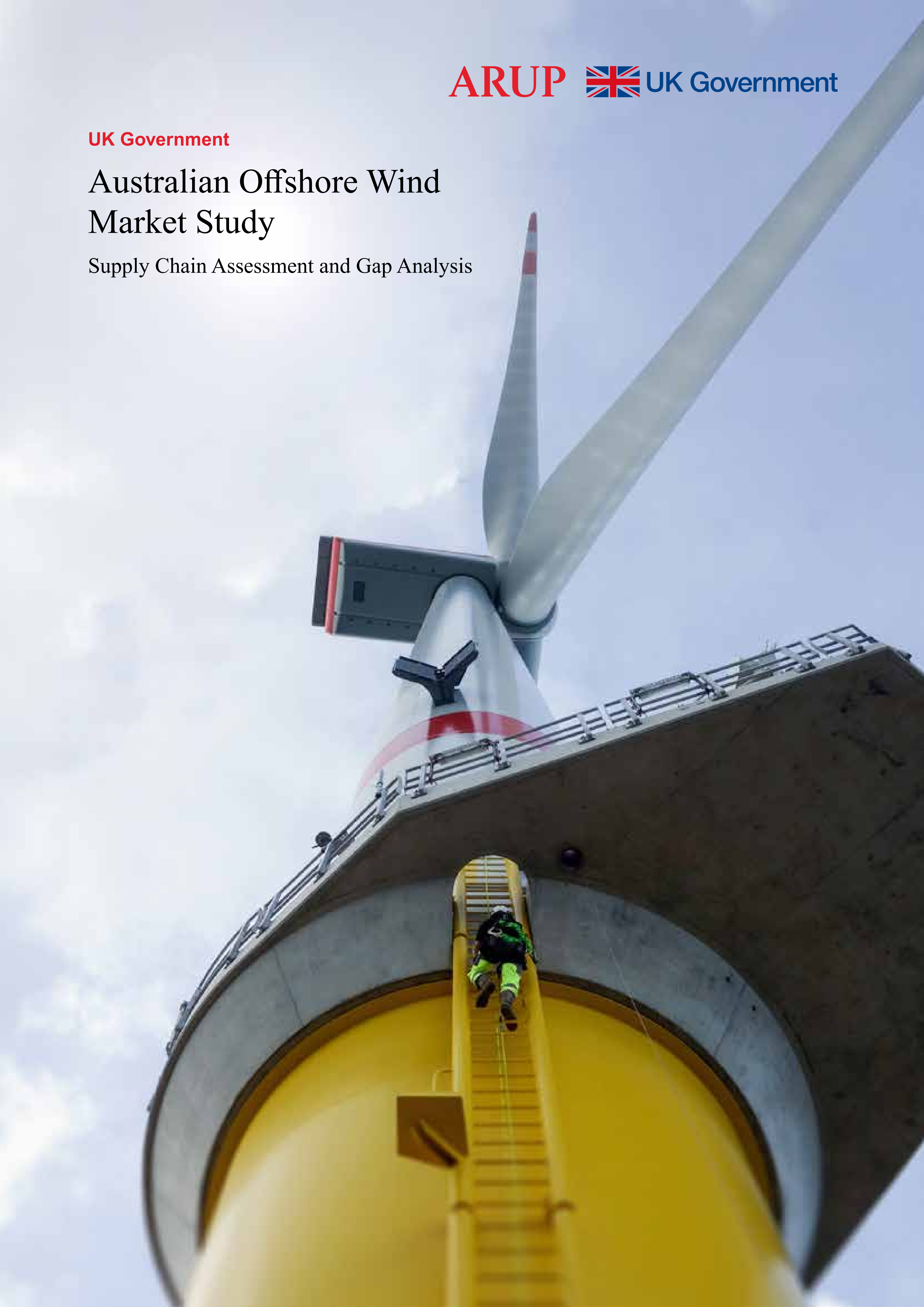
ARUP UK Government

UK Government

Australian Offshore Wind Market Study

Supply Chain Assessment and Gap Analysis



"Australia has committed to Net Zero by 2050. Clean energy is a key element in meeting this target with offshore wind playing a major role. UK skills and experience can support the creation of a viable, vibrant, and sustainable offshore wind industry in Australia.

We chose Arup for their global experience and in-depth local knowledge to deliver this report which highlights opportunities for this developing industry."

Ian Barnett, Senior Trade Development Manager
British Consulate-General

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Foreword

The UK has long been at the forefront of tackling climate change and decarbonising its economy. It was the first major economy to commit to Net Zero by 2050.

Achieving this goal requires an unpreceded transitional change in energy generation, storage and transmission. The UK is in a prime position to support and partner with markets like Australia to deliver energy transition needs.

The offshore wind market is expected to grow at pace. The International Renewable Energy Agency, for example, proposes to install 2,000 GW of offshore wind (OSW) capacity by 2050 to meet the 1.5 degrees scenario. Innovation in offshore wind has and will continue to enable rapid deployment and reduction of cost, making this low-carbon energy source increasingly attractive.

While the Australian offshore wind market is still in its formative stages, the Federal Government is actively accelerating its growth. We are keen to support the development of a successful OSW sector in Australia. In addition to sharing policy expertise, we also want to understand the opportunities for UK developers and suppliers to participate.

In early 2023 the UK Government commissioned Arup to undertake a high-level overview of existing domestic capabilities in Australia that can support the OSW sector, potential gaps where UK supply chain companies could provide support, and barriers which could impede UK industry participation.

It gives me pleasure to launch this report and to amplify the concluding paragraph of the Executive Summary – 'through the strong relationship between the UK and Australia, there is a willingness, openness, and collaborative environment for which Australian OSW can benefit from the support of the UK. The support can take multiple forms, through supporting early-stage development, knowledge and skills sharing, in addition to joint-ventures and partnerships as well as embedment and development of Australian in-country facilities and capabilities in the supply chain to support the national build-out of OSW in Australia'.

Louise Cantillon
British Consul General and
Deputy Trade Commissioner Asia Pacific

Executive Summary

The Australian Offshore Wind (OSW) market is burgeoning, with six priority areas and five (declared and proposed) OSW zones across Victoria, New South Wales, and Tasmania. The Gippsland (Victoria) and the Hunter (NSW) areas have been the first declared zones, commencing the feasibility application process and positioning the market for growth.

The history of OSW in the United Kingdom (UK) dates back to 2000, with the development of the Blyth OSW pilot project comprising two 2MW WTGs (Wind Turbine Generators). Since then, the UK has gone on to be the second largest OSW market globally, with 13.9GW of installed capacity as of 2023.

The knowledge and experience of organisations within the UK to support the fabrication, construction and maintenance of these windfarms has developed to varying degrees across the value chain. In its twenty-three-year history, the UK has managed to provide value to projects supporting domestic and international markets in key areas, also advancing domestic UK supply chain, benefited by both the local content requirements, increasing market surety, infrastructure development and public sector support.

This Supply Chain Assessment has taken a birds-eye view of the Australian OSW market to appreciate the scale and nature of the demand to better recognise the needs to support the market growth.

The analysis used a series of assumptions to convert the projected offshore wind development from giga-watts (GW) into the timeframe and high-level build-up of the scale of the required key componentry and services.

The indicative scale of the market that has been built-up is assumed to be 20-40GW by 2040 under a low and high case. This is based on the assumed development of 9 - 12GW in Victoria, 8 - 12GW in New South Wales and up to 3 – 4.5GW in Western Australia and 3 – 4.5GW in Tasmania, with a potential additional 10GW in later second rounds spread across the various states under the high case. The report then analysed both the UK and Australian supply chain capabilities (as of Q1 2023) to see where the strengths, weaknesses and opportunities lay to bolster the industry growth within Australia.

"Our analysis is helping shape investment and collaboration opportunities needed for growing Australia's offshore wind market – a critical market for creating a scalable renewable energy supply."

Damon Sunderland,
Australasia Offshore Wind Leader, Arup

The analysis has been framed across 27 supply chain categories with the capability ranked in a scale of 1 to 6 (1:E1 being existing highly capable organisations able to provide full capabilities and 6:PW2 being organisations with the need of significant investment to provide the necessary supporting capabilities) across both geographies as shown below (E1 – PW2).

Supply Chain Overall Rating System

Rating Reference	PW2	PW1	P2	P1	E2	E1
Rating Description	Potential support with investment	Potential with investment	Potential support with growth	Potential with growth	Existing support capability	Existing Full Capability

A summary of the study findings for key areas of support for the supply chain categories are highlighted below, where there are strengths within the UK capabilities and potential gaps in the Australian.

Capability	UK (Overall Rating)	Australia (Overall Rating)
Engineering Design	E1	P1
Inter-array Cable	E1	PW1
Blade Manufacture	E1	PW2
Tier 1 – Transport Installation Contractor	E1	PW1
Grouting	E1	P2

As highlighted above, exports from the UK could provide inter array cables (IAC), dynamic cable products and wind turbine blades, strengthened by the tariff free, free-trade agreement between the UK and Australia (Section 5.1.2.1). UK suppliers of these products will require strategies to compete with suppliers who are geographically closer to Australia – noting that the UK is >10,000 nautical miles from Australia. There are also potentially higher associated labour costs in the UK compared to neighbouring Asian supply chains competing in the Australian market. The UK will therefore need to leverage low-carbon, high quality and automated supply chains to enable value to be provided to the Australian Market.

Beyond the key product export opportunities highlighted between the UK and Australia, there are multiple other key services, skills and expertise that the UK will be well positioned to support the Australian OSW market. Through 20+ years of development in the UK market, there has been considerable Research and Development (R&D) that has supported innovation in the technologies, design and the operations to continually improve and pave the way for the industry development. The services the UK could provide include: engineering designers, Tier 1 – foundation transport and installation contracting services, offshore grouting contractor services, operation and maintenance (O&M) contractors and Tier 2 – O&M vessel suppliers and designers, as well as innovative technology and software for improving maintenance and inspection.

Another opportunity for UK business to enter the Australian OSW market is to leverage off the considerable research into lower carbon solutions within the fields of:

- Future fuel vessel design,
- Lower carbon manufacturing,
- Floating offshore wind technologies,
- Specialist advanced technologies/ hardware and software, Supporting project decision making throughout the life-cycle (i.e. automated and remote O&M inspection technologies).

Through the strong relationship between the UK and Australia, there is a strong willingness, openness and collaborative environment for which Australian OSW can benefit from the assistance of the UK. The support can take multiple forms, through supplying services in early-stage development, knowledge and skills sharing, in addition to joint-ventures and partnerships as well as embedment and development of Australian in-country facilities and capabilities in the supply chain to support the national build-out of OSW in Australia.

1. Introduction

Offshore wind energy is a globally fast-growing source of large-scale electricity generation, playing a key role in supporting climate and sustainability targets. While the Australian offshore wind market is still in its formative stages, the Federal Government has been active in promoting the acceleration of its growth.

1.1 Background

In August 2022, the Commonwealth Government announced six areas for potential OSW development, shortly followed by the enactment of the Commonwealth Offshore Electricity Infrastructure Act 2021 (OEI Act). This Act introduced a regulatory framework for licensing offshore activities in declared zones in Commonwealth Waters.

Consultation on the first identified area in Gippsland, Victoria (VIC) was followed by a declaration in December 2022 for 15,000 km^2 of seabed, for which feasibility application submissions closed in April 2023.

The second declared area in Australia was made in July 2023 with the 1,854 km^2 Hunter Zone in NSW, for which the feasibility applications are due in November 2023. The other key areas under consultation are the Illawarra Zone off the coast of Wollongong NSW, the Southern Ocean Zone off the coast of Portland Victoria and the Bass Strait Zone off the northern coast of Tasmania.

State governments are also playing a key part in the country's OSW industry. The VIC government set out its first two implementation statements, outlining crucial areas for the roll-out of OSW including transmission, ports, industrial development and legislation and regulation. It is anticipated that states such as NSW and WA will soon also follow suit.

1.2 Report Context

The UK government is keen to support the development of a successful OSW sector in Australia. In addition to sharing policy expertise from years of involvement in the UK OSW industry, The Foreign Commonwealth & Development Office (FCDO) is interested in understanding the opportunities for UK developers and suppliers to participate.

Arup Australia Pty Ltd (Arup) have been commissioned to provide a high-level overview of existing domestic capabilities in Australia that can support the OSW sector. The review aims to identify potential gaps where UK supply chain companies could provide support, and barriers which could impede UK industry participation.

The industry in Australia is fast paced and quickly evolving.

The information presented in this report is based on the findings of the market and general capabilities across the major supply chain packages as of Q1 2023 noting the following limitations:

The scale of the Australian market is based on assumptions of the potential project awards (GW) within each of the Australian state development areas. There are a number of speculative assumptions on the number of projects and sizing that will proceed. *The values assessed are provided as an indicative number only and based on assumptions that will develop over time.*

The declared areas and associated assumptions are based on the status of the market at Q1 2023 and subject to changes that will likely have implications on some key assumptions.

The projects that have been included are only the publicly announced projects with likely further projects not having been declared (for confidentiality reasons), as well as uncertainty on the future projects beyond this decade.

The number of substructure types have purely been based on the viable water-depth. No design work, or consideration for the geology, met-ocean conditions or other factors have been considered.

The substructure types considered are not comprehensive and there are likely multiple other solutions that could be deployed. The purpose of this report is to highlight the likely high-level number of units split between fixed and floating.

The number of organisations in the study for the capability assessment have been considered under the limited supply chain categories are not exhaustive and limited to a small cross section of firms. There are multiple other supply chain areas that were not considered, nor did the study have the scope or remit to go into the granularity of the multiple other tiers of the supply chain, given the limited scope and timeframe. The study could be further developed, or built on to provide greater granularity and clarity.

The project has been developed with consultation with key organisations and we acknowledge the input and support from MMA Offshore, Wilson Transformers, Global Wind Organisation (GWO) and the Foreign Commonwealth Development Office (FCDO).

2. Market Context

2.1 Scale of Australian market

With the vision of reaching net zero by 2050, the Australian government has pledged to increase renewable electricity generation from 29% to 82% by 2030. To reach these targets, the country will need to more than double its installed renewable energy capacity from 45 GW to 96 GW by 2035[1].

According to the International Energy Agency (IEA) Australia has >4,000 GW of offshore wind potential, more than 50% of which falls within deep water[2]. While there is no installed offshore wind capacity, there are approximately 43 publicly announced projects in the pipeline at various stages of development.

The 43 announced projects belong to only 16 developers and have combined capacity of 86 GW. While all states have at least one planned project, Victoria (VIC) holds the majority (18), closely followed by NSW (12) and Western Australia (WA) (10). 44% of the proposed projects are expected to be floating, with all NSW projects falling into this category.

Currently OSW project development in Australia is anticipated to take 6 to 10 years. Typically, 3 to 5 years is spent in early-stage feasibility and development before approvals and licences are acquired to begin the 3-to-5-year construction process. A summary of the current process from area identification on the part of the government to construction and operation is provided in *Figure 1*.

The most advanced project is currently the Star of the South which has spent the last two years carrying out marine and ecology surveys, engaging community and stakeholders and preparing environmental assessments. The 2.2 GW project is anticipating the award of a lease in the Gippsland area by 2023 and hoping to acquire environmental approvals and licences shortly after.

Figure 2 shows the projected installed offshore wind capacity in Australia based on the announced projects. Given the infancy of the market, there is a limited number of published commercial operation date (COD) estimates for the proposed projects. Published COD estimates were retrieved from the 4COffshore database, and the remainder were estimated according to the duration of a feasibility licence, the location of the proposed project and the type of project technology.

The base case for the estimate assumes an average project timeline of 8 years which includes a full 7-year feasibility licence duration and a year for securing the licence. Assuming the declaration of REZs will be staged throughout the next two to three years, the time added to the base case is conditional on location: Gippsland (0 years), Hunter (0 years), Illawarra (1 year), Southern Ocean (1 year), Bass Strait (2 years), Perth/Bunbury (2 years), and other (5 years). Given supply chain limitations and added development complexity, an additional year is added to projects which utilise floating technology.

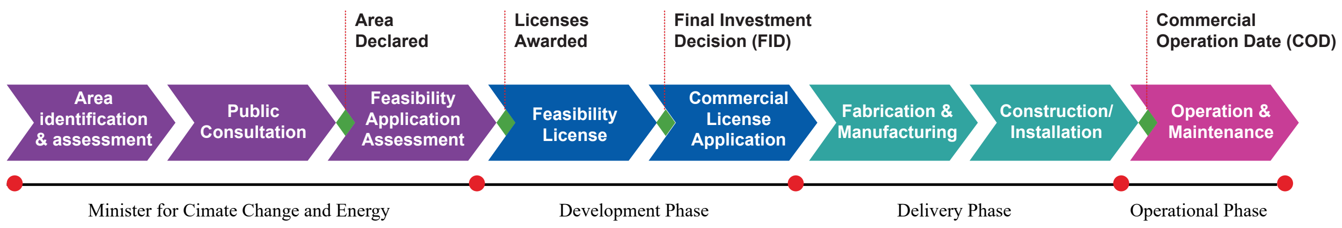


Figure 1 Australian OSW development process timeline

[1] 4COffshore Floating Wind Progress Update H2 2022
[2] International Energy Agency (IEA) Offshore Wind Outlook 2019

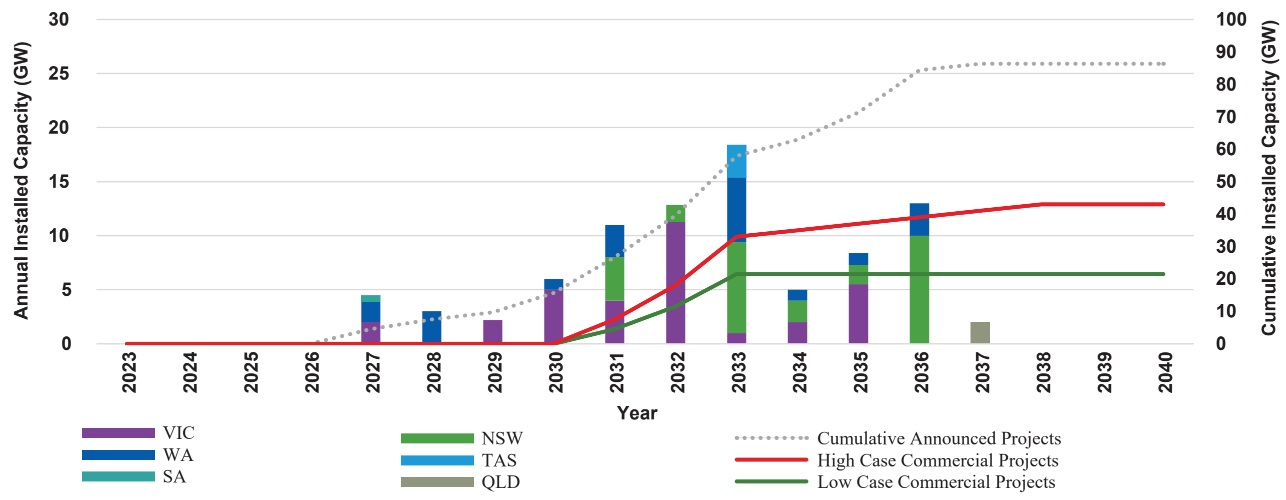


Figure 2 Australian OSW Forecasted Installed Capacity

The cumulative build-out of 86 GW by 2040 is the cumulative scale of all proposed projects, noting that not all of these will be awarded licences, or developed. It is more reasonable to anticipate that each leasing round will have a limited number of awarded projects that progress to reach FID. Taking this bottom-up approach with the anticipated commercial project lines represents a more realistic view of OSW installations. This has been considered for a low and high case as shown below in *Table 1*.

The build-up has assumed Gippsland is awarded 3-5 projects, Hunter, Illawarra, Southern Ocean and Bass Strait, and Perth/Bunbury are each awarded 2-3 and there is an additional 2 added each year until 2038 for any outside of the identified REZs – for the high case. Using these assumptions, total installed OSW capacity within Australia by 2040 will be 20 - 40 GW (rounded to the nearest 10GW).

