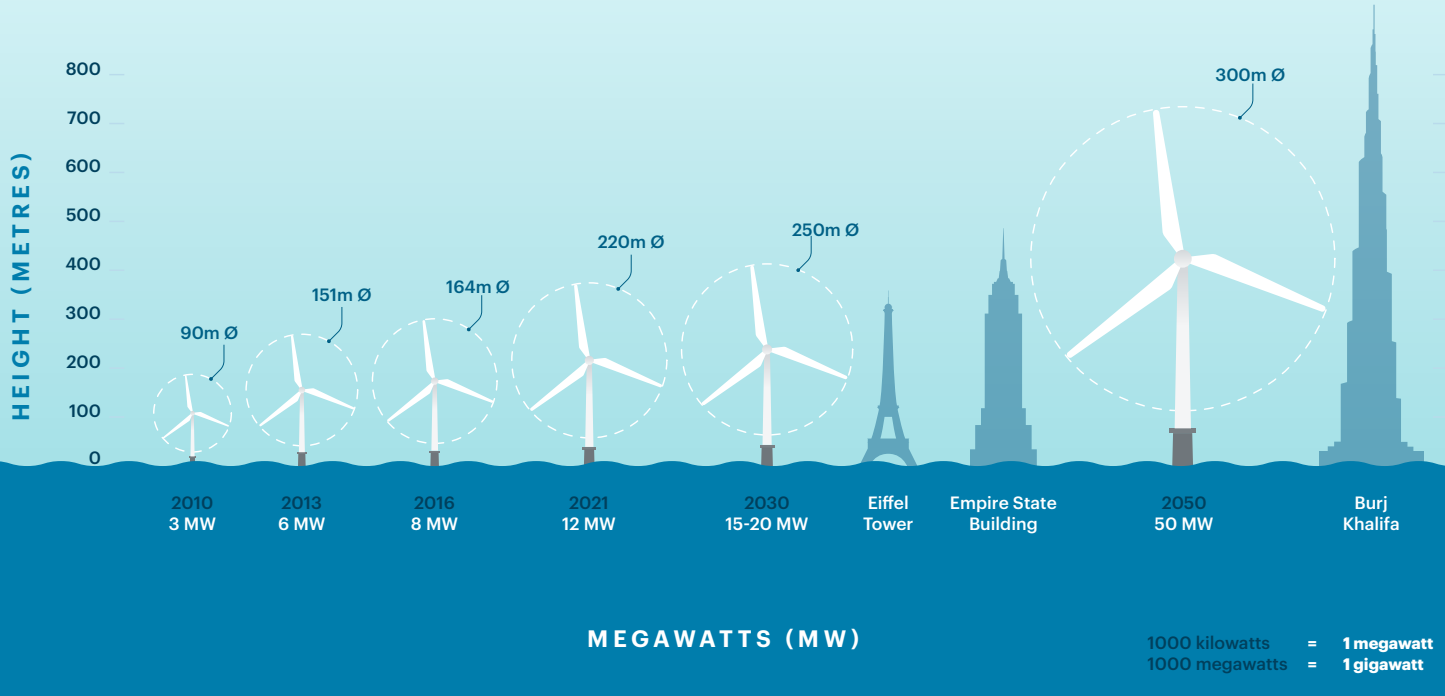


Figure 2. Evolution of wind turbine size and power output

[3] vestas.com.

Why go offshore?

Australia is fortunate to have a large landmass, a relatively small population and abundant solar and wind resources.

So why would you build wind farms offshore? The short answer - bigger is better.

Whilst building wind farms onshore can reduce challenges and costs associated with operating in the marine environment, there are transport and logistical constraints which limit how large an individual turbine can be[4].

Other factors such as competing land uses, socioeconomic and environmental impacts, proximity to markets and generally lower and less consistent wind speeds limit the potential size, generation capacity and efficiency of onshore wind installations[5].

Taking wind offshore reduces or removes many of these constraints allowing wind farms to be scaled up to generate more energy, more efficiently, with fewer installations. These benefits, combined with access to more reliable and consistent wind speeds and reducing costs means that offshore wind farms are becoming increasingly competitive in the global energy market.

In some locations, offshore wind has already become the most cost competitive option for new generation with further efficiencies expected from economies of scale and future innovation.

[4] The largest onshore wind turbines have a capacity of around 6,000 kilowatts (ge.com; vestas.com).

