IMPROVING DECISION-MAKING IN RELATION TO OFFSHORE WIND

Priority knowledge and decision support needs for Australia

TECHNICAL REPORT

Improving decision-making in relation to offshore wind: Priority knowledge and decision support needs for Australia

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The **Biodiversity Council Australia** – The Biodiversity Council is an independent expert group founded by 11 Australian universities to promote evidence-based solutions to Australia's biodiversity crisis. The Biodiversity Council is a trusted voice in communicating information on Australia's most pressing biodiversity issues to the community, business and governments to ensure biodiversity and Country prosper. **biodiversitycouncil.org.au**

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Acknowledgement of Country: AMCS, ACOWE and the Biodiversity Council acknowledge the Traditional Custodians of this land and sea Country, and pay our respects to their Elders past and present. We acknowledge that this land and sea Country was, and always will be, Aboriginal land and sea.

As the oldest continuing culture in the world, Indigenous Australians have a deep, enduring connection to Country – Land, Sea and Sky. This connection encompasses cultural identity, health, and wellbeing. For Indigenous Australians Country refers to more than a physical or geographical area. Rather, it encompasses the interconnectedness of 'all living things on the land and in the seas, and it also includes connected language, knowledge, cultural practice and responsibility'[1].

Each designated zone for offshore wind development is situated on Aboriginal Country, holding deep cultural significance and rich cultural heritage, including submerged cultural landscapes on the continental shelf.

Indigenous Australians maintain a deep connection to Sea Country. It is important that decisions made in relationship to the Offshore Energy Infrastructure Zones, prioritise the rights, and needs of Indigenous Australians, promote Indigenous leadership and ensure the wellbeing of Country.

marineconservation.org.au/offshore-wind-report

1. Janke, T., Cumpston, Z., Hill, R., Woodward, E., von Gavel, S., Harkness, P., and Morrison, J. (2021) 'Indigenous'. Australia State of the Environment Report. Department of Climate Change, Environment, Energy and Water

Humpback Whale in Sydney Harbour

Executive Summary

There are significant environmental, social and cultural values in zones designated for offshore wind.

Australia's marine and coastal ecosystems are among the most biodiverse in the world, with deeply interconnected relationships between oceans, coasts and human societies. The designated Offshore Electricity Infrastructure Zones (OEIZs) are situated within three of Australia's marine bioregions, each of which holds critical environmental, socio-economic, and cultural significance.

Offshore wind is poised to make significant contributions to Australia's energy transition; however, it presents both risks and benefits to these values.

The exploration, construction, operation, and decommissioning of offshore wind projects may impact environmental, socio-economic and cultural values in both positive and negative ways. Further research is needed to fully understand, assess, and mitigate risks effectively. At the same time, offshore wind has the potential to deliver ecological, social, and cultural benefits, including contributions to renewable energy targets, job creation, and co-benefits for marine ecosystems. These potential benefits must be carefully weighed alongside the risks to ensure informed, balanced decision-making.

A robust evidence base is essential to making environmentally, socially, and culturally appropriate decisions regarding offshore wind in Australia.

Decision-making, at its core, involves collecting and analysing all relevant information, as well conducting research and forecast modelling of potential benefits and impacts. It also requires effectively communicating relevant information to stakeholders, seeking their feedback through meaningful and appropriate consultation, and ultimately making decisions grounded in the best available evidence.

Requirements for adequate and appropriate evidence to inform decision making is outlined in the legislation.

The regulatory framework in Australia sets the requirements for decision-making under the *Offshore Electricity Infrastructure Act and the Environmental Protection and Biodiversity Conservation Act.* Under the legislation, decisions made in relation to offshore wind must be informed by engagement with rightsholders, stakeholders, local communities, and in some instances the public at large. Accordingly, all these actors need access to sufficient and trusted information on the potential risks and benefits that offshore wind developments pose to ecological, social, and cultural values, to enable them to make well informed decisions.

Collecting, analysing, and sharing relevant environmental, social, and cultural knowledge and data, including that from existing databases and resources, will provide a strong foundation for participatory and evidence-informed decision-making. Information must be gathered and made available and accessible in a way that maximises meaningful and culturally appropriate community engagement, ensures efficient data collection, and supports rigorous and iterative assessment processes.

There are significant gaps in our current knowledge

Despite existing knowledge, there are still significant knowledge gaps that require dedicated research efforts. Offshore wind is a new industry in Australia, understanding of its impacts and benefits relies largely on international research and case studies. While global experiences offer valuable insights, they do not fully account for Australia's specific ecological, regulatory, logistical and cultural conditions and context. As a result, substantial additional knowledge is required across all relevant categories to support effective decision-making.