Table 1 Offshore wind development scales

Announced Areas	State	GW/ Project	Year of First Power	Low Case		High Case	
				No. Projects	Total GW	No. Projects	Total GW
Gippsland	VIC	1.5	2031	3	4.5	5	7.5
Hunter	NSW	2	2032	2	4	3	6
Illawarra	NSW	2	2033	2	4	3	6
Southern Ocean	VIC	1.5	2032	2	3	3	4.5
Bass Strait	TAS	1.5	2033	2	3	3	4.5
Perth/Bunbury	WA	1.5	2033	2	3	3	4.5
Other	OTH	1	2034	0	0	2	2
Other	OTH	1	2035	0	0	2	2
Other	OTH	1	2036	0	0	2	2
Other	OTH	1	2037	0	0	2	2
Other	OTH	1	2038	0	0	2	2
Totals				13	21.5 (20)	30	43 (40)

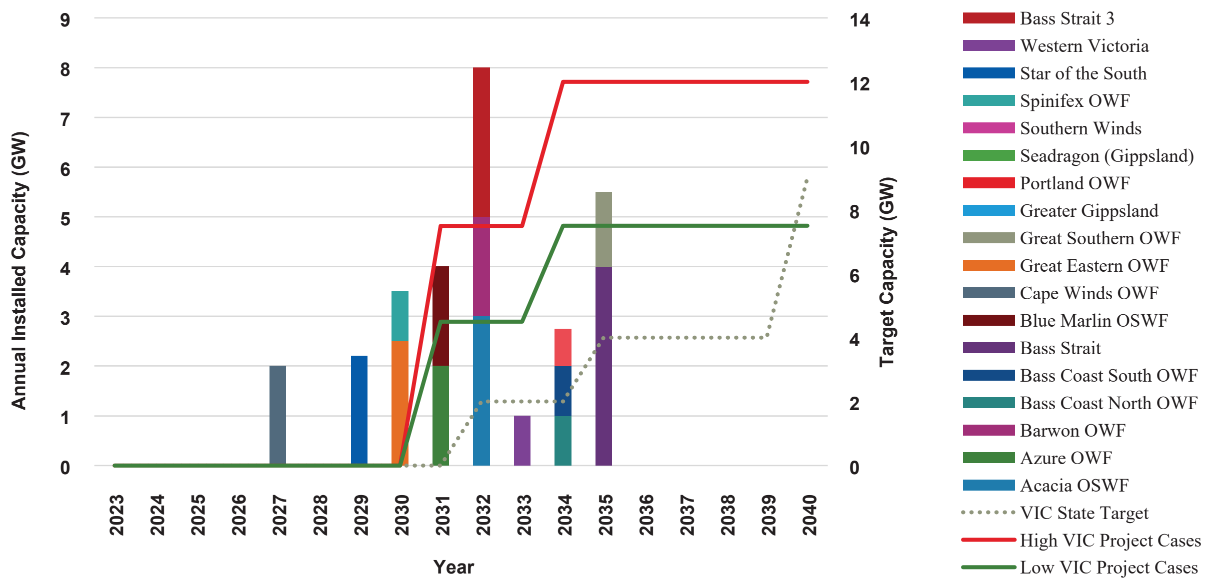


Figure 3 VIC OSW Forecasted Installed Capacity

2.2 State markets

2.2.1 Victoria

Victoria has embraced offshore wind as a central component of its decarbonisation strategy. Cognisant of the potential for large scale power generation, The Victorian Government set ambitious targets of 2 GW by 2032, 4 GW by 2035 and 9 GW by 2040. The targets were accompanied by the release of an offshore wind policy directions paper in March 2022 followed by an implementation statement in October 2022[3]. The implementation statement is designed to provide certainty and facilitate collaboration between developers, manufacturers, government, and local stakeholders. The October 2022 statement is the first of a series of statements which will be released in the coming years. Statement 1 announced plans to lead a coordinated approach to transmission as well as plans to invest in the upgrade of a preferred offshore wind construction port. The second implementation Statement 2 released in March 2023 providing further details on coordinating port and grid infrastructure.

Victoria is providing further support through the Energy Innovation Fund (EIF). The EIF is targeted at supporting the commercialisation of emerging and innovating renewable energy technologies and projects.

The first round of the EIF was dedicated to offshore wind and secured funding for three offshore wind projects: Seadragon, Great Southern and Star of the South. The funding will support feasibility studies and pre-construction development activities as well as bring the investment needed to support the creation of a competitive offshore wind sector to the state.

Figure 3 compares the capacity of proposed projects against the state targets. Most Victorian projects are anticipated to come online in early 2030. These are the projects that are planned for the recently declared Gippsland REZ. Projects which do not fall within this zone typically make up the remaining capacity installed after 2033.

While there are 18 publicly proposed projects in Victoria, despite this, there is a limit to the seabed area available, and the amount of capacity that can be connected to the Victorian Grid. It is therefore appropriate to assume that not all projects will be awarded a feasibility licence and that approximately three to five will lead to commercial projects in the first round. Assuming the second round awards another two to three projects, the approximate total installed capacity by 2040 should reach 7.5 - 12 GW in the context of the 9 GW target.

[3] Offshore wind energy

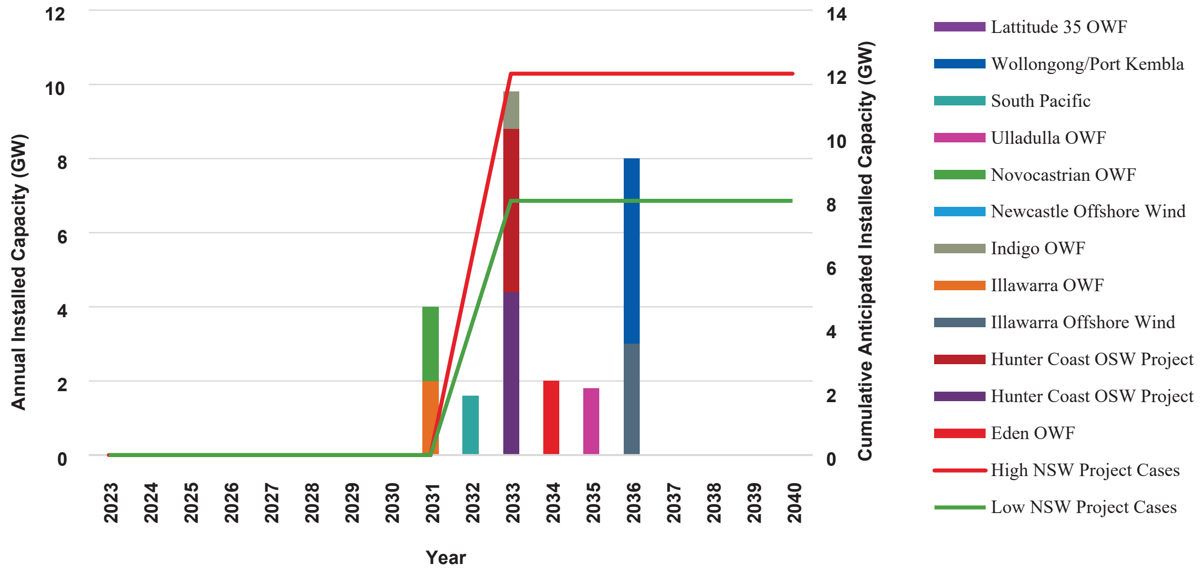


Figure 4 NSW OSW Forecasted Installed Capacity

2.2.2 New South Wales (NSW)

While the NSW Government has not announced any regulations or targeted support for offshore wind, it has provided an initial framework through the Electricity Infrastructure Investment Act 2020 (NSW) (EII Act) and the Electricity Infrastructure Roadmap[4]. The roadmap outlines five designated Renewable Energy Zones (REZs) intended to deliver 12 GW of network capacity. Two of the REZs, Hunter-Central Coast and Illawarra, include the provision of offshore areas for potential future offshore wind projects. The NSW Government is understood to be currently exploring opportunities to declare targets for offshore wind capacity.

Figure 4 shows the forecasted growth of the OSW industry in NSW until 2040. Hunter and Illawarra are anticipated to be the two declared OSW areas and as such, closely follow the Gippsland timeline with most projects coming online in the early 2030s. Given the size of the Hunter and Illawarra REZ's and limited grid capacity, it can be reasonable to assume that each zone will see the success of two to three projects within the first leasing round (depending on project size and final zone areas).

Assuming each project has capacity of approximately 2 GW, and average project completion from date of announcement is eight years, NSW may be able to reach a total installed capacity of 8 - 12 GW by the end of 2032 across both the Hunter and Illawarra*.

**It is noted that the proposed development potential considered is based on the anticipated offshore wind feasibility licence areas as of Q1 2023 (at the point of development of the report). Therefore, following further refinement of the zones that has and will develop since, the potential total OSW capacity developed by 2040 may vary.*

[4] Electricity Infrastructure Roadmap | NSW Climate and Energy Action

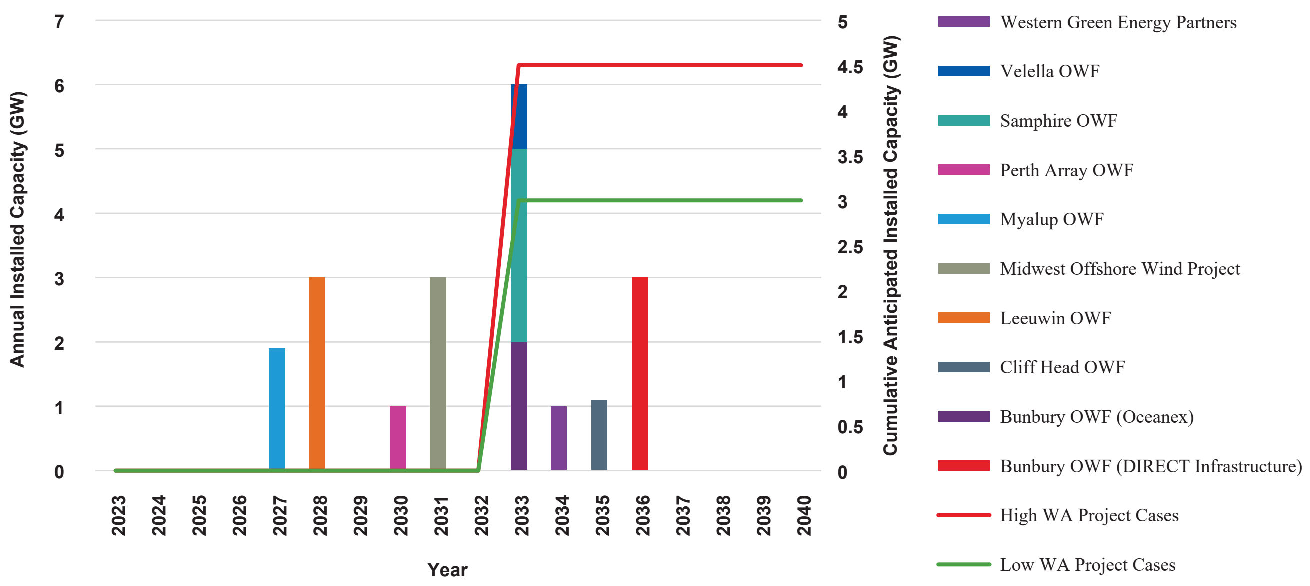


Figure 5 WA OSW Forecasted Installed Capacity

2.2.3 Western Australia (WA)

In its 2020 Climate Policy paper the WA Government committed to achieving net zero emissions by 2050[5]. Close to 40% of the state's electricity generation is used in the large mining and manufacturing industry, which the state is looking to rapidly decarbonise. While the WA Government has not set a specific OSW or renewable energy target, it is actively establishing a renewable hydrogen industry.

Figure 5 shows the forecasted growth of the OSW industry in WA until 2040. While there are 10 proposed projects within the state, it is not yet clear when the offshore REZ will be declared or what kind of support the state Government is looking to offer to developers. Given these circumstances, COD targets before 2033 are highly ambitious.

The Anticipated lease awards trend line provides a more realistic indication of the capacity expected from the WA OSW Industry. This trend line assumes the Perth/Bunbury offshore wind area will be declared in 2025, through which three projects will be successful and reach completion eight years later in 2033 and achieving a cumulative 4.5GW capacity.

The state is looking to be a significant producer, exporter, and user of renewable hydrogen, the production of which will require significant increase in renewable electricity production[6].

[5] Western_Australian_Climate_Policy.pdf (www.wa.gov.au)
[6] EPWA-Renewable Hydrogen Target for Electricity Generation in the SWIS-Consultation Paper_0.pdf (www.wa.gov.au)
[7] Tasmanian_Renewable_Energy_Action_Plan_December_2020.pdf (stategrowth.tas.gov.au)

2.2.4 Tasmania (Tas)

On 27 November 2020 Tasmania reached it's 100% renewable electricity target, indicating that the state has enough renewable capacity to meet its base requirements[7]. The State intends to build on this commitment and double its renewable generation to 200% of its current needs by 2040. Being home to a strong wind resource, Tasmania is planning major expansions in wind farm investment to help meet its new target. Currently there are no offshore wind specific targets and only one proponent has announced intention to develop within the area. Assuming the Bass Strait offshore wind zone is declared in 2025, and up to three projects are successful, it is possible that Tasmania will reach 4.5 GW of installed OSW capacity by 2033.

2.2.5 South Australia (SA)

SA has a comparatively large portion of renewable penetration with 41% of its electricity coming from large scale wind farms. The SA government is looking to achieve 100% net renewables by 2030 as well as looking to develop a hydrogen export economy[8]. In the 2022 Integrated System Plan the Australian Energy Market Operator identified a candidate offshore wind zone (OWZ) along the south-east coast just north of Mount Gambier. Currently only one proponent has publicly announced plans to develop within that OWZ, and the state Government has not announced any targets or support mechanisms for offshore wind within this area.

2.2.6 Queensland (QLD)

QLD is currently operating on 22.7% of electricity generated from renewable sources. The government is hoping to accelerate plans towards its target of 50% renewable by 2030, 70% by 2032 and 80% by 2035. Wind resource is not as strong in QLD in comparison to other states at this stage, offshore wind is not factored into the states' target plans. While there are no candidate OWZs within QLD, one proponent has indicated interest in developing an offshore wind farm off the Gold Coast.

[8] Renewable Energy | SA Government Financing Authority (safa.sa.gov.au)

3. Supply Chain Criteria

The Australian and state market analysis creates a basis on which the scale of the demand can be considered. *Figure 6* provides a summary of anticipated OSW installed capacity based off the anticipated lease awards for each state to 2040. The high case assessment assumes 30 projects across the country will have capacity to generate 40 GW of power by the end of 2040. The high case (40GW total) is what the later supply chain demand has been analysed against. Although a single, ambitious commercial projects scenario with various uncertainties, this helps in calibrating the potential order of magnitude scale of the different supply chain elements.

The typical band of offshore wind supply chain services are categorised within the areas and capabilities defined below. Each area and capability are assessed according to the anticipated lease awards over the next 17 years, to provide a clear analysis of the capabilities in demand in Australia against this high case. A discussion on the assumptions and requirements is included in Section 3.1 to 3.10 and a summary timeline for the supply chain criteria is provided in Section 3.11.

ID	Supply Chain Area and Capabilities
D	**Development Services**
D1	Met-Ocean Data Collection
D2	Geotechnical & Geophysical
D3	Engineering Design
F	**Foundation Substructure**
F1	Substructure Fabrication
F2	Foundation Assembly Facility
F3	Secondary Steel
F4	Scour Protection
F5	Grout
W	**Wind Turbine Manufacture**
W1	Blade Manufacture
W2	Tower Manufacture
W3	Nacelle Manufacture
E	**Electrical Infrastructure**
E1	Offshore Substation
E2	Onshore Substation
E3	Inter-array Cable
E4	Export Cable

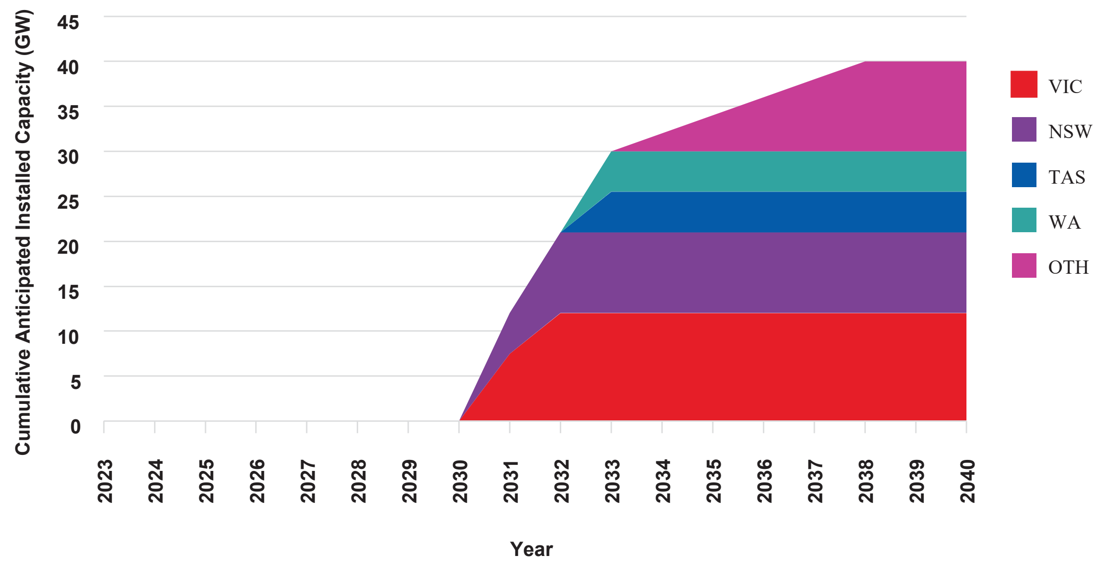


Figure 6 Australia's Anticipated OSW Installed Capacity to 2040

ID	Supply Chain Area and Capabilities
T	**Transportation**
T1	Onshore Heavy Lift Transportation Services
B	**Onshore Building Contractors**
B1	Building and Warehouse Construction Contractors
P	**Ports**
P1	Foundation Marshalling (Construction Port)
P2	WTG Marshalling (Construction Port)
P3	Operation and Maintenance Port
TIC	**Transportation & Installation Contractors**
TIC1	Tier 1 – Balance of Plant (BoP) Transport Installation Contractor
TIC2	Tier 1 – WTG Transport & Installation
TIC3	Tier 2 – Transport Vessel Charterer
TIC4	Tier 2 – Offshore Support Vessels (OSV) Charterer
OS	**Offshore Safety**
OS1	Offshore Safety Training
OM	**Operation & Maintenance Contracts**
OM1	Tier 3 – Vessel Supplier (Crew Transfer/Service Operation)
OM2	Tier 2 – Operation and Maintenance Contractor
OM3	Tier 2 – SCADA and Operations Contractor
OM4	Tier 1 – Maintenance Contractors (Non-OEM)

3.1 Development Services

There are a multitude of development services required for the early stages of the windfarm development, this study has focused on the met-ocean data collection, geotechnical and geophysical surveying and engineering design services.

3.1.1 Met-Ocean

Met-Ocean data for OSW is typically retrieved through measurement over an average of one to two years within the feasibility stage of a project. The data is usually derived using a floating lidar (FLiDAR) or meteorological mast (Met Mast) and is used to inform both the engineering design, yield analysis, as well as the construction phase planning.

Assuming each project requires its own unit, and the units are installed six years prior to COD for a duration of two years, the maximum number of individual active units required to be installed within Australia will be up to nine in 2027. The UK, Crown Estate as part of the attempt to stimulate and streamline the Celtic Sea development provided £6 million to the Cornwall FLOW Accelerator program (part-funded by the European Regional Development Fund) seeking to provide applicants to the Celtic Sea region valuable data to accelerate and improve the application process.

3.1.2 Geophysical & Geotechnical

Geotechnical and geophysical (G&G) surveys are typically required along the cable route as well as across the proposed site seabed. The survey data feeds into the cable route burial technique and foundation selection and detailed design of the offshore foundations. The package of surveys can typically take around a year to complete and will need to be completed approximately six years before COD. The analysis has considered this timeline and assumed one G&G assessment per project, with the maximum number of survey packages required in Australia would be up to nine in 2027.