[5] The report "Wind Energy in Europe 2019" showed onshore wind farms generated on average 24% of their total capacity compared to 38% for offshore wind farms windeurope.org.

What does an offshore wind farm look like?

An offshore wind farm consists of generation and transmission infrastructure.

The number of wind turbines to be installed will depend on the intended generating capacity of the wind farm. Using current technologies and dependent on site specific factors such as wind speeds, a 1 gigawatt (GW) (1,000 MW) offshore wind farm may need between 60 and 100 turbines.

Turbines are connected via subsea cables to offshore electrical substations which regulate current and boost voltage for export to onshore grid connection infrastructure via a high voltage export cable.

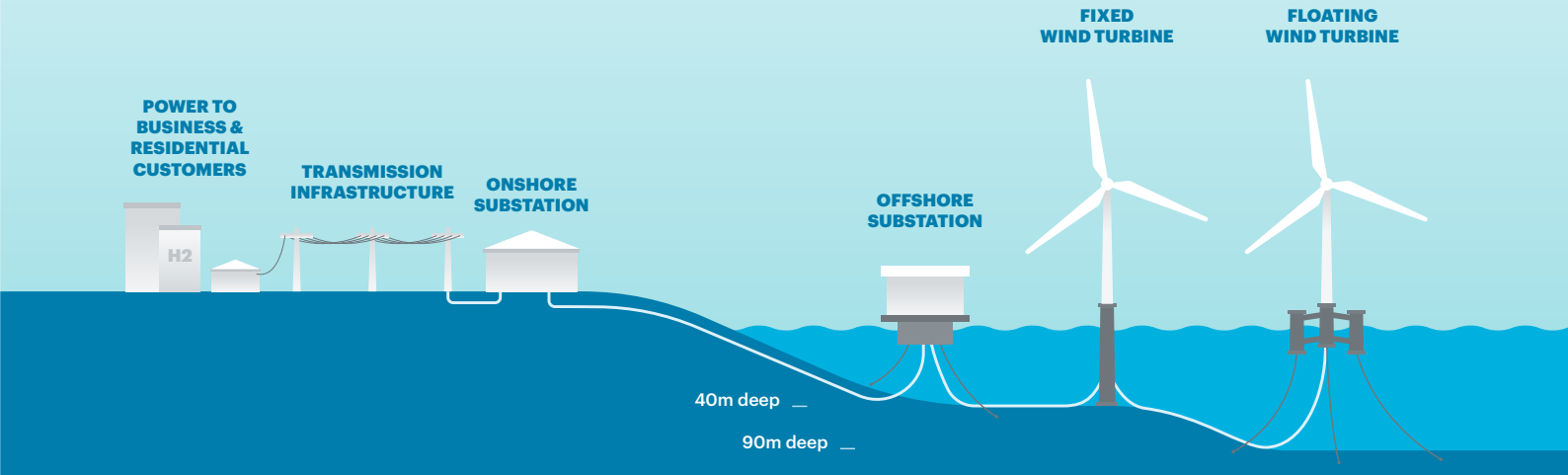


Figure 3. Typical example of an offshore wind farm

Fixed and floating offshore wind turbines

Fixed bottom foundations and floating turbines are the two primary technologies for offshore wind energy.

Turbines with a fixed foundation are secured directly to the seabed.

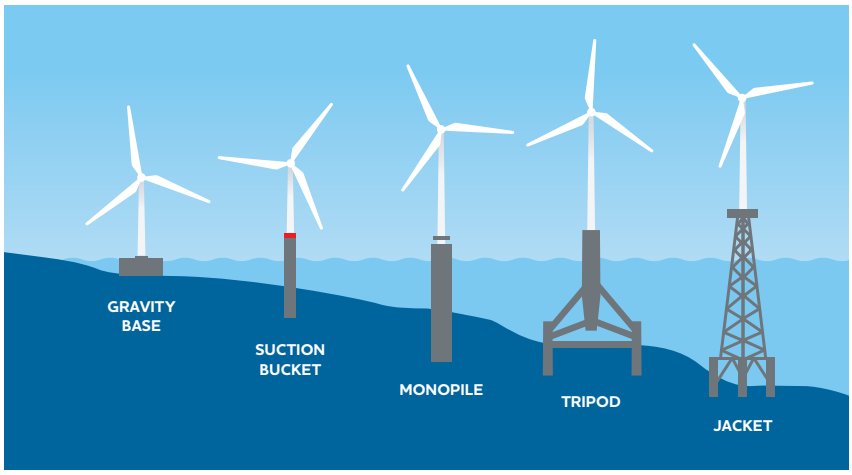
The type of fixed foundation on which the offshore wind turbine can be installed will be dependent on water depth and substrate conditions.