Figure 7 features an offshore geotechnical drilling survey vessel performing site investigations. The vessels are required to perform downhole and seismic cone penetration testing, rock coring and geophysical logging.

Figure 7 Offshore geotechnical drilling vessel

3.1.3 Engineering Design

The engineering design considered in this assessment has been broken into major packages for the balance of plant including foundations, electrical systems, and onshore and offshore substation design. While these activities would not occur entirely concurrently and there are multiple ways of contracting them, the average duration can be simplified into a five-year period. In reality there will be multiple contracts, sub-contracts and specialist elements as well as alternative contracting strategies. Traditionally the turbine will be developed by the WTG OEM, who will often carry out an EPCI role. The balance of plant packages can either be separated out or delivered in inclusive contracts of a combination of design, fabrication and installation.

This study therefore assumes all design activities are started (pre-FEED) over five years prior to installation and therefore eight years before COD.

The main design packages include the below categories and key inclusive elements from pre-FEED, FEED and detailed design:

WTG Foundations

- Foundation (Mono-pile, gravity base, jacket, floating substructure) design.
- Detailed design of substructures, foundation, and primary structural components.

Cables

- IAC: The planning, testing, designing of arrays.
- Export: Cable sizing, landing design.

Offshore Substation (OSS)

- OSS foundation (indicative ACE Floating Deepwater Spar OSS Foundation developed by Arup is shown below in *Figure 8*).
- OSS topside electrical and structural design..

Onshore Substation

- Design of substation distribution, high voltage cables, transmission lines and civil and building design.

Figure 8 Arup ACE Spar Deepwater OSS Platform

3.2 Foundation Substructure

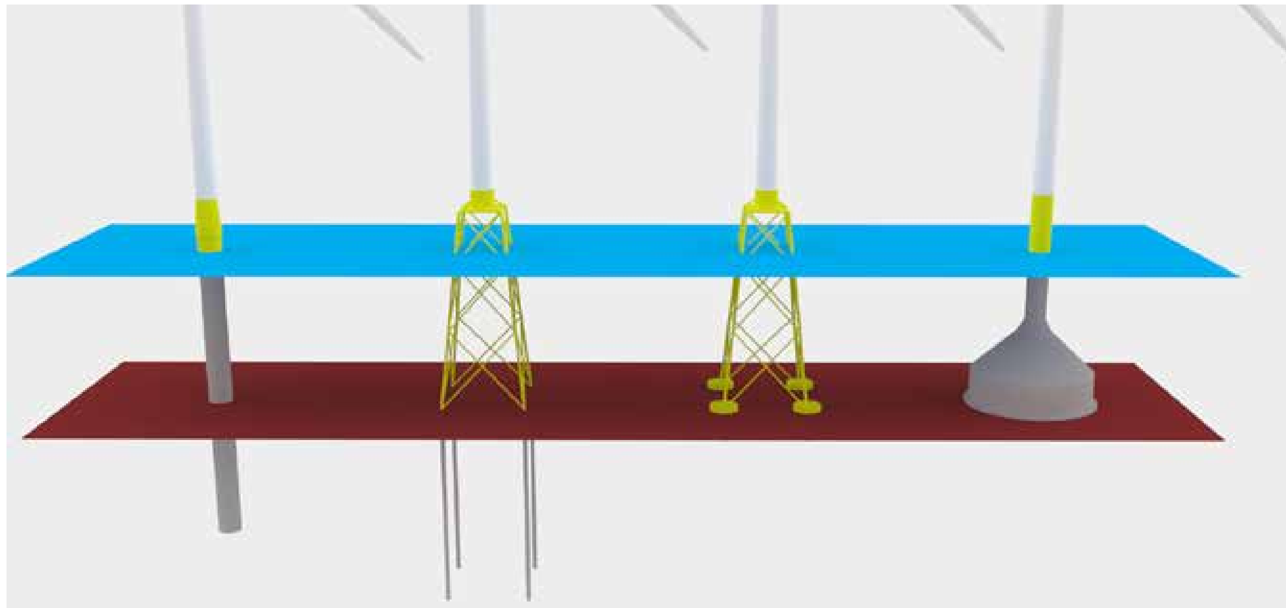


Figure 9 From left to right Monopile, Pin-Pile Jacket, Suction Bucket Jacket, Gravity Base Structure (GBS).

The type and number of foundations influence the fabrication procurement, foundation fabrication and assembly infrastructure needs along with all the other foundation ancillary items. There are many factors that need to be considered in the forecasting of foundation types for OSW.

The most significant factor as to whether specific foundation types are suitable is the site water depth.. The typical fixed wind foundation types as output from the Arup (Optif Fixed OSW) foundation sizing analysis tool are shown in *Figure 9.*

This study assumes sites within 40 m water depths projects will have the opportunity to utilise monopiles or gravity base substructures, those between 40 and 60 m will likely require jackets and any site beyond 60 m would favour floating foundations. Open-source bathymetry data for each approximate declared area was used to cut the declared area bathymetry into sections and determine the proportion of monopile/GBS, jacket and floating foundations as shown in *Figure 10.*

The percentages of relevant water depths were then considered to factor the total number of turbines to consider the potential likely types of substructures within the regional developments summarised in *Table 3.* These have been used in considering the total number of each of the structure types likely required to be fabricated to support the market based on the turbine size growth over the years (15, 17.5MW and 20MW) and number of units in the respective regions.

Typically, the foundation components are supplied four years before COD, to allow a year for fabrication before installation begins. The second year of foundation fabrication (for simplicity) has been considered to overlap with the first year of installation of the foundations. Two full years for fabrication have therefore been factored into the assessment, assuming that half of the units are supplied each year. The number of foundations is equal to the number of WTGs required to achieve the set power rating (based on the turbine scale (MW) for the corresponding COD year, with the date of foundation production then worked back from the COD date).

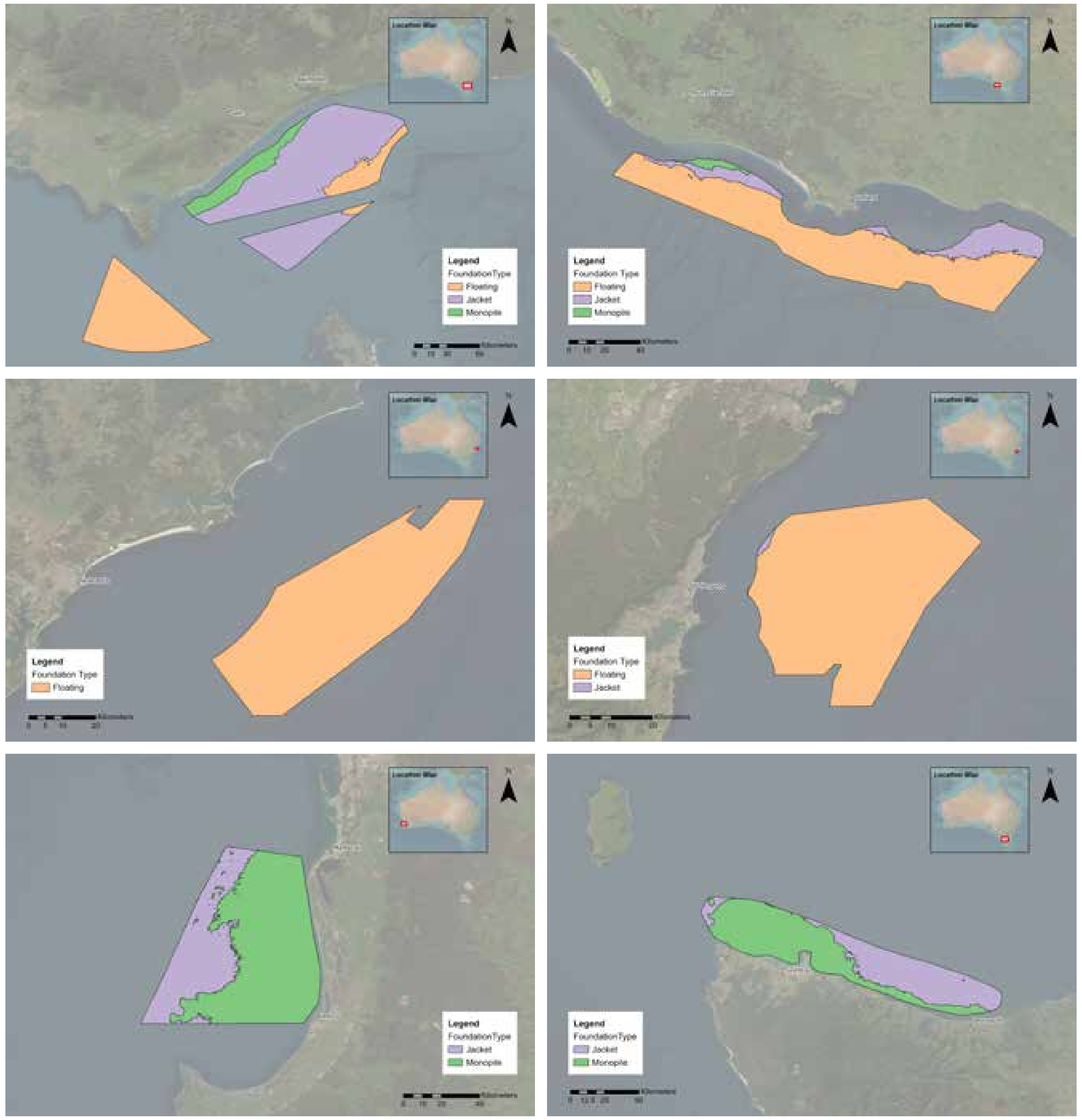


Figure 10 Bathymetric spread OSW zones from top to bottom (left to right): Gippsland, Southern Ocean, Hunter, Illawarra, Perth/ Bunbury and Bass Strait. Perth/Bunbury and Tasmania areas are pre-consultation (at the time of reporting)

Table 3 Percentage of different foundation types for the different region offshore zones, based on bathymetry

Offshore Wind Region	Monopile/ GBS	Jacket	Floating
Gippsland	8%	55%	36%
Hunter	0%	0%	100%
Illawarra	0%	0%	100%
Southern Ocean	2%	18%	80%
Bass Strait	56%	44%	0%
Perth/Bunbury	67%	33%	0%
Other	63%	35%	2%

Figure 11 Monopile load-out for Walney OSW Farm, UK

3.2.1 Monopiles

A monopile is fabricated by rolling 3m to 4m wide steel plates into a cylindrical form, or steel can, using specialist machinery. A series of these steel cans are subsequently welded together to form the monopile length. The scale of monopiles being fabricated for projects to date have been up to 11m diameter and increasing for larger turbine units.

The transition piece for monopile foundations provides the key connection elements from the foundational pile to the WTG and usually constructed in a separate facility. Works typically include large section rolling, blasting and coating, fabrication of open and closed section steel beams, connection of boat landing, access ladders, working platforms, and cable J-tubes. The transition piece is either grouted or bolted onto the monopile after pile driving has been completed.

Note: High carbonate content is common within Western Australia and the Bass Strait. Given this, there may be geological risk for the feasibility of Monopile installation (or other driven foundation types) at specific sites – effecting the number deployed within Australia.

3.2.2 Gravity Base Substructures

The alternative to other shallow to medium water depth offshore foundations is the use of gravity base substructures (GBS), that can be designed from reinforced concrete and offer an alternative to the other mainly steel fixed bottom foundation typologies. Arup have worked closely with partners Hochtief and Costain to develop the Gravitas foundation solution (*Figure 12*). This is an example of a GBS that can be economically mass produced and installed with low marine operational risk.

Key to the solution was ensuring that installation and decommissioning led the design of the structural form. The structure's innovative self-floating shape allows it to be towed to site without requiring specialist towing vessels and to be installed using simple water ballasting operations. The structure is designed to be stable during towing and installed in year-round weather conditions, with only moderate downtime. The foundation caters for water depths of up to 60m and can be adapted to suit increasing turbine sizes.

Figure 12
Gravitas GBS design
(Arup Hochtief Costain)

Figure 13 Jacket Fabrication Smulders UK

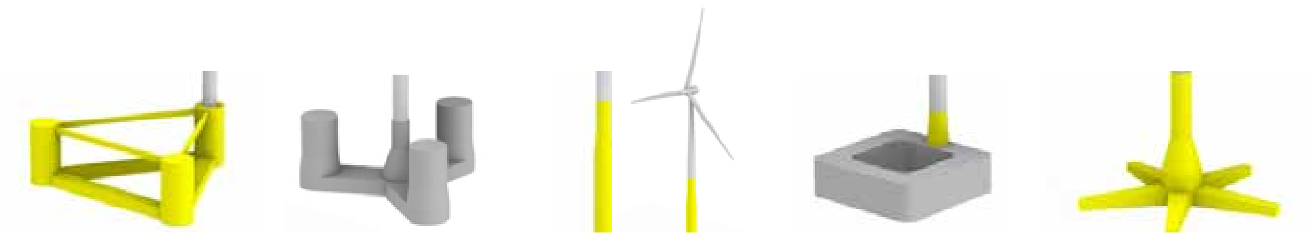
3.2.3 Jackets

Jackets are typically chosen as a more economic (in terms of total tonnage) solution for deeper water sites. The manufacturing of jackets is more complex due to the various small tubular members required (chords and braces) and the number of intricate nodal complex welded joints needed. Typical jackets for recent projects are up to 2,500t and have footprints of up to 40 x 40m.

Typically pin-piles, also need to be fabricated to secure the jacket to the seabed, albeit a simpler process, than the jacket formation as these are uniform individual rolled and welded tubular members. The pin-piles will be typically between 2.0 – 3.0m in diameter and masses depending on the number (typically 3, or 4 legged) and the site conditions. The transition piece, including secondary and tertiary steelwork, is constructed in the same place as it is integrated into the top of the jacket. It is noted that for specific applications and geology that suction bucket jackets are a viable solution with these larger diameter suction bucket sections fabricated and welded to the base of the jacket legs.

3.2.4 Floating Substructures

There are 4 key typologies (Semi-submersible, Barge, Tension Leg Platform and Spar-buoys) of floating offshore wind substructures that are fabricated in either steel or concrete. The example key parameters for floating foundations are summarised in *Figure 14* from the Arup foundation sizing tool.



Semi-Sub Steel
Approx global dimensions:
W 80m → 120m
L 80m → 95m
D 30m → 35m

Mass excluding ballast:
3700t → 6000t

Semi-Sub Concrete
Approx global dimensions:
W 80m → 100m
L 80m → 90m
D 35m → 40m

Mass excluding ballast:
16,000t → 20,000t

Spar-buoy Steel
Approx global dimensions:
L 115m → 170m
Ø 16m → 19m

Mass excluding ballast:
3900t → 6180t

Barge Concrete
Approx global dimensions:
W 50m → 110m
L 50m → 58m
D 14m → 23m

Mass excluding ballast:
12,500t → 20,250t

TLP Steel
Approx global dimensions:
W 70m → 120m
L 80m → 120m
D 50m → 65m

Mass excluding ballast:
2700t → 2870t

Figure 14 Floating Foundation typologies and material overall sizing (15MW Foundations)

It is noted that there are a large number of floating offshore wind foundation technologies that are continuing to be developed of varying forms. The above are simply an example of some of the main forms and geometry that will vary as the technologies are further developed and considered for site specific applications.

3.2.5 Secondary Steel

There are multiple elements of the fixed and floating foundations including stainless steel and other fabrication elements that are required to be secured onto the transition pieces, jackets and floating substructures that are considered secondary steel and supplied by specialist subcontractors. These secondary steel elements include: boat landings, corrosion protection systems, J-tubes, access ladders, working platforms and other ancillary elements.

These key elements provide the opportunity for smaller steel fabricators to support and contribute to the wider foundation fabrication. There are also opportunities in the production of tooling and temporary structures for the OSW installation.

3.2.6 Foundation Ancillaries

3.2.6.1 Grout

The offshore grouting for projects will be required to form the connections of the jacket to pin-piles and Monopile and transition pieces. It can be assumed the required cement/ grout typically has a minimum compressive strength of 100 MPa and of a Marine Grade (inert) Flowable Grout. It is also critical that these grout products form an early (<24 hour) strength to prevent (early age cyclic) cracking from the stresses on the offshore structures (caused by offshore conditions). This will also be crucial in the getting the Marine Warranty Surveyor sign-off and achieving the weather window availability for installation.

The specialist grouting operations will typically be provided by a tier 2 contractor working on the tier 1 foundation transport and installation contractor's vessel. The assessment has assumed that there will be a single grouting contract for indicatively 60% of the monopiles/ GBS and jacket installations – noting that the grouting will not be required for the gravity base substructures, or the suction bucket jackets.

3.2.6.2 Scour Protection

The installation of the foundations for both the OSS, gravity bases, jackets, or monpile foundations will lead to a potential change in the bed morphology. The foundation design will therefore have to consider the necessary scour protection solution to prevent the erosion of the seabed around the structures.

There are multiple design options with traditional designs utilising granular rock in either a one or two-layer (filter and armour layer) scour protection system. Depending on the design this will likely need to be a high density >2.4t/m^3 quarried rock at a suitable controlled grading, that is loaded out of an appropriate port to the installation vessel. The source of the rock is typically from a local quarry to try to minimise transportation costs and handling losses. There are also alternative scour protection solutions such as gabion baskets, concrete mattress and frond matts that are being developed tested and considered with innovation in alternatives seeking to reduce the cost and programme for installation.

The number of scour protection packages assumed are based on the total number of Monopile/ GBS and jacket foundation installations and supplied four years before COD.

3.3 Wind Turbines

There are three main WTG components: blades, towers, and nacelles. WTG technology is growing rapidly, and it is anticipated that future projects within Australia will utilise increasingly higher power turbines.

Higher power rating will allow a project to produce the same amount of power with less turbines and or increase project sizing. The technology development assumptions used in this study are summarised in *Table 4*.

Table 4 WTG technology development assumptions

Date Range	Power Rating (MW)	Rotor Diameter (m)
2023 - 2025	10	165
2026 - 2030	15	225
2031 - 2035	17.5	240
2036 - 2040	20	250

Typically, WTG components are supplied three years before COD, and staged over several years. This study assumes that the WTG components for each OWF are supplied evenly over a two-year period, the second year overlapping with the start of WTG installation. The largest supply requirements anticipated to be in 2029 with ~2,400 blades, 800 towers and 800 nacelles. A UK Blade Fabrication site is featured in *Figure 15*, detailing Siemens B75 blades manufactured at Green Port Hull, UK awaiting export.

Figure 15 Siemens wind turbine blades at Green Port Hull, UK

Figure 16
Inter-array cables and cable protection Gwynt y Mor

3.4 Electrical Infrastructure

The electrical components of an OWF can be arranged into four packages: offshore substation, onshore substation, inter-array cables and export cables.

3.4.1 Offshore and Onshore Substations

The offshore and onshore substation packages will be commissioned in parallel and 4 years prior to COD. The number of offshore substations (OSS) for a given project may vary depending on the capacity of the OWF and the cost of the technology available. The assumption used in this study is that a 1 - 2 GW project would have on average two offshore substations. This would result in a peak of 24 OSS in 2028 – 2029 within Australia being contracted.

The study then assumes each project would connect to a single onshore substation, with a comparative Australian peak of 12-number parallel contracts in 2028-2029. An offshore substation at Gwynt Y Môr Wind Farm is shown on page 39, where it was designed and fabricated by Siemens and Harland & Wolff, Belfast UK.

3.4.2 Inter-Array Cables (IACs)

The installation of the inter-array cables (IACs) follows the installation of the WTGs. While the layout of the IACs will determine the exact length of cabling required, it is possible to approximate the length based off a simple radial layout with one to two cable entries per WTG. Assuming the average spacing between WTGs is 10 times the rotor diameter, the scale of the turbine (MW) and project size (GW) the length of IAC cable has been approximated. Taking this high-level average length per project it is anticipated that demand in Australia will require a peak of 2,025 km of cabling in 2029. *Figure 16* shows the inter-array cable installation on the Gwynt y Mor project in the UK.

3.4.3 Export Cables

For a 1.5 GW project, it is most likely that at least two export cables would be required. Assuming the average distance to shore is 50 km, the peak supply of export cables would be 900 km in 2029 to service the multiple projects. An example of the installation of export cables is shown in *Figure 17*, where an export cable is being connected onshore for the London Array OSW Farm.

Figure 17
Inter-array cables and cable protection Gwynt y Mor

3.5 Transportation

Figure 18
Heavy Lift Self Propelled Modular Transporters

Onshore heavy lift transportation services are required for the movement of key offshore wind components including foundations, WTG towers, nacelles, and blades.

On any typical offshore windfarm there will likely be several ~ 6 major contracts for the onshore transportation. *[This is based on individual contracts at: foundation fabricators, foundation T&I contractor, blade manufacturing facility, tower fabricator facility, nacelle manufacturing facility, WTG T&I contractor marshalling facility].*

An example of the self-propelled modular transporters (SPMT)s commonly used for the in port component and equipment transportation are shown above in *Figure 18*.

3.6 Onshore Building Contractors

Figure 19
Construction of warehouse at Lowestoft, UK for the EA One O&M Base

The development of the design and construction of onshore bases will be required to construct the offshore wind farm support facilities including any onshore fabrication facilities being developed, construction marine management facility, port side operations and maintenance warehouses and buildings housing staff and the transmission control centre.

It is likely each project will require a single master building contract as a minimum to provide the construction marine management facility and O&M facilities (although these could be separated into two contracts). Construction work will take place prior to and parallel to the installation activities between 3-5 years before COD.

Figure 19 shows the construction of a warehouse at Lowestoft, UK developed for the East Anglia One O&M base.

3.7 Ports

Offshore wind projects will typically require access to several ports to address the fabrication, construction (marshalling), operations and maintenance needs. The specific type of port can vary depending on the location of the wind farm, the size of the WTG, chosen foundation and site conditions.

There are three main ports required to be set-up within the country for each project: Foundation Marshalling, WTG Marshalling and O&M port. Although it is noted a combination of these roles can potentially be serviced by a single port, or multiple facilities within the same port or harbour.

3.7.1 Foundation Marshalling (Construction Port):

The foundation construction port is required to temporarily marshal and store the foundations loaded in from the fabrication facility, prior to the load-out for installation. The scale and size of the foundations for OSW require a high specification port facility. The typical characteristics are for deep navigable waterway: 12 - 15m deep – governed by the Heavy Lift Vessel (HLV), quay berths of corresponding 12 - 15m depth, and large land areas: 10-20 ha, with long heavy lift quays: 300 – 500m. The port is required to be as close to the site as possible to minimise foundation installation costs and program.

Figure 20
Jacket Marshalling activity at Nigg Energy Park

Figure 21
Wind Turbine Component Marshalling – Able Seaton Port, UK

Jacket Foundations:
An example of a jacket foundation marshalling is at Nigg Energy Park, Scotland, UK shown in *Figure 20.* The site consists of warehouse storage facilities, large open areas for storage, and long quays, with heavy lift wharf aprons.

Monopiles:
The temporary storage of monopiles and transition pieces are required within the marshalling port prior to load-out of the elements to the installation vessel.

Floating Foundations:
Due to the footprint, mass and scale of common floating foundations (such as semi-submersibles and barges) the industrial build-out of floating foundations is favouring the storage post fabrication utilising wet storage to limit the number of heavy lift operations and providing sufficient buffer for the WTG integration, using berthed or anchored floating foundations.

3.7.2 WTG Marshalling & Integration (Construction Port)

The WTG construction port is required to temporarily marshal the nacelles, tower sections (typically transported in 1/3rd sections) and the three blades per WTG. These components are loaded in from their specific manufacturing facilities over the quay, transferred to storage, prior to the load-out to the installation vessel. The scale and size of the WTG components require a high specification port facility, with wide navigational approach: 150 m, deep waterways and quay berths: 10 - 12m, and large land areas (20-30 ha) with long heavy lift quays (200 – 400 m). The port is also required to be as close to the site as possible to minimise turbine installation costs and program.

The key major difference for the floating offshore wind projects to the port site is the need to instead of loading out the WTG components to an installation vessel, the WTGs are likely to be installed at the quayside onto the floating substructure. This results in a higher draught requirement for towing the substructure in and out requiring up to 12 – 16m navigable channel depth and berth depth. The other critical difference is the need to mobilise a much larger heavy lift crane to install the WTG components at the berth onto the floating substructure.

3.7.3 Operation and Maintenance Port

The operations and maintenance port selected will need to be ideally located to the project site with the CTV vessel model facility likely required to be within <75 km of the offshore site and a potential SOV site within ~150 km from the site. The operations and maintenance base will require navigational draft (~3.0 m CTV, ~8.0 m SOV), berth length(s) (30 m CTV, 80 m SOV), moderate land area with access to the quay (1-2 ha).

An example of an operation and maintenance port is at Port of Grimsby, UK. It currently acts as an operation and maintenance base for Orsted and RES and has developed as an O&M hub.

The ports selected to support the Offshore Wind industry will be required to be near the offshore wind farm sites and therefore limited opportunity for UK support or influence. However, the knowledge and skills sharing opportunities from the UK offshore wind O&M hubs and centres of excellence could provide valuable lessons.

3.8 Transportation & Installation (T&I)

Installation and commissioning, represent 20 - 30% of a traditional fixed wind project costs, relying on the specialist vessel fleets and major offshore contractors. Transportation and installation (T&I) services can be separated into Tier 1 and Tier 2 contracting services.

Tier 1 services include the T&I of foundations (FOU) and WTGs. The key Tier 2 contract opportunities considered in this study include the charter of the transport vessels and offshore support vessels (OSVs) and ancillary services such as offshore grouting operations (as discussed in section 3.2.5.1).

Typically, a Tier 1 BoP installation can be split between 1-3 major contracts per project each of 2 - 3 years, which is spent completing the transportation, marshalling and installation works. Assuming the BoP T&I work begins three years before COD, for the first anticipated project in Australia this would be in 2028. The largest number of contractors required in full time operation in Australia would be up to 36 at a peak in 2030.

While the type and quantity of Tier 2 service vessels varies in type and quantity depending on the type of foundations and project size, it is assumed that the BoP T&I of each project would require at a minimum one OSV and up to five ancillary vessels/ barges. This results in a peak within Australia of 12 active OSVs in country by 2030.

Typically, a single Tier 1 WTG installation company is contracted to a project, 1-2 years of which is spent completing the installation works. Assuming the WTG T&I begins two years before COD, the first of such work in Australia would begin in 2029 with the first anticipated project. The largest number of contractors in full time operation could be up to 12 in 2031.

While the type and quantity of Tier 2 service vessels varies depending on the size of the WTGs, it can be safe to assume that the WTG T&I of each project would require a minimum of three ancillary vessels. This means an additional 36 ancillary vessels/ barges operating in 2031. Given both FOU and WTG T&I require ancillary vessels/ barges, the total estimated number of active T&I ancillary vessels required in Australia each year will peak in the overlapping work packages with ~93 vessels in 2030. An example for installation is shown in *Figure 23*, where Seajacks' self-propelled jack up vessels are used to transport and assemble WTGs.

Figure 22 Self-propelled jack up vessel in port Great Yarmouth, UK

3.9 Offshore Safety Training

On average, the construction phase of an offshore wind farm will be active 24/7.

On average, the construction phase of an offshore wind farm will be active 24/7.c According to the IRENA (2018), Renewable Energy Benefits: Leveraging Local Capacity for Offshore Wind[9], there are 8,650 FTE jobs created per 500MW OSW capacity. Taking the IRENA presented percentage for Transport and Installation and Grid Connection (10.66%) and O&M (27.89%) this translates to a total of 1,844 and 4,825 staff FTE per GW for T&I and O&M respectively.

Although all of the staff will be required to undergo safety training there will be a limited number that are either Australian based or undertake their training within Country. To calculate the total number of personnel receiving safety training the T&I and O&M staff numbers have been factored by 20% and 60% respectively as presented in the tables (Section 3.11 and Appendix A). This translates to a total of ~15,800 staff required to undertake offshore safety training for T&I and ~79,100 staff during the O&M phase within Australia. This is a high-level assumption and does not account for additional numbers required for staff change-over, or cross over between projects and the cumulative effects of re-certification and training.

Training centres are located worldwide to upskills workers in wind turbine technical and safety skills in accordance with the Global Wind Safety standards. *Figure 23* demonstrates an insight in height and rescue training at a GWO certified location.

While many workers in Australia's oil and gas industry have offshore safety training, the training they receive is specific to oil and gas and is not sufficient for offshore wind. Wind-turbine-specific safety training will likely also be required, along with the need to develop industry specific training centres.

[9] IRENA Leveraging Local Capacity for Offshore Wind

3.10 Operation & Maintenance (O&M)

The O&M services will typically involve both Tier 1 contractors responsible for the overall operations and maintenance activities, as well as Tier 2 providers of services and vessel suppliers.

It can be assumed that each project will require individual O&M contracts for the operational phases of the project. It is assumed the operation services and maintenance work begin the same year the project reaches COD. Typically, these contracts are active for the entire operation duration of the wind farm (which can be estimated to be approximately 25 years). The typical breakdown of these contracts across the asset and timeline are shown below in *Table 5*, with the various groups and stages.

As a baseline the assessment has assumed that there would be a minimum of two operation and maintenance contracts for the OFTO and Offshore Operator respectively.

Crew Transfer Vessels (CTVs) and Service Operation Vessels (SOVs) are the two most common types of vessels used during the O&M phase for regular wind farm maintenance. The choice of vessel and technical specifics are dependent on the project O&M strategy, which depends on the number of WTGs, distance to port, metocean conditions, contracts, and business case. Generally, larger projects (>50 WTGs) further from shore (>50 km) will tend to use SOVs which can support crews up to two weeks, while smaller projects closer to shore would be inclined to use daily commute CTVs.

The number of projects supported by SOVs currently make up 35% of the market and are increasingly becoming more common as capacity and distance to shore of OSW increases . Given the limited number of available ports in Australia, it is reasonable that projects will follow a similar trend for SOVs, the remainder of which (65%) will still utilise CTVs. The number of maintenance vessels required can be estimated using a simplified ratio of service vessels to WTGs, 1:20[10].

The largest cumulative peak number of vessels required for O&M will be 93 CTVs and 53 SOVs peaking in 2038. This is based on the project projection to 2040 and could exceed this beyond the next 20-years depending on the market growth. A typical offshore CTV and SOV vessel transporting crew and equipment to a wind turbine is shown in *Figure 24*.

Table 5 O&M typical breakdown of the operation contracts across an offshore windfarm assets and timeline

Stage	Onshore	Offshore Export	Offshore Generation
Initial	Assets: Substation Operator: Substation Provider	Assets: Export (Offshore Substation & Export Cables). Operator: Supplier(s).	Assets: Turbine Blades, Nacelle, Tower Operator: WTG OEM
Early O&M *(2 – 5 Years)*	Assets: Substation	Assets: Export (Offshore Substation & Export Cables)	Assets: Substructure (Transition Piece, Foundation, Inter Array Cables) Operator: Offshore Operator
Post Warranty *(5 – 30 years)*	Operator: Offshore Transmission Network Owner (OFTO)	Operator: OFTO	Assets: WTG Nacelle, Rotor and Blades. Operator: Offshore Operator, or WTG OEM. Assets: WTG Towers, Transition Piece, Foundation, Inter Array Cables Operator: Offshore Operator

[10] 4COffshore Status & Outlook: CTVs and SOVs Q1 2023

Figure 24 Offshore CTV (top) and SOV (bottom)

3.11 Australian Supply Chain Demand Summary

Development Services

Capability	Unit(s)	Assumptions	2023 - 2026	2027 - 2030	2031 - 2034	2035 - 2038	2039 - 2040
Met-Ocean Data Collection	Active units	– Installed six years prior to first power – In commission for an average of two years – One unit commissioned per project	14	12	4		
G&G	Service contracts	– Surveys are run six years prior to first power – Surveys are completed within the year – One G&G survey per project	11	15			
Engineering Design	Concurrent design activities	– Engineering design commences eight years prior to first power – Five years for FEED & detailed design packages – Four design packages: foundations, electrical systems, onshore and offshore substation	88	96	32		

Foundation Substructure

Capability	Unit(s)	Assumptions	2023 - 2026	2027 - 2030	2031 - 2034	2035 - 2038	2039 - 2040
Monopile/ GBS Foundations	Units supplied	– Supplied four years before first power (two years for fabrication and two years for installation) – Supply is split across a two-year duration – Monopile/ GBS <40 m water depth		428	288	32	
Jacket Foundations	Units supplied	– Supplied four years before first power (two years for fabrication and two years for installation) – Supply is split across a two-year duration – 40m < Jacket water depth <60m		568	160	18	
Floating Foundations	Units supplied	– Supplied four years before first power (two years for fabrication and two years for installation) – Supply is split across a two-year duration – Floating >70m water depth		1221	8	1	
Grout	Units Supplied	– Each supply is for a single foundation – Supplied the same year as the foundation – Applies to 60% of fixed foundation types (accounting for: pin-pile jackets and monopiles)		498	224	25	
Scour Protection	Units Supplied	– Each supply is for a single foundation – Supplied the same year as the foundation – Applies only to fixed foundation types		996	448	50	

Wind Turbines

Capability	Unit(s)	Assumptions	2023 - 2026	2027 - 2030	2031 - 2034	2035 - 2038	2039 - 2040
Towers	Units supplied	– Turbine rating increases over time – One tower per WTG – Supplied three years before first power – Supply is split across a two-year duration		1900	661	165	
Nacelles	Units supplied	– Turbine rating increases over time – One nacelle per WTG – Supplied three years before first power – Supply is split across a two-year duration		1900	661	165	
Blades	Units supplied	– Turbine rating increases over time – Three blades per WTG – Supplied three years before first power – Supply is split across a two-year duration		5700	1983	495	

Electrical Infrastructure

Capability	Unit(s)	Assumptions	2023 - 2026	2027 - 2030	2031 - 2034	2035 - 2038	2039 - 2040
Export Cables	km of cable supplied	– Two export cables per project – Average distance to shore is 50 km – Supplied three years before COD		2550	1200	300	
Inter-Array Cables	km of cable supplied	– Average spacing 10D – Number of turbines based on MW turbine rating and project size. – Supplied three years before COD		5738	2880	720	
Offshore Substations	Units Fabricated & Installed	– An average of two offshore substations per project – Fabricated/Installed four years before COD		44	16		
Onshore Substations	Units Fabricated & Installed	– One onshore substation per wind farm – Fabricated/Installed four years before COD		22	8		

Capability	Unit(s)	Assumptions	2023 - 2026	2027 - 2030	2031 - 2034	2035 - 2038	2039 - 2040
Transportation & Installation Contractors							
Active FOU T&I Contracts	Active contracts	– One contract per project – Installed over a two-year duration – Installation begins three years before COD		28	20	6	
HLV for FOU T&I	Active units	– One HLV per FOU installation contract (fixed projects only)		20	10	3	
OSV for FOU T&I	Active units	– One OSV per FOU installation contract		28	20	6	
Ancillary vessels for FOU IT&I	Active units	– Five barges per FOU installation contract		140	100	30	
Active WTG T&I Contracts	Active contracts	– One contract per project – Installed over a two-year duration – Installation begins two years before COD		16	28	10	
Jack-up vessels for WTG T&I	Active units	– One Jack-up vessel per fixed WTG installation contract		14	12	4	
Ancillary vessels for WTG T&I	Active units	– Three barges per WTG installation contract		48	84	30	
Offshore Safety							
Construction Offshore Safety Training	Staff requiring training	– 369 FTE maritime construction jobs per GW – IRENA staff per 500MW factored by T&I percentages. Total staff factored by 20% for AUS local content. – Training is done the year before the first construction activity begins	4982	8677	2214		
O&M Offshore Safety Training	Staff requiring training	– 1,930 FTE O&M jobs per GW – IRENA staff per 500MW factored by T&I percentagesTotal staff factored by 20% for AUS local content – Training is done the year before COD		20605	41495	11580	
Operations & Maintenance Contracts							
Tier 1 O&M Contractors	Active contracts	– Two service contracts per project: Operation and Maintenance – Contracts begin at COD – Contracts remain active for 25 years			37	53	53
Tier 2 CTVs	Active units	– 0.65 CTVs per 20 WTGs – Vessels begin operation at COD – Remain active for 25 years			77	93	93
Tier 2 SOVs	Active units	– 0.35 SOVs per 20 WTGs – Vessels begin operation at COD – Remain active for 25 years			42	53	53

4. Australian & UK Capabilities

The proceeding sections describe the overall capabilities across the two nations to highlight the relative capabilities, capacities, typical organisations, and investments made.

4.1 Development Services

4.1.1 Met-Ocean Data Collection

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current and planned development for capability in supporting met-ocean data collection and analysis for offshore development. These capabilities are summarised below.

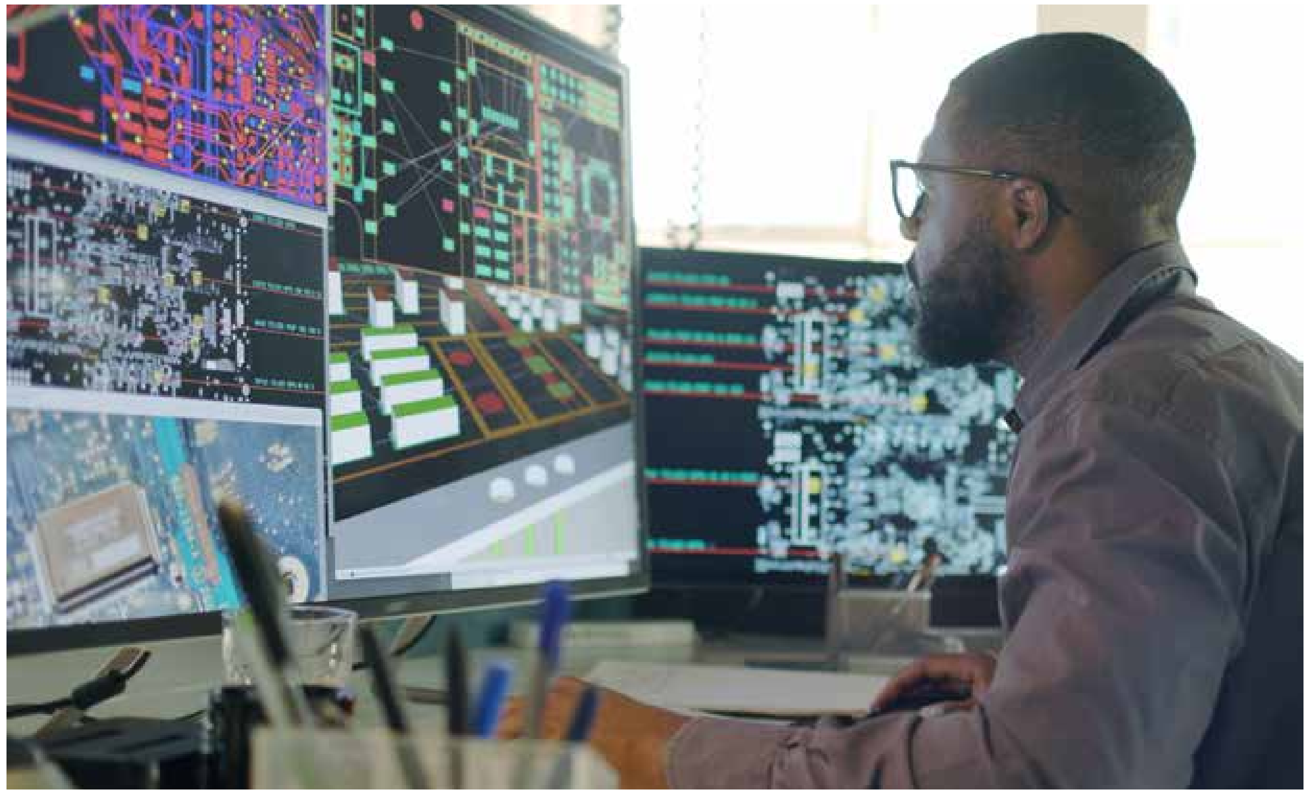
Characteristic	Australia	United Kingdom
Existing Capabilities	– FLiDAR Buoys supplied by international organisations in country capable of real-time wind, wave, and current data collection. – Design, data management and met-ocean analysis services.	– Perform offshore wind measurements with meteorological towers and FLiDAR buoys. – Seabed monitoring, sediment dynamics mitigation, cable prediction, and 3D visualisation of wind farm site
Indicative organisations	International (in-country): – RPS Group – TEK-Ocean (AKROCEAN)	– ZX Lidars – Radius Technology – SeaRoc Group
Future & proposed developments	RPS is in the process of constructing another 7 buoys.	SeaRoc Group in collaboration with Japan Radio Co to build and develop marine management software for the Japanese wind farm market.
Experience in offshore (wind) project support	– RPS Group deployed two buoys in South Korea in 2020 to support Equinor's investment decision for a floating offshore wind farm. – TEK-Ocean deployed, maintained, and recovered two AKROCEAN buoys for Star of the South in Gippsland.	– Long history and track record in deploying met-ocean survey equipment. – SeaRoc Group provided services to E.ON's offshore wind farms in 2012 and 2018 – Robin Rigg, Scroby Sands, Humber Gateway
Skills, labour, equipment	– 9 buoys and another 7 under construction (RPS) – 10 buoys (TEK-Ocean) – TEK-Ocean Spirit which is an 87m MPSV with 60t Subsea crane installed	– Skills in the design of equipment, deployment, and analysis of data. – Project equipment deployed and Marine Data Exchange developed by the Crown Estate – supporting data share.
Critical investments, partnerships	TEK-Ocean and AKROCEAN merger.	None of note.
Likelihood of export		– Radius Technology's meteorological towers have been deployed in UK, Irish, German, Danish and Swedish waters. – SeaRoc Group can export their software around the world.