Fixed foundation turbines are limited to water depths of 30-80 metres[6].

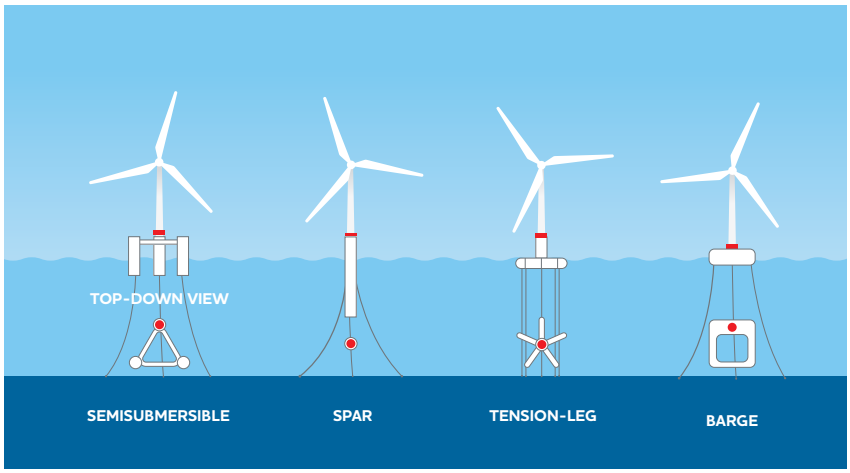
Floating turbines are mounted on a floating foundation, secured by anchored cables to the seabed.

Floating turbines have the ability to be installed at greater depths, allowing them to access many of Australia's best offshore wind resources.

By 2050, the contribution of floating offshore wind is predicted to represent 6% of the offshore wind share, with a total installed capacity of around 300 GW[7].

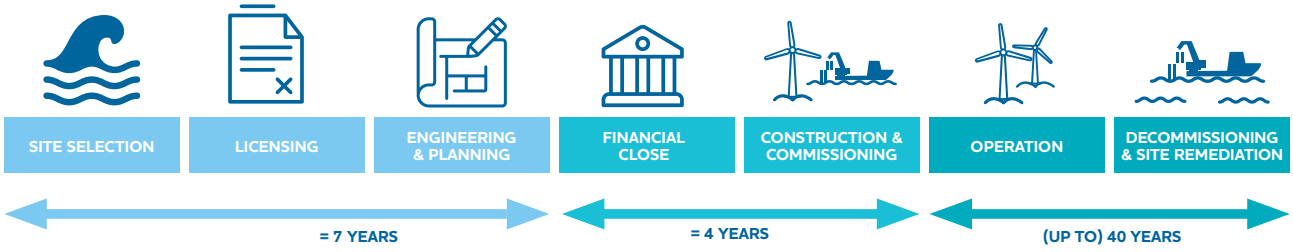


Typical fixed foundations (not to scale)



Typical floating foundations (not to scale)