4.1.2 Geotechnical and Geophysical

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current and planned development for capability in supporting geotechnical surveying data collection and analysis for offshore development. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	– Geophysical surveys, geotechnical investigations, hydrographic surveys, and pipeline route inspection surveys. – Ground modelling and consultancy services (Fugro and UTEC) – UXO surveys, bathymetry, and charting services (EGS) – 2 vessels with max depth of 2000 m (MMA) – 6 vessels with max depth of 3000 m (Fugro) – 5 vessels and one un-manned vessel (Guardian) – 6 vessels, and ROV services (EGS)	– Site investigation, development of ground models, advisory, and database design and management (Gardline) – Geological and geophysical surveys, including downhole cone penetration testing, seismic cone penetration testing, downhole sampling and high-quality rock coring (Fugro) – Offshore geotechnical, geophysical, 2DHR, environmental and ROV surveys (Calecore)
Indicative organisations	– MMA Offshore – Fugro – Guardian Geomatics Pty Ltd – EGS Survey – UTEC Survey	– Fugro – Gardline – Calecore (company dissolved in 2017) – Coastline Surveys (company dissolved in 2008)

Characteristic	Australia	United Kingdom
Future & proposed developments	No known	Fugro's geotechnical testing laboratory capacity increased by 50% with the implementation of over 100 testing devices.
Experience in offshore (wind) project support	Fugro has been awarded two geotechnical investigation contracts for the development of the Dutch IJmuiden Ver Site V-VI, Nederwiek (zuid) Site I and Hollandse Kust (west) Site VIII offshore wind zones.	Fugro was awarded the contract to perform geotechnical site investigations for the Ørsted Hornsea Three and Hornsea Four in 2022
Skills, labour, equipment	– Fugro has multiple vessels with equipment capable of performing thorough tests. The company also provides ground modelling and consultancy services. – EGS have a ROV	– Fugro has multiple vessels with equipment capable of performing thorough tests. – Gardline has nine multipurpose vessels for surveying. – Calecore has a geotechnical vessel (with drilling rig), a geophysical survey vessel in North Sea and Artic, and a multirole survey vessel.
Critical investments, partnerships	No known	Fugro partnered up with AS Mosley and the University of Strathclyde to develop a device to monitor fatigue in the mooring lines attached to floating hulls. Research was funded by the Scottish Government via the Floating Offshore Wind Technology Acceleration Competition 2020
Likelihood of export		– Fugro – Worldwide – Gardline – UK, Europe



4.1.3 Engineering Design

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the design stages of future Australian OSW projects. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Foundation (WTG and OSS) – Concept feasibility studies, including geotechnical assessment. – Detailed design of substructures, foundation, and primary structural components. – Design of offshore structures, legacy oil and gas. Cables (IAC & Export) – Concept feasibility studies including grid connection, landfall, and preliminary export cable routing. – IAC and export cable pre-FEED and FEED as well as array layout design. OSS Electrical – Concept feasibility studies for substation site selection, preliminary capacity and distribution and cost assessment. – Pre-FEED to Detailed design of OSS HVAC system.	Foundation (WTG and OSS) – Concept feasibility studies, detailed design of substructures, foundation and primary and secondary components. – Bespoke products for foundation design, development and testing. – Project development, project engineering, wind turbine measurements, engineering support services, asset operations and management, design and analysis software of OSW turbine interactions. Cables (IAC and Export) – Pre-FEED design, array layout optimisation IAC. – IAC FEED. – Export cable pre-FEED and FEED design, burial, protection and landfall. Substation Electrical – Engineering design pre-FEED to detailed design HVAC and HVDC, project management, operations support and integrity assessment.
Indicative organisations	– Arup – DNV – Tetra Tech – Ramboll – RES Group – RPS – Worley – Wood – WSP	Foundations – Arup – Atkins – Cowi – Ramboll UK – DNV – acquired UK based wind energy consultancy Garrad Hassan in 2021. IAC Cable Arrays: – Arup – Intertek – Natural Power – Pelagian Substation: – Arup – Atkins – Cowi – Wood Group Kenny

Characteristic	Australia	United Kingdom
Experience in offshore (wind) project support	– Arup provided engineering services managing the pre-feasibility design and investigations of three Australis OSW projects as well as providing other key engineering services. – RPS provided high level due diligence studies for environmental or consenting risk assessments for the Star of the South (SoS) project. It is supporting SoS with offshore approvals and EIA work. – WSP is providing project management, environment, planning and engineering services to SoS. Specifically, power system studies for grid integration and grid connection.	Foundations – Arup was commissioned by an EPC contractor to develop the concept and detailed design for a 187MW offshore wind farm in the east coast of Japan. – Arup performed conceptual design of a concrete hull for Equinor's floating wind turbine, Hywind, Scotland. – Atkins was contracted to design 84 jacket substructures and foundations for the 588MW Beatrice Offshore Windfarm in the outer Moray Firth, UK. – As a wind turbine certifier, DNV released the first integrated rule set for OSW structures, standardising processes of new structures in 2020. – Ramboll provided detailed design for 160 individual foundations for the Siemens SWP 3.6MW turbines in the Gwynt Y Môr Offshore Wind Farm. Project was completed in 2014. Cables – Pelagian provided detailed route engineering and cable burial assessment for the Gwynt Y Môr Offshore Wind Farm. – Pelagian completed a cable route engineering and cable burial risk assessment for the Rampion Offshore Windfarm. Work included design and layout of array cables in 20-40m of water around planned jack up locations. Windfarm was completed in 2018. Substations – Wood was awarded a contract to modify Equinor's Gulfaks A and Snorre A oil and gas platforms so they can be powered by Hywind Tampen wind park. Work involved upgrades to platform, integration of wind park and onshore control room.
Skills, labour, equipment	Limited international organisations with experience overseas.	Multiple UK based and international Engineering Design firms with experience in country.
Critical investments, partnerships	No known	Atkins partnered up with Hitachi and Linxon to research the feasibility of floating substations.
Likelihood of export		Worldwide

4.2 Foundation Substructure

The fabrication of foundations projected for the UK foundations are mainly supported by European and Asian major shipyards and fabricators. This highlights that to date there has been minimal supply of foundations from UK based companies with limited support from Smulders (for jacket assembly and transition piece fabrication).

The projection for 2025 – 2027 highlights that SeAH Wind have secured the Hornsea 3 contract for which they propose to deliver from the Monopile factory being developed within Teesport, UK to support.

4.2.1 Monopiles

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the fabrication of offshore monopiles. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	No local capabilities	None
Capacities	n/a	Planned SeAH facility to produce 100-150 monopiles per year.
Indicative organisations.	n/a	– SeAH Wind (with planned facility in Teesside) – Smulders Projects UK (investment at existing Wallsend facility to allow for production of transition pieces)
Future & proposed developments.	No known	– Planned SeAH Wind monopile manufacturing facility at South Bank on Teesside, works commenced in July 2022 – Ørsted announced a multi-million-pound agreement to place the first order of monopiles at the planned SeAH facility in Nov 2021. – Smulders Projects UK is investing £70m for new equipment into the existing site at Wallsend in North Tyneside to enable the production of wind turbine transition pieces.
Experience in offshore (wind) project support.	n/a	No existing experience

Characteristic	Australia	United Kingdom
Skills, labour, equipment.	n/a	– £300m SeAH Wind monopile manufacturing facility in Teesport. – Planned SeAH facility estimated to employ 1500 jobs in construction, 750 jobs during operation. – Smulders Projects UK Wallsend transition piece fabrication proposed to create 325 direct jobs.
Critical investments, partnerships.	n/a	– Planned SeAH facility received £107m investment from UK Infrastructure Bank. – Tessport is a UK Freeport (with tax benefits for organisations manufacturing). – The Teesport development has received funding from the Department of Business Energy & Industrial Strategy (BEIS) – now Department for Energy Security and Net Zero (DESNZ).
Likelihood of export		Worldwide

4.2.2 Jacket Foundations

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the fabrication of offshore WTG and OSS jackets. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Small jacket, or modular subsea structures.	Production and assembly of Marine grade (MG) steel components (Smulders Project UK)
Indicative organisations	Potential capabilities: – CIVMEC – Nepean – Other steel fabricators.	– Smulders Eiffage Projects UK – Harland & Wolff's (owned by InfraStrata) fabrication yards in Belfast, Fife, Appledore and Isle of Lewis (yards previously owned by BiFab – Babcock – Global Energy Group.

Future & proposed developments	No known	– Harland & Wolff were awarded a £26.5m contract in 2021 to build eight wind turbine generator foundation jackets for Saipem's 450 MW Neart na Gaoithe wind farm (£26m contract):
		  – The scope changed from eight jackets to four jackets because of material delays
		  – Harland & Wolff terminated contract in 2023 due to material delays and cost escalations.

Characteristic	Australia	United Kingdom
Experience in offshore (wind) project support.	No offshore wind specific experience – CIVMEC is a heavy engineering and construction provider that has worked on the fabrication of large-scale offshore oil and gas platforms in Australia (WA). – Nepean is an engineering and manufacturing company that has experience in the fabrication of steel structures for the mining and oil and gas industry in Australia.	Smulders built 46 jackets for the Beatrice OSW Farm, 11 suction bucket jackets for the European Wind Deployment Centre, and 55 jackets for the Moray East OSW Farm (2019).
Skills, labour, equipment.	– CIVMEC Henderson facility (Perth) is the largest heavy engineering facility in Australia. They also have facilities in Newcastle, Gladstone, and Port Hedland. – Other steel fabricator (fabrication yards and equipment).	At maximum, the Smulders Eiffage facility employed in excess of 2,000 people on the Hadrian, Wallsend, Newcastle UK yard.
Critical investments, partnerships.	No known	Smulders managed to get investment from BEIS as part of the £160m Offshore Wind manufacturing investment support scheme.
Likelihood of export		Limited given competition from the Asian market.

4.2.3 Secondary Steel

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in fabrication of secondary steel. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Fabrication of: – Pressure Vessels, Offshore Containers, Plate Fabrication, Structural Steel, Heat Exchangers.	Fabrication of MG Steel: – OSW Boat Landings – OSW Access Structures – Installation Frames – Sea Fastenings – External Platforms – Transition Pieces.
Indicative organisations	– Thornton Engineering – Superior Energy – Civmec – -Other steel fabricators.	– Wilton Engineering; – Lionweld Kennedy; – Marine Fabricators
Future & proposed developments	No known	No known

Characteristic	Australia	United Kingdom
Experience in offshore (wind) project support.	No experience in OSW	Wilton's manufactured installed and fitted-out secondary steel on 21-transition piece structures for Hornsea One. This included internal and external platforms, concrete platforms, ladders, boat landings. Shot blasting and painting was carried out on site by Wilton's sister company Universal Coatings utilizing its new 2,256 square meter Preparation & Coatings facility.
Skills, labour, equipment.	– Civmec >2,500 employees – Thornton Employs 94-employees.	– Wilton Engineering employs 201-500 employees – fluctuating with workload. – As part of its workforce development, Wilton has launched an in-house Apprenticeship Academy, which is supporting an initial group of 30 trainees.
Critical investments, partnerships.	No known	Wilton has been a portfolio company of FW Capital since 2014, having received a total of £3million from the Tees Valley Catalyst Fund (TVCF) to support project bonding, helping them win over £50m of contracts. Last year Wilton secured a £750,000 CBILS loan from NPIF – FW Capital Debt Finance.[11]
Likelihood of export		No existing export.

[11]Wilton Engineering Article (Posted on 6th July 2022): www.wiltonengineering.co.uk/smes-across-the-north-boosted-by-100m-investment/

4.2.4 Foundation Ancillaries

4.2.4.1 Grout

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the offshore grouting activities. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Mixing, testing, and pumping of marine grade grouts	Mixing, testing, and pumping of grouts (low to ultra-high strength), inspection and maintenance of grout
Capacities	Unknown	Grout mixing equipment
Indicative organisations	Grouting services: – GeoOceans – Neptune Marine Services Concrete mixing/production: – BluCem – Boral Concrete – Holcim Concrete – Sika Australia – Forsoc Australia	Grouting services: – FoundOcean – PES UK Ltd – BAUER Renewables Ltd Concrete mixing/production: – Arcon – Masterflow UK – Sika UK.
Future & proposed developments	No known	No known
Experience in offshore (wind) project support.	– Boral concrete has supplied grout for several offshore oil and gas projects specifically for drilling platforms in the Bass Strait and in the Timor Sea off WA. – Geo Oceans has completed several offshore projects in Australia including the grouting and sealing for the Chevron Wheatstone LNG project. – Neptune Marine has provided grouting services for a number of subsea structures including pipelines, foundations and platforms within Australia.	– FoundOcean grouted the jacket foundations of the Ormonde Offshore Wind Farm in 2010. – FoundOcean grouted 3 jackets every 24 hours during the Beatrice Offshore Wind Farm (grouted 86 jacket foundations) in 2018. – In 2021, FoundOcean secured a contract to provide grouting services for a 100-turbine wind farm in Taiwan, creating 30 new jobs in Livingston.
Skills, labour, equipment.	>300 employees at Neptune Marine Australia.	– >100 employees – Grout mixing equipment: jet mixer, pan mixer, batch grout mixer with mounted cement surge tank
Critical investments, partnerships.	No known	UKEF provided £500m of financing for OSW projects in Taiwan, to guarantee trading opportunities for UK companies. The investment assisted FoundOcean in securing the Taiwan contract.
Likelihood of export		Existing Exports: – Worldwide – FoundOcean having previously worked in Western Australia on North Rankin B jacket grouting under Heerema Australia Pty.

4.2.4.2 Scour protection

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the scour protection provision for foundations. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	– Design, analysis, and construction support – Supply of scour protection systems including rock bags, concrete mattresses and articulated concrete blocks.	– Design and manufacture of Frond Mats (buoyant polypropylene strands as a scour protection alternative to rock). – Manufactures two types of frond mats: Anchor Retained Front Mats and Weighted Front Mats
Indicative organisations	– Geofabrics – Boskalis Australia – Offshore Protection Systems – InterMoor Australia (Perth)	– Seabed Scour Control Systems (SSCS) – Subsea Protection Systems (SPS)
Future & proposed developments	No known	No known
Experience in offshore (wind) project support.	– None. – All organisations have experience supplying the Australian oil and gas industry.	– The self-installing scour protection system mat, designed by SSCS and SPT Offshore, was installed as a test site at the East Anglia one OSW Farm.
Skills, labour, equipment.		SSCS: <25 Employees.
Critical investments, partnerships.	None known.	SSCS was involved in an Innovate UK backed £1m collaborative project with SPT Offshore to develop a self-installing scour protection system.
Likelihood of export		Worldwide

4.3 Wind Turbine

4.3.1 Blade fabrication

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the fabrication of offshore monopiles. These capabilities are summarised below.

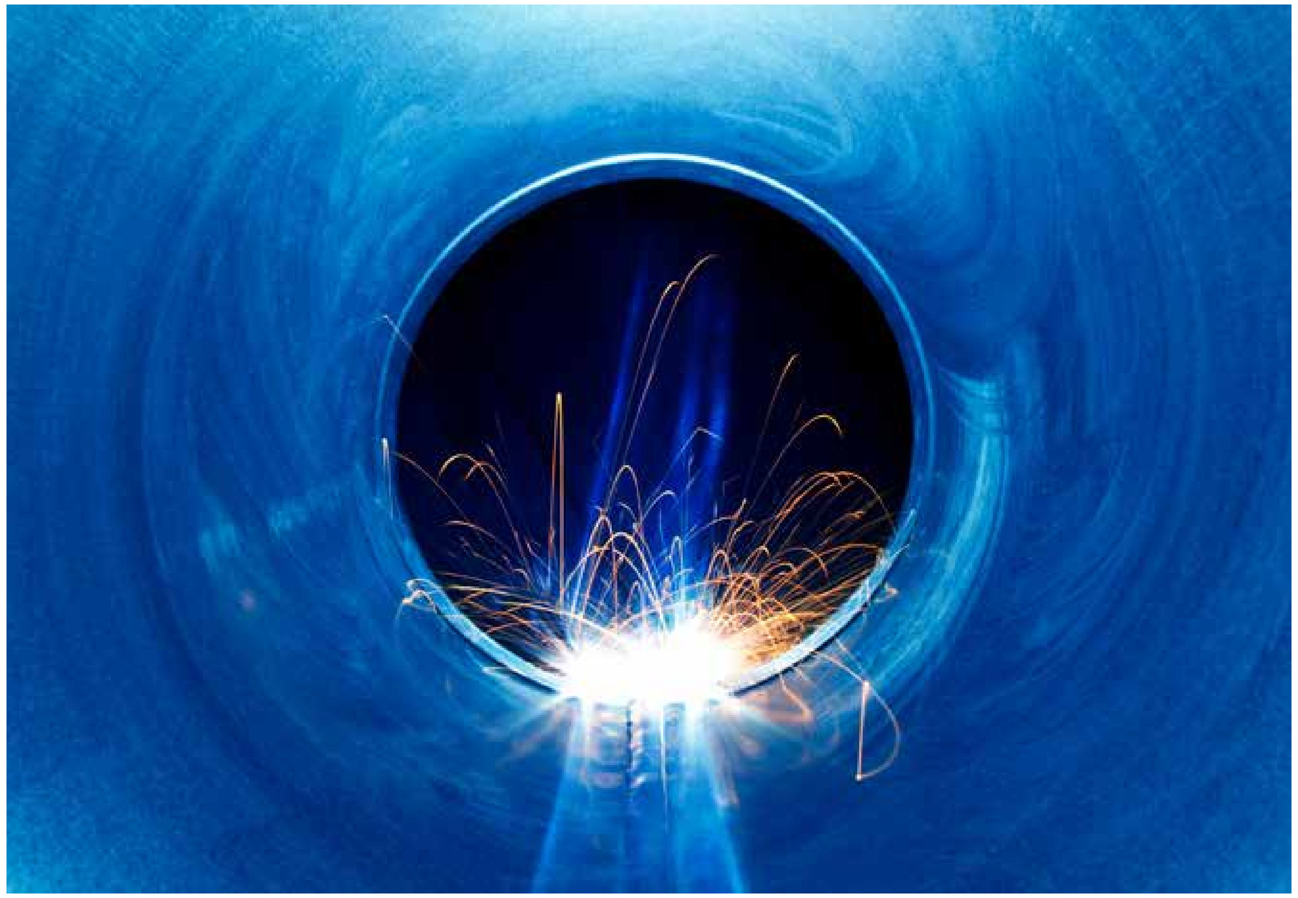
Characteristic	Australia	United Kingdom
Existing Capabilities	No local capabilities	– Fabrication of 81m long OSW blades (Siemens, Hull) – Testing and fabrication of 80m long V164 OSW turbine blades (Vesta)
Capacities	n/a	– Vestas IOW: 1,000 blades to North European markets, including more than £360m worth of exports since 2014. – Siemens Gamesa at Green Port Hull exports 600 blades beyond UK waters.
Indicative organisations	Local capabilities in fibre glass reinforced polymer composite manufacturing: – RPC Technologies – Advanced Composite Structures Australia	– Siemens Gamesa at Green Port Hull – Vestas in Isle of Wight – Planned GE Renewable Energy blade manufacturing plant in Teesside.

Characteristic	Australia	United Kingdom
Future & proposed developments	No known	– The Siemens Hull factory is being extended doubling its size adding 41,600m^2 planned to be completed in 2023. – The planned GE renewable Energy plant expects to create 750 direct and 1500 indirect jobs in the area. The 107m blades to be manufactured at the plant will benefit the Dogger Bank Offshore Wind Farm.
Experience in offshore (wind) project support	No experience	Siemens manufactured the blades for OSW farms off the east coast of UK e.g. EA One, Dudgeon, Beatrice, Triton Knoll, and Hornsea One and Two
Skills, labour, equipment.	RPC has 500+ engineers and skilled staff throughout Australia working on Glass Fibre moulded specialist products.	– Siemens Gamesa investment at Green Port Hull expected to create/ safe guard 1,080jobs. – University of Hull working alongside Siemens Gamesa to research ways to increase the size of turbine blades.
Critical investments, partnerships.	No known	– Green Port Hull required an initial investment of £310m from Siemens Gamesa and £190m from Associated British Ports. – £186m investment (joint investment from UK Government (BEIS – OSW Manufacturing Investment Scheme and Siemens Gamesa) to enable Siemens to double size of facility and to be able to produce longer blades.
Likelihood of export		Main exports are currently for the northern European markets.

4.3.2 Tower Fabrication

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the design and development of blades for offshore WTGs. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Only onshore tower fabrication facility for 3.5 MW and 4.5 MW turbines (Keppel Prince).	– None (previous CS Wind UK Campbeltown and Mabey Bridge Chepstow facilities closed in 2021 and 2015 respectively).
Capacities	n/a	– Mabey Bridge had the capacity to produce 170 units per year during operation. – CS Wind Towers had the capacity to produce 50 towers per year during operation.



Characteristic	Australia	United Kingdom
Indicative organisations	– Keppel Prince. – Civmec. – Thornton engineering.	– CS Wind Towers Scotland in Campbeltown (facility closed in 2021). – Mabey Bridge in Chepstow (facility closed in 2015) – Harland & Wolff's (owned by InfraStrata) fabrication yards in Fife and Isle of Lewis (yards previously owned by BiFab.
Future & proposed developments	Keppel Corporation's onshore wind tower fabrication longer-term target involves growing its portfolio of renewable energy to 7 GW by 2030, KRE plans to have 3 GW of installed capacity by the end of 2025	– £110m proposed Nigg Offshore Wind factory under consideration (proposed by Global Energy Group, to be operated by Haizea Wind Group) – Haizea exited the project in 2022, delaying site opening.
Experience in offshore (wind) project support	No experience	Mabey Bridge manufactured five 80m towers and installed them along with nacelles, rotor hubs and blades for the Seamer wind farm in Teeside, UK in 2012.
Skills, labour, equipment.	– 350 employees at the Portland facility – Manufacture, blasting, painting and fit-out services	Engineering and manufacturing skills in metal fabrication, handling, joining and process design.

Characteristic	Australia	United Kingdom
Critical investments, partnerships	No known	– The Scottish government invested £52m into BiFab. – DONG Energy (now Ørsted) made a multi-million-pound investment for the start-up of CS Wind manufacturing facility in Campbeltown.
Likelihood of export		None: Past products delivered to projects in the UK

4.3.3 Nacelle

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the design and development of nacelles for offshore WTGs. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Potential onshore nacelle capabilities (Marand Precision Engineering)	None
Capacities	None currently.	Limited to testing facilities,
Indicative organisations	Marand Precision Engineering	Offshore Renewable Energy (ORE) Catapult (for research and testing only).
Future & proposed developments.	Proposed development to enable assembly and testing of the 4MW drive chains and hubs	No known proposed fabrication capability being developed.
Experience in offshore (wind) project support.	No experience	In 2019, GE's Haliade 150-6MW and Haliade-X 12 MW nacelles underwent testing at ORE Catapult's facility in Blyth, Northumberland
Skills, labour, equipment	Unknown	None
Critical investments, partnerships	– Partnership with Vestas. Marand will supply facility space, personnel, and equipment to meet Vestas' onshore wind nacelle manufacturing requirements. – Vestas will provide testing equipment, assembly line layout, production training and supervision, and transportation of all components to the assembly area	
Likelihood of export		Unlikely, given no current or planned capacity.

4.4 Electrical Infrastructure

4.4.1 Offshore Substation

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the offshore substation fabrication. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	No local capabilities	Electrical Systems/ Transformers – Alstom Grid – design of substations, application of HVDC and automation technologies. – Siemens – Design and construction of HVDC systems Superstructure: – Smulders Project UK – Production and assembly of steel components – Siemens – Fabrication of steelwork components Substructure: – Harland & Wolff in Belfast – Steel design, fabrication and construction
Indicative organisations	Electrical Systems: – See onshore substation organisations. Substructure: – Civmec (Henderson).	Electrical Systems/Transformers – Alstom Grid in Stafford – Siemens Renewable Energy Engineering Centre in Manchester Superstructure – Smulders Project UK – Siemens manufacturing facility in Manchester – Harland & Wolff in Belfast. Substructure – Harland & Wolff in Belfast.
Future & proposed developments	n/a	– No known

Characteristic	Australia	United Kingdom
Experience in offshore (wind) project support	n/a	Electrical Systems/Transformers – Alstom Grid provided their automation control system for the substations in the 580MW Race Bank. – Alstom Grid, with assistance from ABB, designed self-installing HVDC offshore substations for the London Array PSW Farm (operational in 2013). Superstructure – Siemens and Harland & Wolff designed and fabricated the 1500 tonne offshore substation platform for the Gwynt y Môr OSW Farm in 2013. – Smulders started the production of two substations for the Moray West OSW Farm in 2022. Substructure – Harland & Wolff designed and fabricated the substation jacket for the Humber Gateway Offshore Windfarm in 2014.
Skills, labour, equipment	n/a	Harland & Wolff has two Goliath Gantry cranes: – Span: 140m – Lifting height: 70m and 80m – Safe working load: 840t and 900t
Critical investments, partnerships	n/a	No known.
Likelihood of export		Existing Exports: – UK, Asia and Europe (Alstom Grid) – UK and Europe (Harland & Wolff) – Challenges with competition from the Asian supply chain.

4.4.2 Onshore Substation

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the onshore substation fabrication. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Wilsons Transformers manufacture power and distribution transformers: – Power transformers (≤550 MVA) – Distribution transformers (≤5,000 kVA)	– Design, construction and maintenance of HV substations (Siemens). – Cabling and substation construction works (J Murphy and Sons).
Indicative organisations	– Wilsons Transformers – Multiple civil onshore contractors.	– Siemens Transmission & Distribution. – Powerstream Electrical Services (company dissolved in 2022). – J Murphy and Sons.

Characteristic	Australia	United Kingdom
Future & proposed developments	No known	No planned developments
Experience in offshore (wind) project support.	No offshore wind experience, although Wilsons have previously aided the design and manufacture of onshore wind: – 2 x 170MVA power transformers for the 240MW Ararat Wind Farm (2015). – 240MVA 220/33kV power transformer to the Dundonnell wind farm (2019). – 185MVA 220/33kV power transformer to the ACCIONA's Mortlake South wind farm (2020).	– Siemens constructed and installed the 4.7-hectare onshore substation platform for the Triton Knoll OSW Farm. It was operational in Dec 2021. – Powerstream Electrical Services built Walney OSW Farm's onshore substation at Heysham in 2010 for $1.1m USD. – J Murphy and Sons was awarded £21.8m contract to construct the onshore substation for the Race Bank OSW Farm
Skills, labour, equipment.	– Wilson Transformers are understood to have 243 employees. – Major civil engineering workforce.	– 3,500 global employees (J Murphy and Sons). – Siemen's contract with the Triton Knoll project involved >200 people working on the design and delivery phase in the Manchester office.
Critical investments, partnerships.	No known	No known
Likelihood of export		Limited with global competition.

4.4.3 Inter-Array Cables

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the Inter-Array Cables fabrication. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Manufacture of medium voltage cables up to XLPE 3-core 33 kV for terrestrial use.	– Manufacture of 66kV subsea cable technology – 66kV dynamic turnkey inter-array cable systems – Design and manufacture of umbilical systems
Indicative organisations	– Nexans Australia (Lilydale) – Prysmian (NSW)	– JDR Cables in Hartlepool – Prysmian in Wrexham – Oceaneering in Rosyth
Future & proposed developments	No known	– JDR to invest £3m into existing Hartlepool facility, with the installation of a new vertical layup machine to increase production capacity by 25%. This would allow facility to produce cables above current 66kV range (132kV and 150kV cabling planned). – JDR won a contract in Dec 2022 to supply 139km of 66kV inter-array cable and accessories for the Moray West OSW Farm. The farm is expected to be operational in 2024/2025.
Experience in offshore (wind) project support	No offshore wind experience, although Nexans have supplied 275 km of 33 kV cables for the Ballarat onshore wind project. Both Nexans and Prysmian are international organisations active in other OSW geographies.	– JDR was awarded a contract in 2015 to design and manufacture 110km of 36kV inter-array cables for the Ørsted's 580MW Race Bank OSW Farm. JDR also manufactured the hangoffs, electrical T-connectors and cable cleats. – JDR manufactured >206km of 66kV aluminium core inter-array cables at their Hartlepool facility for the Moray East OSW Farm in 2021. – Prysmian supplied >300km of 66kV inter-array cables to Hornsea Project Two in 2021. All the submarine cable cores were produced in their Wrexham facility.

Characteristic	Australia	United Kingdom
Skills, labour, equipment	– Nexans employs 350 people across Australia. – Nexans' Lilydale facility has 20,000 m² fabrication facility and 2 ha of open-air storage.	– New JDR Cables facility in Cambois to create 170 new jobs during construction phase and 400 new jobs during operations. – JDR Hartlepool employs >180 people
Critical investments, partnerships	No known	The BEIS Offshore Wind Manufacturing Investment Support Scheme is partly funding JDR Cable's new facility in Cambois, Northumberland.
Likelihood of export		Existing Exports: – Worldwide (JDR Cables) – North Sea, Mediterranean, western Africa, south-east Asia. (Oceaneering) Likelihood: Possibility with key product and IP of dynamic cables

4.4.4 Export Cables

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the Export Cables fabrication. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	No local capabilities in Australia.	No current capability in the UK.
Indicative organisations	Potential future capability: – Prysmian – - Nexans	– JDR cables (planned facility in Cambois, existing facility in Hartlepool) – XLCC (planned facility in Hunterson, Scotland.
Future & proposed developments	No known	– XLCC in the planning stage of creating a high voltage cable manufacturing facility in Hunterson. They will be producing XLPE coated HVDC subsea export cables by 2025. – XLCC has designed a new Cable Laying Vessel to address increase in future demand. Vessel plans to be operational by 2025. – Construction has started on a new JDR Cables facility in Cambois, Northumberland. The 69,000m^2 factory is expected to cost £130m and start operations in 2024. – The new facility will be the only location in UK capable of manufacturing high voltage subsea cables from start to finish.
Experience in offshore (wind) project support	None	None
Skills, labour, equipment	Prysmian Group has 9 warehouses and 500+ employees across Australia and NZ	– JDR Hartlepool employs >180 people. – New JDR Cables facility in Cambois to create 170 new jobs during construction phase and 400 new jobs during operations. – XLCC plans to hire at least 360 graduates from Ayreshire college between 2023-2025.
Critical investments, partnerships	No known	– JDR Cables was one of the dynamic export cable competition winners from Carbon Trust's Floating Wind Joint Industry Project. – The next phases of the project involved the Carbon Trust and the twelve Floating Wind JIP developers supporting JDR Cables in the development of dynamic export cables ranging from 130kV to 250kV.
Likelihood of export		Possibility with key product and IP of dynamic HV export cables

4.5 Transportation

4.5.1 Onshore Transportation Services

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the onshore transportation services are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	SPMT, Crane, Heavy Haulage	SPMT, Crane, Heavy Haulage
Indicative organisations	– Heavy Haulage Assets. – Lampson – Mammoet Australia.	– Allelys. – Osprey Group – Mammoet UK
Future & proposed developments	No known	No known
Experience in offshore (wind) project support	No in-country experience.	– Allelys delivered and installed four transformers for the Dogger Bank OSW Farm. – Mammoet UK provided the handling and lifting services for the 2,250t Seagreen Offshore Wind Farm jackets mobilising a heavy lift ringer crane.
Skills, labour, equipment	Heavy Haulage Assets Employs 56 People.	– Allelys Employs 46 employees. – Mammoet UK Stockton Facility employs 180 people.
Critical investments, partnerships		Mammoet UK invested £7.2 million into a (2.43 ha) state-of-the-art base on the Teesside Estate, near Stockton.
Likelihood of export		Unlikely to be supported by UK organisations with major organisations having national and regional offices.

4.6 Onshore Building Contractors

4.7.1 Building and Warehouse Construction Contractors

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the building contractor services are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Design, Procurement, Construction of commercial properties, warehousing, offices.	Design, Procurement, Construction and Commissioning O&M Offices, Warehousing, Factory and Fabrication Facilities.
Indicative organisations	Large Number of Organisations (including: Akura, Entegra, EVGG and others)	Large Number of Organisations (including: NRS Group, Hobson & Porter, Balfour Beatty, Bowmer + Kirkland and others)
Future & proposed developments	No known	No known
Experience in offshore (wind) project support	No OSW specific experience.	– NRS Group Constructed the East Anglia One Lowestoft Operation and Maintenance Base. – Bowmer & Kirkland were the Principal Contractor for developing the Equinor O&M base for Dogger Bank.
Skills, labour, equipment		Bowmer & Kirkland has 1,450 employees.
Critical investments, partnerships	No known	No known
Likelihood of export		Unlikely to benefit UK Organisations unless they imbed Australian market.

4.7 Ports

4.7.1 Australian Infrastructure Ownership

At the time of writing there is no national strategy on the development of the ports to support the growth of offshore wind in Australia. This is partly due to the differences in the public and private ownership of the port infrastructure across the states, along with the differing approaches and readiness of the states. The ownership nuances are described below for Victoria, NSW and WA.

The port infrastructure is key to the development of the industry in Australia and could also lay the foundations for supporting the growth of the domestic supply chain and act as a catalyst to make the OSW market in Australia more attractive to the wider industry.

Victoria:

The state of Victoria has a mixture of public and private ports, with the Ports of Melbourne, and Westernport (Port of Hastings) forming part of the state-owned Ports Victoria. The Ports Victoria is a Victorian Government authority that manages the safe transit of vessels into and out of Victoria's commercial ports.

The Port of Geelong is an example of a privately owned port that is owned by SAS Trustee Corporation (STC) and Brookfield's LINX Cargo Care Group, with 50% ownership by each party.[12]

[12]Port of Geelong 2022, About Port of Geelong, https://Port of Geelong.com.au/about/. Accessed 24 Nov. 2022

NSW:

The main ports of New South Wales underwent privatization in 2013 for Port Botany and Port Kembla and 2014 for the Port of Newcastle. NSW Ports operates Port Botany and Port Kembla under 99-year leases from the State of NSW, acquired in 2013 for $5.1 billion. NSW Ports is 80 percent owned by Australian superannuation funds investing on behalf of more than six million individual Australians.

The Port of Newcastle (PoN) is privately owned entity by 2 major shareholders holding an equal stake in the port. The Infrastructure Fund (TIF) and China Merchants Port Holdings Company (CMP), each own 50%[13]. The other major port along the NSW Coast is the Port of Eden. The Port of Eden is owned and managed by the Port Authority of New South Wales, which is a corporation owned by the State Government of New South Wales. The Port Authority of New South Wales, also operate the Sydney Harbour and in-charge of the pilotage and navigation across all the NSW commercially navigable ports.

Western Australia:

There are two types of ports that operate in WA. The Port Authority and the privately owned (single use) ports. There are Eight Port Authority ports wholly state government owned and regulated under the Port Authorities Act 1999 and operate as corporate entities with a board of management that reports to the Minister for Transport. There are thirteen smaller, privately-owned single user ports, governed by the Shipping and Pilotage Act 1967 and Marine and Harbours Act (SPA ports). Authority ports can also have private single-user berths within the authority operated port under individual state agreements with the user.

4.7.2 Australian Infrastructure Development

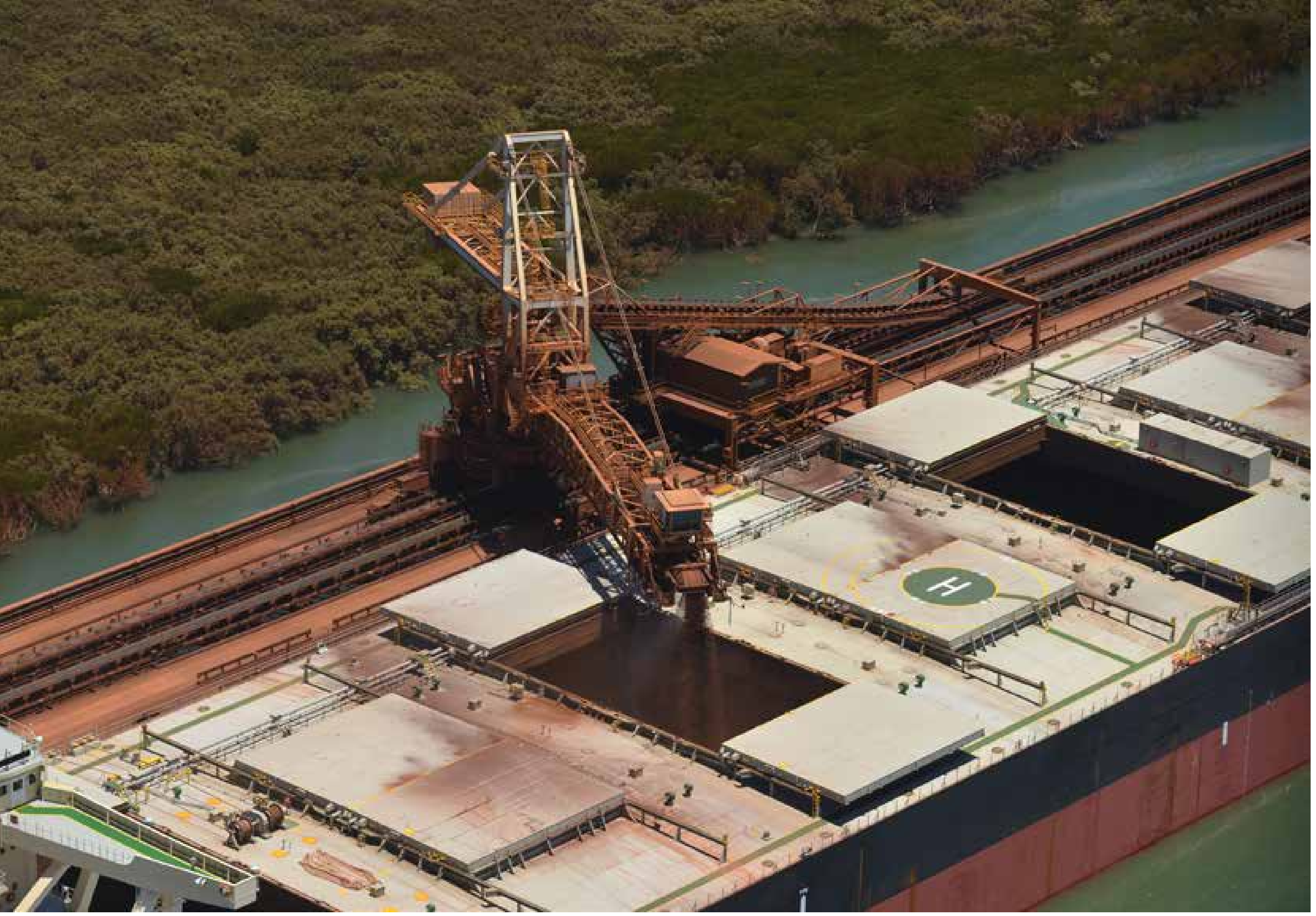
The main infrastructure assets and potential developments and the state contexts are summarized below for Victoria, NSW and WA respectively. It is noted that these are a select number of ports at varying stages of development and readiness. The report acknowledges that other viable port options could offer alternatives.