Timeframe for a typical offshore wind farm development



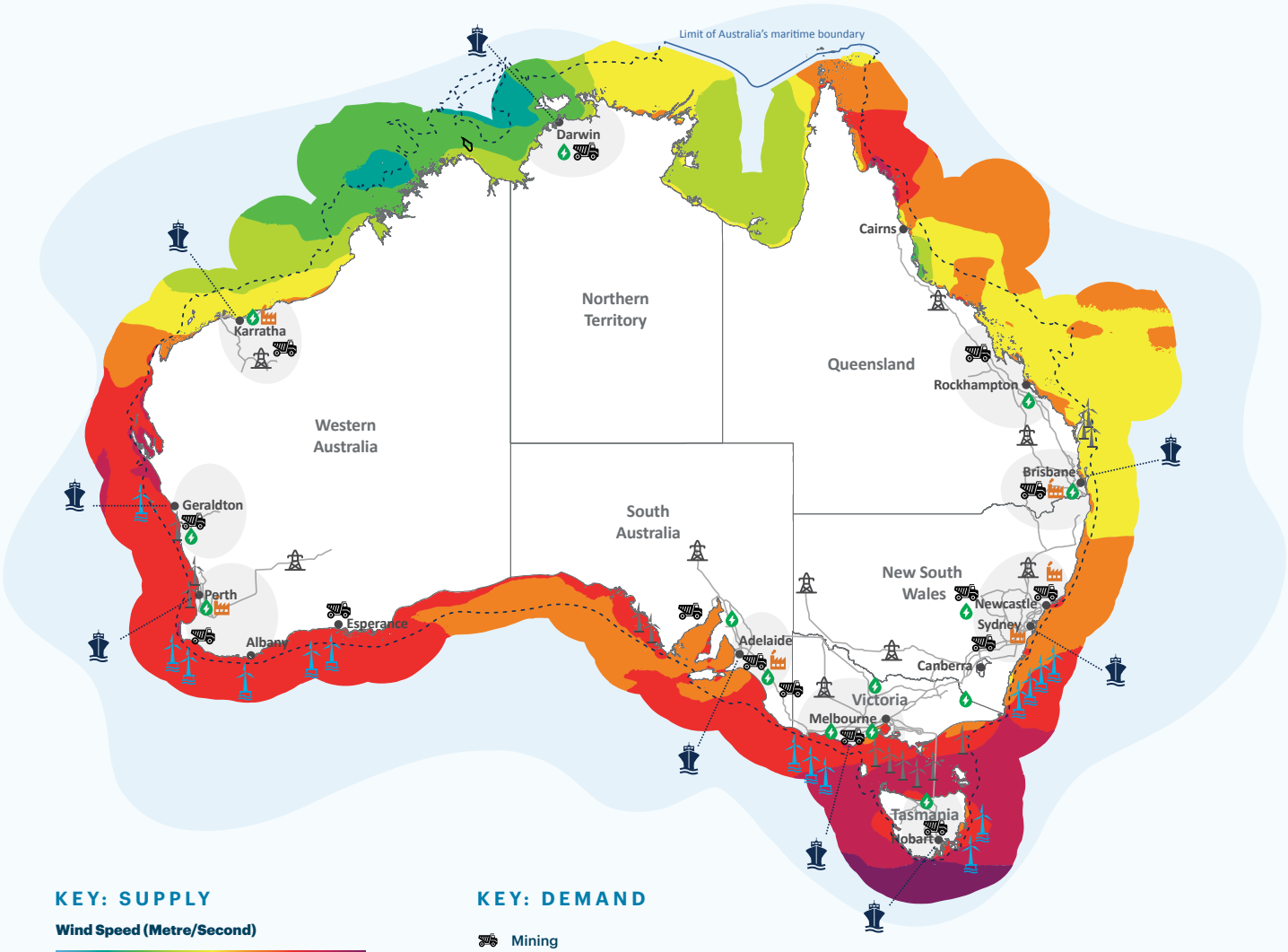
[6] Fixed Offshore Wind | Tethys (pnnl.gov).

[7] DNV 2023, Floating Wind: Turning Ambition into Action.

Offshore wind potential in Australia

Australia possesses world class offshore wind resources. The Global Wind Energy Council estimates Australia has the potential to generate up to 5,000 gigawatts (GW) of electricity from offshore wind using a combination of fixed and floating infrastructure. This represents more than 80 times the installed capacity of Australia's two largest electricity networks.

Australia's highest quality offshore wind resources are generally in the southern half of the continent adjacent to large population centres, industrial hubs and mining projects. International offshore wind developers are increasingly recognising the potential of Australia as an emerging market. Offshore wind represents a proven and competitive generation technology that can contribute to the diversification of Australia's energy mix.



KEY: SUPPLY

Wind Speed (Metre/Second)

<4 5-6 7-8 9-10 >11

Wind speed data is sourced from the Global Wind Atlas and depicts wind speed at 100 metre hub height at 250 metre resolution.

90 metre mark

Fixed wind turbines
Suitable for water depths of up to 90 metres.

Floating wind turbines
Suitable for water depths greather than 90 metres.

KEY: DEMAND

- Mining
- Green hydrogen potential
- Heavy industry
- Transmission infrastructure
- Ports
- High electricity demand

Offshore Infrastructure Regulator

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