Victoria:

As part of the Victorian Offshore Wind Policy Directions Paper and Implementation Statement has stated that the Port of Hastings is the preferred port for eastern Victorian projects[14]. The port has received government funding to support the facility as a publicly owned port.

The Port of Geelong, has also declared their interest in developing further there Lascelles Wharf and land-area to be able to support OSW construction.

[13]Port of Newcastle, https://www.portofnewcastle.com.au/about-our-port/, Accessed 16 Jan. 2023
[14]Victoria Offshore Wind Implementation Statement 2: https://www.energy.vic.gov.au/__data/assets/pdf_file/0017/622241/offshore-wind-implementation-statement-2.pdf/



NSW:

The NSW Ports Port Kembla and the privately owned Port of Newcastle have both stated their interest in supporting OSW development in the region.

The Port Kembla has existing planning consent to reclaim and develop the outer harbour for a container terminal, but has been proposed to be adaptable for initially supporting OSW[15].

The Port of Newcastle also similarly has the Mayfield precinct that is proposed for a container terminal that is also sighted for potential OSW support, along with development of the Walsh point North Arm channel for floating OSW given the large vacant land area.

Western Australia:

Fremantle is a container port that operates under the Fremantle Port Authority and one of the larger facilities in the region. The other regional ports are mainly large bulk export ports (i.e. Albany, Broome, Bunbury and Port Hedland – to name a few). The Australian Marine Complex (AMC), Henderson is Western Australia's key shipbuilding and industrial precinct, supporting the manufacturing, fabrication, assembly & maintenance for energy, marine and defense industries.

There are no stated OSW specific infrastructure development proposals (at the time of writing) for the region. However, the existing neighbouring industries and the historic offshore legacy from oil and gas may make the AMC an opportune location to develop capabilities within the country.

There are opportunities for organisations to benefit from wider port infrastructure upgrades and available future development areas to support operations within the major ports, or bringing fabrication to these locations. There will be challenges around the availability of the infrastructure given the limited number of major ports along the coastline and the need for significant investment. It is recommended that the organisations carry out further detailed studies into these opportunities and seek early engagement with the infrastructure owners to establish availability.

[15]Port Kembla Outer Harbour, Desire to Support OSW (ABC Article 22nd Feb 2023): www.abc.net.au/news/2023-02-22/windfarm-future-demands-port-kembla-facilities-planned/102003542

4.8 Transportation & Installation

The UK Offshore Tier 1 Foundation Transport and Installation Contracts have been dominated by European and Asian Heavy Lift contractors. However there has been activity and success for the UK based organisation Seajacks described in further detail below.

4.8.1 Tier 1 – Foundation/ WTG Transport & Installation Contractors

The capabilities across the geographies of Australia and the United Kingdom have been assessed to try to understand the current capability in supporting the transport and installation contracts. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	No existing tier 1 contractor activities within Australia in the Offshore Wind Transportation and Installation.	Operate self-propelled jack up vessels capable of offshore wind turbine installation and maintenance (Seajacks)
Capacities	Unknown	Fleet of five self-propelled jack up vessels
Indicative organisations	International Organisations (in country): – DEME Offshore – Van Oord – Jan De Nul	Seajacks Head Quartered in Great Yarmouth, UK
Future & proposed developments	No declared development of Australian flagged vessels, or capability in the Australian market.	Two vessels, Nessie and Siren, to be delivered to Seajacks in 2024 and 2025 respectively.
Experience in offshore (wind) project support	All three indicative organisations have extensive experience in offshore wind transport and installation in Europe, Asia and North America.	Seajacks was contracted to transport and install the Walney 2 wind farm in 2011.
Skills, labour, equipment	Limited in country experience and vessels and equipment.	– 5 self-propelled jack-up vessels: Scylla, Zaratan, Hydra, Leviathan, and Kraken – 2 more vessels joining in 2024 and 2025: Nessie and Siren – 275 employees (Seajacks)
Critical investments, partnerships	No known	
Likelihood of export		Existing Exports: – Japan, Taiwan, UK (Seajacks) Likelihood: High competition, particularly from (European) organisations active in the Australian dredging market.

4.8.2 Tier 2 – Transport Vessel Charter

The capabilities across Australia and the United Kingdom have been assessed to try to understand the current capability in organisations providing transport vessels for OSW projects. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	– Towage services for vessels used in the construction and installation of offshore oil and gas facilities. – Escort services line handling, berthing and unberthing assistance.	– Towage services for coastal and offshore projects, transportation of cargo on barges, fleet equipment services, diving and sub-surface engineering (GPS Marine) – Marine civils support, towage services and vessel charter (Williams Shipping) – Sale and charter of vessels (Fairways Marine Brokerage)
Capacities	Unknown	– 14 tugboats, 27 barges, 2 crane barges (GPS Marine) – 12 barges, 19 tugboats, 75m bespoke wind turbine barge (Williams Shipping)
Indicative organisations	– Smit Lamnalco – Svitzer Potential: – MMA Offshore – Bhagwan Marine – Offshore Unlimited – TEK-Ocean	– SMS Towage. – Svitzer. – GPS Marine – Williams Shipping – Fairways Marine Brokerage
Future & proposed developments	No known	No known
Experience in offshore (wind) project support	No Australian experience – Smit Lamnalco and Svitzer both have experience in OSW towage in Europe and Asia. – The potential organisations have local experience in the oil and gas industry	Williams Shipping provides turbine blade deliveries, by collecting blades from the Isle of Wight and shipping them to the Vestas facility on the mainland. After the blades are painted, the barge transports the blades to a load out port (Southampton or Portsmouth).

Characteristic	Australia	United Kingdom
Skills, labour, equipment	– Smit Lamnalco have more than 200 vessels worldwide – Svitzer have more than 400 vessels worldwide, approximately 114 of which are in Australia.	– Fleet of tugboats, barges, and crane barges (GPS Marine) – Fleet of barges, tug boats, and a bespoke wind turbine barge (Williams Shipping) – Williams Shipping's wind turbine barge is crewed by a team of 16 on four shifts. – Required 2 crane drivers and 2 signalers to lift the blades onto the barge. – Williams Shipping employed 5 marine apprentices in Dec 2022, totalling the number of apprentices to 9.
Critical investments, partnerships	No known	No known
Likelihood of export		– UK and Europe (GPS Marine) – UK and northern Europe (Williams Shipping)

4.8.3 Tier 2 – Offshore Support Vessels (OSV)

The capabilities across Australia and the United Kingdom have been assessed to try to understand the current capability in organisations providing offshore support vessels for projects. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	– Transport of equipment supplies and personnel to and from offshore facilities. – Deliver offshore support services such as anchor handling, towing, platform supply and standby rescue.	– Deliver specialised offshore equipment for foundation installation and cable laying (Osbit) – Offshore foundation installation, and offshore grouting (LDD) – Installation and maintenance of subsea cables systems (Global Marine)
Indicative organisations	– DOF Subsea (Perth) – MMA Offshore – TEK-Ocean	– Osbit – LDD – Global Marine
Future & proposed developments	No known	BP and EnBW have partnered up to investigate the use of zero or low-emission OSVs for their three planned OSW farms in the UK. – They plan to build four OSVs in Scotland to support their wind farms.
Experience in offshore (wind) project support	– DOF Subsea have provided OSV services to a number of offshore wind farms throughout Europe including Hywind Scotland and Hornsea One. – MMA and TEK-Ocean do not yet have offshore wind experience but have serviced the oil and gas industry in Australia and abroad.	– Osbit installed the inter array system for the Race Bank OSW Farm – LDD provided drilling services to secure the steel monopile foundations for the Gwynt y Môr OSW Farm. – Global Marine has no offshore wind farm experience but is heavily involved in cable installations for the telecommunication, and oil & gas industries.

Characteristic	Australia	United Kingdom
Skills, labour, equipment	– DOF Subsea have 29 support vessels ranging up to 160 m in length and 32 m in width. They have crane capacity up to 100 t and integrated walk-to-work system.	– 3 specialist cable installation vessels, 4 repair and maintenance vessels, and long-term charter vessels (Global Marine)
Critical investments, partnerships	No known	As part of the Clean Maritime Demonstration Competition, the UK government has awarded £1.8m towards research focusing on converting the operations of OSVs to be fully electric.
Likelihood of export		Opportunity to provide vessels, or vessel design services.

4.9 Offshore Safety

4.9.1 Offshore Safety Training

The capabilities across Australia and the United Kingdom have been assessed to try to understand the current capability in organisations providing offshore safety training. These capabilities are summarised below.

Characteristic	Australia	United Kingdom
Existing Capabilities	Classroom and practical training in first aid, manual handling, fire awareness, working at heights, sea survival, advanced rescue, blade repairs	Classroom and practical training in first aid, manual handling, fire awareness, working at heights, sea survival, advanced rescue, enhanced first aid, wind limited access (onshore and offshore)
Indicative organisations	– Skylar Safety in Brisbane – Fire & Safety Australia – RIGCOM in Sydney – Thomson Bridge in Melbourne	– CWind Training Grimsby – Maersk Training UK in Aberdeen – Belay Rope Access in Newhaven – Taskmasters in Old Romney
Future & proposed developments	No known	No known
Experience in offshore (wind) project support	Training courses relevant to site work on onshore wind farms. No training courses related to offshore wind farms.	Training relevant to onshore and offshore wind farm site work.
Skills, labour, equipment	– Industry standard safety equipment at training facilities – <50 employees at Skylar Safety	– Industry standard safety equipment at training facilities. – CWind teaches over 3000 courses per year.
Critical investments, partnerships	All companies require GWO certification to become a training provider.	– All companies require GWO certification to become a training provider. – GWO is a non-profit body founded and owned by its members (OEMs & Operators).
Likelihood of export		No, since practical training only occurs in-house.

4.10 Operation & Maintenance

The capabilities across Australia and the United Kingdom have been assessed to try to understand the current capability in organisations providing operation and maintenance services. These capabilities are summarised below in , considering both Tier 1: O&M full services and Tier 2: O&M Vessel Supply Contractors.

Characteristic	Australia	United Kingdom
Existing Capabilities	Tier 2 Vessel Supply Contractors: Transport of personnel supplies and spare parts to offshore assets for operation and maintenance work including balance of plant, inspection, maintenance, cleaning, training, and monitoring and control.	– Tier 1 O&M Services: Balance of plant, inspection and maintenance of turbines, blades, and HV transmission assets, digital operational planning and asset management (James Fisher Renewables) – Tier 1: OFTO/transmission services, maintenance, monitoring, statutory inspections, crew transfer vessels, logistics (RES) – Tier 2 Vessel Supply Contractors: Personnel and equipment transfer, O&M and construction transport support (Rix Sea Shuttle and HST Marine). – Tier 2/3 Asset inspection: Innovative asset inspection hardware and software.
Indicative organisations	– Bhagwan Marine (CTV) – Offshore Unlimited (CTV)	– James Fisher Renewables – RES – RIX Sea Shuttle (CTV) – HST Marine (CTV) – BladeBug.
Future & proposed developments	No known	James Fisher Renewables signed a memorandum of understanding with Uptime International for the use of motion compensated gangways in their new development of SOV. This would ensure safety and efficiency of transportation between vessels and turbines.

Characteristic	Australia	United Kingdom
Experience in offshore (wind) project support	No offshore wind experience. – Both organisations have serviced a number of projects predominantly in the offshore oil and gas industry.	– In 2022, James Fisher Renewables was awarded three multi-million-pound 13–15 year contracts to provide O&M services at Thanet, Gwynt-y-Môr and Humber OSW Farms. – James Fisher Renewables was awarded 15-year contract in 2019 to provide O&M services to OFTO assets at Greater Gabbard Offshore Wind Farm. – RES was appointed to provide O&M services to offshore transmission assets at the Walney 1 Wind Farm. – Rix Sea Shuttles chartered two CTV vessels, Rix Lynx and Rix Leopard, for Hornsea One.
Skills, labour, equipment	– Bhagwan Marine has over 650 staff and operates more than 150 vessels and marine assets. It currently has 17 CTVs within Australia which range from 8.4-21.3 m in length, 2.8-6.4m in width and with capacity to carry 6-20 personnel. – Offshore Unlimited have four CTVs in Australia which range from 21.5-35m in length, 5.4-11.5m in width and with capacity to carry 32- 56 personnel.	– 2500+ employees worldwide for RES. – Rix Sea Shuttle has six crew transfer vessels. Each vessel is operated by a two-person crew. – HST Marine has four fast crew suppliers, two utility CTVs, and two hybrid CTVs.
Critical investments, partnerships	No known	James Fisher is the parent company of seven companies for which it has acquired and developed based in the UK (EDS HV Group, Fendercare Marine, High Technology Sources Limited, Martek, RMSpumptools, Roto 360, ScanTech).
Likelihood of export		– UK, Europe, Asia (James Fisher Renewables) – UK, northern Europe, North America, Australia (RES) – UK (Rix Sea Shuttle) – UK, Europe (HST Marine)

5 Gap Analysis

The gap analysis across the geographic capabilities have sought to highlight where there is significant gaps across the Australian supply chain and complimentary capabilities from the UK. This has been conducted by developing a Red, Amber, Green (RAG) rating of the supply chain capabilities across the two geographies.

Ref.	Rating Group	Capability
E1	Existing	Capable with existing facilities/ offerings to provide the main relevant suite of services to support Australian OSW project(s).
E2	Existing	Capable of providing partial services with the existing capabilities (likely requiring additional partnering, or reliant on other organisations) to support the Australian OSW Project(s).
P1	Potential	Able to provide limited support with potential downgraded capabilities and or experience in, or plans/ intent to support the OSW industry to provide the main services (Requires future upgrades and developments.
P2	Potential	Able to provide limited support with potential and either experience in, or plans/ intent to support the OSW industry supporting services to the OSW industry.
PW1	Potential with investment	In developing new localized facilities, the organization could diversify with investment and development of the skills to provide the main relevant services to support the OSW Industry.
PW2	Potential with investment	In developing new localized facilities, the organization could provide the supporting services relevant services to support the Australian OSW industry.

5.1 Key organisational opportunities

5.1.1 Capability Gap Analysis Rating

Taking the above capabilities highlighted in Section 4 and comparing these against the relative capability categories within the capability scoring for the UK and Australia are summarised below with the relevant commentary.

ID	Capability	United Kingdom R	United Kingdom Justification	Australia R	Australia Justification
Development Services					
D1	Met-Ocean Data Collection		Existing organisations active in the offshore wind space providing design, fabrication and installation of FLiDAR and met-mast.		Active organisations in the market able to provide the provide the design, fabrication and installation of FLiDAR.
D2	Geotechnical & Geophysical		Existing organisations active in the offshore wind space providing geotechnical & geophysical services.		Organisations with legacy in the Oil and gas industry active in Australia supporting geotechnical & geophysical services.
D3	Engineering Design		Existing organisations active in the offshore wind space providing engineering design of foundations, cables and substations.		Existing organisations active in the offshore space providing engineering design of foundations and electrical systems, but limited OSW experience in country.
Foundation Substructure					
F1	Substructure Fabrication		Historically limited capability, but potential developing further capabilities with investment to expand the substructure fabrication offering.		Limited offshore fabrication capability. No existing organisations active in the offshore wind substructure component fabrication and limited scale of marine grade steel fabrication and supply.
F2	Foundation Assembly Facility		Facilities established to support foundation assembly within the offshore wind space.		Limited capability, with potential building off existing shipyards capabilities.
F3	Secondary Steel		There are moderate (medium to small) sized organisations involved actively in the UK OSW supply chain delivering secondary steel, sea-fastenings and installation tooling.		There are competent small structural steel companies engaged in mining, oil and gas and other industries, but with limited marine grade fabrication and offshore experience.
F4	Scour Protection		Innovative OSW scour protection solutions developed by UK organisations under-going testing and field trials. Varying level of practical experience in providing scour protection at scale.		Existing organisations with existing scour protection experience in the offshore oil & gas industry transferable to the offshore wind space.
F5	Grout		Existing organisations active in the offshore wind space providing grouting services with experience in offshore installation.		Organisations with potential for providing grouting services for offshore wind projects. Existing grouting experience in offshore oil & gas projects, with differing scale and specific needs.

ID	Capability	United Kingdom R	United Kingdom Justification	Australia R	Australia Justification
Wind Turbine Manufacture					
W1	Blade Manufacture		Fabrication and testing of turbine blades, with facilities developed by OEMs at multiple port sites within the UK.		No organisations active in the offshore wind space manufacturing turbine blades. Potential skills within existing fibre glass reinforced polymer composite fabricators requiring OEM support .
W2	Tower Manufacture		No current UK organisations active in the offshore wind space manufacturing tower components.		No offshore wind tower manufacturing. Potential investment for onshore tower fabricators to increase capabilities and diversify.
W3	Nacelle Manufacture		No UK based organisations in the offshore wind space manufacturing nacelles.		No manufacturing of nacelles for the offshore wind market within Australia. Potential investments required for existing manufacturing companies working in the onshore wind market.
Electrical Infrastructure					
E1	Offshore Substation		UK companies active in the offshore wind space providing design of OSS and limited fabrication of OSS foundations.		No current offshore wind OSS fabrication capabilities in country. Limited design experience provided by international engineering design firms active within Australia.
E2	Onshore Substation		Existing organisations active in the offshore wind space providing design and fabrication of structural and electrical components for onshore substations.		Potential existing organisations capable of design and construction of onshore substations for offshore wind projects. Existing onshore substation transformer and component fabrication and experience limited to smaller onshore wind projects.
E3	Inter-array Cable		Inter-array cable manufacturing at multiple sites and dynamic cable fabrication research and development.		No existing organisations active in the offshore wind space manufacturing subsea cables with necessary armouring IAC voltages, or dynamic properties (for floating wind). Potential investment for existing major cable manufacturers to diversify.
E4	Export Cable		Offshore wind cable manufacturers seeking to increase capabilities with investment to enter the export cable manufacturing market.		No existing organisations active in the offshore wind space manufacturing high voltage export cables. Potential investment for future companies.

ID	Capability	United Kingdom		Australia	
		R	Justification	R	Justification
Transportation					
T1	Onshore Transportation Services		There are some medium sized organisations involved in supporting Heavy Lift and Transportation activities within the UK, as well as presence of a global organisation active in the market.		The Australian heavy lift and transport industry has been active in the mining and oil and gas sectors, but has no experience in offshore activities. There is however a presence from a global organisation active in this space in other markets such as the UK.
Onshore Building Contractor					
B1	Building and Warehouse Construction Contractors		The UK civil and building construction industry is well established with many organisations with experience in delivering OSW construction and O&M bases.		There are multiple contractors spread across the states of Australia able to design, procure and construct sufficient buildings, warehouses and facilities to support the OSW industry.
Transportation & Installation Contractors					
TIC1	Tier 1 – Foundation Transport Installation Contractor		Limited capability vessel fleet for the fixed wind transportation and installation of foundation components from UK organisations.		No existing organisations of Australian origin, or with Australian vessel fleets active in the offshore wind space for transporting and installing fixed wind foundations.
TIC2	Tier 1 – WTG Transport & Installation		Limited capability in the offshore wind space transporting and installing the WTG components offshore.		No existing Australian organisations, or vessel fleets active in the offshore wind space transporting and assembling the turbine.
TIC3	Tier 2 – Transport Vessel Charterer		Organisations active in the offshore wind space providing transport vessel charters but limited in scale and capabilities.		Australian organisations capable of providing chartering services for transport vessels for supporting the offshore oil & gas industry, although many vessels mobilised from overseas.
TIC4	Tier 2 – Offshore Support Vessels (OSV) Charterer		UK companies within the offshore wind market capable of providing chartering services for OSV. Planned investments underway to increase fleet of OSVs available.		Potential organisations within Australia actively working in the region and capable of supplying platform supply vessels (PSV)s and OSV.
Offshore Safety					
OS1	Offshore Safety Training		Existing organisations active in the offshore wind space providing offshore safety training.		No existing organisations active providing offshore safety training, but capabilities in GWO onshore module training.
Operation & Maintenance Contracts					
OM1	Tier 2 – Vessel Supplier (Crew Transfer/Service Operation)		UK organisations active in supplying charters for crew transfer and service operation vessels.		Existing Australian organisations have experience in supplying vessels for the offshore oil & gas industry.
OM2	Tier 1 – Operation and Maintenance Contractor		Existing organisations active in the offshore wind space delivering long-term operation and maintenance contracts for wind farm assets.		No Australian organisations active in the offshore wind space operating and maintaining wind farm assets.

5.1.2 Opportunities

As highlighted above there are key areas where the UK has organically developed (limited) component fabrication capability, as well as leading expertise and service to support the growth of the OSW market globally. The critical value, strength and success of UK organisations have been founded on the research and development, with innovation led offerings to deliver the scale and cost saving that the offshore wind industry has needed to increase commercial viability. Critically, this research and development has been supported by the Offshore Renewable Energy Catapult UK (ORE Catapult), local enterprise partnerships and national investment and funding schemes, as well as collaboration with the academia and industry.

There are various levels of support and market engagement that UK organisations may be able to provide to support the Australian OSW Market.

Skills and People:
The immediate low-risk and low-barriers to entry into the Australian OSW market include technical engineering design, naval architecture and specialist knowledge and experience through personnel within UK organisations operating within Australia.

Provision of services and products:
There are also opportunities through further market positioning and engagement for UK organisations to position for contracting services (Planning and Procurement services, Engineering Design services, Tier 1 and 2 Installation Contracting services, and Operation and Maintenance Tier 1 and 2 services), as well as highlighting product capability and capacity to aid the Australian OSW development.

Market Embedment:
There are potential opportunities for those UK organisations with international reach and Australian registered companies to enter the market more immediately, with further growth and development of their Australian entities. There are also possible opportunities for development of joint-ventures with existing highly competent Australian organisations to accelerate and establish the necessary supply chain capabilities within Australia, in pooling resources, knowledge and market contacts for a successful joint-venture, or partnership.

5.1.2.1 Export Opportunities

Based on the above there are some clear areas where there are strong capabilities within the more established UK supply chain and limited corresponding existing Australian capabilities. These main areas are summarised below that could be considered for product export:

Existing: Blades fabricated within the UK.

Existing: Inter-Array Cables (66kV+ cables and Dynamic Cable Systems).

Existing: Grouting (Offshore tier 2 contractors and specialist product and installation development).

Future: Substructure Fabrication (specifically future Monopile fabrication capability).

Future: Export Cables (HVAC Dynamic and HVDC Cables)

There are inherent barriers and challenges with export with >10,000 nautical miles between the UK and the key Australian regional major port. This distance would lead to inflated transportation cost for any components being shipped from the UK. There are additional tariffs specific to the goods and origin as noted within the Australian Border Force (ABF) Schedule 3, of the Customs and Tariff Act from external markets.

Following the UK and Australian Free Trade Agreement (FTA), that was signed on 17th December 2021, there are reduced tariffs on select goods. As noted in the UK Government Report[16] captured in *Table 6* cutting-edge green products manufactured within the UK, such as offshore wind power components will be exportable tariff-free (compared to the 5% tariff previously).

The reduced tariffs could help to increase the attractiveness of the UK supply chains engaged in manufacturing goods for OSW in exporting and winning contracts to support the development of the Australian OSW market.

5.1.2.2 Key skill sharing opportunities.

Beyond the key organisations exporting key products, or setting-up comparable facilities within Australia, there is an opportunity for the sharing of skills and knowledge. The main opportunities highlighted from the Gap analysis above for skill sharing are:

- Engineering Design (FEED and Detailed Design: OSW Foundations, Electrical Systems)
- Dynamic Export and Inter-Array Cable research and development
- Blade manufacturing techniques and testing
- Foundation and WTG Transport and Installation Logistics
- Offshore sea-survival safety training
- Vessel design services for innovative OSV or low carbon O&M Fleets, and
- Operations and Maintenance knowledge, technologies and software.

There are opportunities for UK based organisations with skilled (visa eligible) workers to seek to develop Australian based support to the market through migration and transfer of skills. Beyond migration and transfer of people there is an opportunity for organisations to benefit from the potential selling of intellectual property or providing remote services. There are examples also of organisations selling royalties for localised fabrication such as NKT forming a joint venture with Walsin Lihwa a Taiwanese firm to develop in-country cable manufacturing. The arrangement involves an investment from both parties, but whereby NKT will act purely as a technical partner and purely generate revenue based on a royalty scheme and dividend.[17]

Table 6
UK Export to Australia tariff removal post FTA on manufactured goods

Item	Previous Australian Tariff	New Australian Tariff
Wind turbine blades	5%	0%
Electrical conductors	Up to 5%	0%
Hand tools	5%	0%
Wind-powered generators	5%	0%
Insulated cable	Up to 5%	0%

[16] FTA Benefits to the UK, Department of International Trade: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1130084/uk-australia-free-trade-agreement-fta-benefits-for-the-uk.pdf

[17] NKT Article 24th February 2023 – Joint venture Deal: https://www.nkt.com/news-press-releases/nkt-will-sign-joint-venture-agreement-to-support-construction-of-the-first-offshore-cable-factory-in-taiwan/

5.1.3 Barriers

The key barriers that were assessed in the study are highlighted below for some of the challenges that will need to be considered and over-come to enable the support of the Australian offshore wind market.

Distance of the Market:
The shear geographic distance of the UK to the Australian market >10,000nm makes the potential shipping of exported products, or the transfer of personnel more challenging than exporting to other markets. The distance also leads to challenges from the different time-zones that will need to be over-come and could cause challenges for organisations managing sub-contractors or communications between the UK and Australia.

Potential Mitigations: Developing transportation solutions to maximise the efficiency of the transportation of the products, increasing quantities and reducing the number of journeys.

Local Content:
The Australian Government has asked any developer seeking a feasibility licence to demonstrate how their project would be in the national interest. This includes showing how the project would look to support and promote local content. This will require the Government working with industry to develop a local content strategy to meet future OSW demand. This strategy needs to recognise local content expectations, while recognising the challenges of localising specific heavy fabrication elements of the supply chain. Key is to ensure that the possibility of mandating local content should be done with care so that it does not create an additional barrier to investment and growth.

Potential Mitigations: The FCDO and Department of Trade (DOT) keeping close communication with the Australian federal and state organisations to understand the local content aims, incentives and the opportunities engagement.

Local Perception:
The local stakeholder perception and desire for the blue-collar workforce to be formed from local labour and for there to be benefits to local jobs and GVA.

Potential Solutions: The appreciation and engagement of new developers to the market need to be mindful of this sensitivity in the procurement process and organisations seeking to support the market should look to engage with existing organisations that have strong relationships and links to the unions and industry bodies.

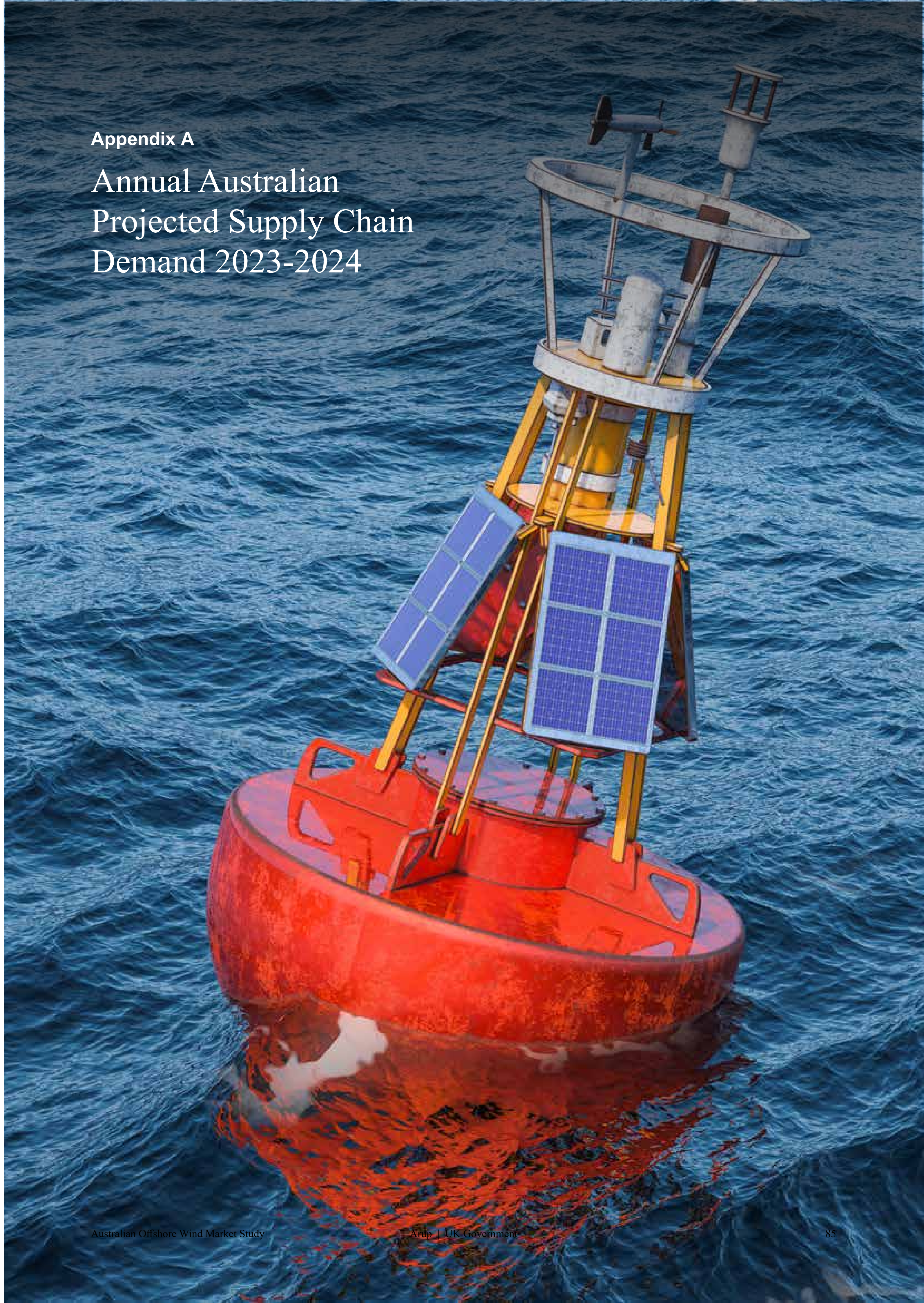
5.1.4 What Next

The mechanisms, options, barriers and context for developing capability to support the Australian Offshore Wind market critically require:

- Further engagement of the industry supply chain.
- UK Foreign Commonwealth Development Office (FCDO) finding opportunities in sharing key lessons learnt and strategic advice for the development of the Australian OSW market. Drawing on successes through schemes such as the Department of Business Energy and Industrial Strategy (BEIS) Offshore Wind Manufacturing Investment Scheme (OWMIS) and Freeports interventions.
- Prioritisation and support to infrastructure development to be able to provide the necessary climate and environment for any supply chain to be able to develop.
- Clear definition of the Australian medium- and long-term national OSW development targets, to provide the scale and certainty for investors and organisations to commit to the Australian market.
- Clarity on the local content requirements to enable industry planning.
- Support from national and state public organisations to provide incentives and support to act as a catalyst to the Australian market.

Glossary

Acronym	Description
AC	Alternating current
APAC	Asia Pacific Region
Capex	Capital expenditure
COD	Commercial Operation Date
CTV	Crew Transfer Vessel
DC	Direct current
Dia	Diameter
DWT	Deadweight tonnage
EGS	Enhanced Geothermal Systems
FLiDAR	Floating light detection and ranging
FOU	Offshore Wind Foundation
FSO	Floating storage offloading
FT&I	Foundation, transport, and installation
G&G	Geotechnical and Geophysical
GFRP	Glass Fibre Reinforced Polymer
GW	Gigawatts
ha	Hectares
HLQ	Heavy Lift Quay
HLV	Heavy Lift Vessel
HQ	Headquarters
HV	High voltage
IEA	International Energy Agency
ISO	International Organisation for Standardization
km	Kilometres
kVA	Kilovolt-amps
LiDAR	Light detection and ranging
m	Meters
MG	Marine Grade
mm	Millimetres
MP	Monopile
MT	Metric Tonne (i.e., 1,000kg)
MVA	Megavolt-amps
MW	Megawatt
NSW	New South Wales
OEM	Original Equipment Manufacturer
OIV	Offshore Installation Vessel
OPEX	Operational expenditure
OSS	Offshore Sub-Station
OSV	Offshore Support Vessel
OSW	Offshore Wind
OWZ	Offshore Wind Zone
PPJ	Pre-piled jackets, or Pin-piled Jacket
ROV	Remote Operated Vehicle
SAW	Submerged arc welding
SPMT	Self-propelled modular trailer
t	Tonnes
T&I	Transport & Installation
TP	Transition Piece
UHLQ	Ultra-heavy lift quay
UK	The United Kingdom
UXO	Unexploded ordnance
VIC	Victoria
WA	Western Australia
WTG	Wind Turbine Generator



Appendix A

Annual Australian Projected Supply Chain Demand 2023-2024

Annual Australian Projected Supply Chain Demand

2023 - 2040

Capability	Unit(s)	Assumptions	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Turbine Rating over Time (MW)			10	10	10	15	15	15	15	15	17.5	17.5	17.5	17.5	17.5	20	20	20	20	20
Development Services																				
Met-Ocean Data Collection	Active units	Installed six years prior to first power In commission for an average of two years One unit commissioned per project	0	0	5	6	9	2	2	2	2	2	0	0	0	0	0	0	0	0
G&G	Service contracts	Surveys are run six years prior to first power Surveys are completed within the year One G&G survey per project	0	0	5	6	9	2	2	2	2	2	0	0	0	0	0	0	0	0
Engineering Design	Concurrent design activities	Engineering design takes place eight years prior to first power Five years for FEED & detailed design packages Four distinct design activities: foundations, electrical systems, onshore and offshore substation	20	44	68	76	84	72	56	40	32	24	16	0	0	0	0	0	0	0
Foundation Substructures																				
Monopile Foundations	Units supplied	Supplied four years before first power (two years for fabrication and two years for installation) Supply is split across a two-year duration Monopile <40 m water depth	0	0	0	0	21	24	188	195	72	72	72	72	32	0	0	0	0	0
Jacket Foundations	Units supplied	Supplied four years before first power (two years for fabrication and two years for installation) Supply is split across a two-year duration 40m < Jacket water depth <60m	0	0	0	0	139	166	143	120	40	40	40	40	18	0	0	0	0	0
Floating Foundations	Units supplied	Supplied four years before first power (two years for fabrication and two years for installation) Supply is split across a two year duration Floating >70m water depth	0	0	0	0	290	610	320	1	2	2	2	2	1	0	0	0	0	0
Grout	Units supplied	Each supply is for a single foundation Supplied the same year as the foundation Applies to 60% of fixed foundation types (accounting for: pin-pile jackets and monopiles)	0	0	0	0	80	95	166	158	56	56	56	56	25	0	0	0	0	0
Scour Protection	Units supplied	Each supply is for a single foundation Supplied the same year as the foundation Applies only to fixed foundation types	0	0	0	0	160	190	331	315	112	112	112	112	50	0	0	0	0	0

Capability	Unit(s)	Assumptions	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Turbine Rating over Time (MW)			10	10	10	15	15	15	15	15	17.5	17.5	17.5	17.5	17.5	20	20	20	20	20
Wind Turbine																				
Towers	Units supplied	Turbine rating increases over time One tower per WTG Supplied three years before first power Supply is split across a two year duration	0	0	0	0	0	450	800	650	316	115	115	115	115	50	0	0	0	0
Nacelles	Units supplied	Turbine rating increases over time One nacelle per WTG Supplied three years before first power Supply is split across a two year duration	0	0	0	0	0	450	800	650	316	115	115	115	115	50	0	0	0	0
Blades	Units supplied	Turbine rating increases over time Three blades per WTG Supplied three years before first power Supply is split across a two year duration	0	0	0	0	0	1350	2400	1950	948	345	345	345	345	150	0	0	0	0
Electrical Infrastructure																				
Export Cables	km of cable supplied	Two export cables per project Average distance to shore is 50 km Supplied three years before COD	0	0	0	0	0	500	600	600	200	200	200	200	200	0	0	0	0	0
Inter-Array Cables	km of cable supplied	Average spacing 10D Supplied three years before COD	0	0	0	0	0	1125	1350	1350	480	480	480	480	480	0	0	0	0	0
Offshore Substations	Units Fabricated & Installed	One offshore substation per wind farm Fabricated/Installed four years before COD	0	0	0	0	5	6	6	2	2	2	2	2	0	0	0	0	0	0
Onshore Substations	Units Fabricated & Installed	One onshore substation per wind farm Fabricated/Installed four years before COD	0	0	0	0	5	6	6	2	2	2	2	2	0	0	0	0	0	0
Transportation & Installation Contractors																				
Active FOU Installation Contracts	Active contracts	One contract per project Installed over a two-year duration Installation begins three years before COD	0	0	0	0	0	5	11	12	8	4	4	4	4	2	0	0	0	0
HLV for FOU Installation	Active units	One HLV per FOU installation contract	0	0	0	0	0	5	11	12	8	4	4	4	4	2	0	0	0	0
OSV for FOU Installation	Active units	One OSV per FOU installation contract	0	0	0	0	0	5	11	12	8	4	4	4	4	2	0	0	0	0
Barges for FOU Installation	Active units	Five barges per FOU installation contract	0	0	0	0	0	25	55	60	40	20	20	20	20	10	0	0	0	0

Capability	Unit(s)	Assumptions	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Turbine Rating over Time (MW)			10	10	10	15	15	15	15	15	17.5	17.5	17.5	17.5	17.5	20	20	20	20	20
Active WTG Installation Contracts	Active contracts																			
Jack-up vessels for WTG Installation	Active units																			
Barges for WTG Installation	Active units																			
Offshore Safety																				
Construction Offshore Safety Training	Staff requiring training	369 FTE maritime construction jobs per GW IRENA staff per 500MW factored by T&I percentagesTotal staff factored by 20% for AUS local content Training is done the year before the first construction activity begins	0	0	0	4982	3879	738	738	738	738	738	140	0	0	0	0	0	0	0
O&M Offshore Safety Training	Staff requiring training	1,930 FTE O&M jobs per GW IRENA staff per 500MW factored by T&I percentagesTotal staff factored by 20% for AUS local content Training is done the year before COD	0	0	0	0	0	0	0	26055	16405	17370	3860	3860	3860	3860	3860	0	0	0
Operation & Maintenance Contracts																				
Tier 1 O&M Contractors	Active contracts	Two service contracts per project: Operation and Maintenance Contracts begin at COD Contracts remain active for 25 years	0	0	0	0	0	0	0	0	10	21	33	37	41	45	49	53	53	53
Tier 2 CTVs	Active units	0.65 CTVs per 20 WTGs Vessels begin operation at COD Remain active for 25 years	0	0	0	0	0	0	0	0	30	53	73	77	81	85	89	93	93	93
Tier 2 SOVs	Active units	0.35 SOVs per 20 WTGs Vessels begin operation at COD Remain active for 25 years	0	0	0	0	0	0	0	0	16	29	39	42	45	48	51	53	53	53

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