While further data collection is needed across all categories, some priority areas require urgent attention to ensure that decision-making is based on the best available evidence. Addressing these gaps will be crucial for improving the understanding of offshore wind's ecological, social, and cultural impacts in an Australian context. These priority gaps include:

- Baseline data in all OIEZs and appropriate control sites (such as in Commonwealth Marine Parks) to provide an adequate measure of changes over time and to help design solutions and mitigation strategies. Baseline data is particularly required for the following areas:
  - Bathymetric data on continental shelf and slope
  - Sedimentary sampling and data on seabed habitats
  - Benthic biodiversity and oceanographic data
  - Geomorphology
  - National level data on threatened and migratory species
  - Passive acoustic monitoring
  - Community perceptions, values, identity and place attachment, demographics and wellbeing to inform social impact assessment and monitoring
  - Cultural heritage (tangible and intangible), including Sea Country and ancient shorelines
- Data on local, regional and temporal scales to assess cumulative social, ecological and cultural impacts and to help inform ecosystem monitoring

Developing standardised and comprehensive assessment and monitoring programs and (where appropriate) ensuring that data is accessible will support best-practice decision-making.

Appropriate and adequate knowledge and data is required for every stage of offshore wind development - from identifying suitable locations for wind farms to planning construction and operations. Decision-making processes depend on accurate information.

It is critical that we build a knowledge base that is centred around Australian specific data and knowledge, that can provide an appropriate level of information on the stressors and impacts. Building a coordinated knowledge base, with standardised data/information collection protocols and data/information standards should be recognised as important. Such mechanisms will also provide opportunities to enhance monitoring needs in Australia's marine environment and enable further identification of knowledge gaps.

Ongoing monitoring and evaluation are critical to assessing the actual impacts and benefits of offshore wind developments and guiding strategies to mitigate potential adverse effects. The effectiveness of monitoring programs depends on their design, ensuring that collected data translates into meaningful insights and actions. Effort should be put into carefully designing best practice and standardised monitoring programs. For monitoring programs to be effective, they should be coordinated by independent bodies, rather than being developer-led, to deliver independent data that supports transparent evaluation and fosters public trust.

Inclusive decision-making depends on genuine and culturally appropriate community engagement.

To enhance decision-making, there is a need for a more structured, transparent, and inclusive approach to community engagement and consultation. Ensuring that communities, stakeholders, and rightsholders are well-informed about the potential environmental, social-economic and cultural impacts of offshore wind projects is not only essential for building social and cultural acceptance but is also a legislative requirement. Inclusive and culturally appropriate engagement will strengthen the legitimacy of offshore wind decision-making and improve project outcomes.

Addressing key research and data needs will be essential in achieving positive socio-ecological outcomes and in enhancing the long-term sustainability of Australia's offshore renewable energy sector.

In summary, offshore wind development in Australia presents both opportunities and challenges. A strong evidence base, inclusive decision-making processes, and rigorous monitoring and evaluation frameworks will be essential to achieving environmentally, socially responsible, and culturally responsive, outcomes. Without this independently verifiable and robust evidence base offshore wind risks a loss of social licence and unacceptable environmental impacts. Ensuring that knowledge is collected, shared, and applied effectively will support informed decision-making, foster community trust, and contribute to the long-term sustainability of Australia's offshore renewable energy sector.

As part of this report, we put forward a roadmap for funding research to support evidence-based decision making for offshore wind (see Figure below).

A road map for funding research to support evidence based decision making for offshore wind

1. Immediate Investment
- Establish a sustainable, long-term funding mechanism
- Develop national data-sharing infrastructure
- Resource Indigenous Australian communities
- Foster meaningful community engagement

2. Short Term Investment (1-2 years)
- Support independent baseline assessments
- Support experimental research
- Cumulative impact modelling

3. Medium Term Investment (2-7 years)
- Establish decision support mechanisms like Marine Spatial Planning to manage operation and decommissioning.
- Population Viability Analysis on listed and culturally significant species.

4. Long Term Investment (Ongoing)
- Continuous monitoring and assessment
- Adaptive management
- Longitudinal studies

We estimate that Australia must make a substantial investment in marine environmental, social, and cultural research over the short to medium term, with industry paying a significant role in this. While industry will shoulder part of this responsibility, there is a clear need for **strong, independent national oversight** to guide this investment effectively.

We therefore recommend an immediate investment to lay the groundwork by:

1. Establishing a **sustainable, long-term funding mechanism** which leverages and consolidates both industry and Government funds to maximise efficiencies and support independent, peer reviewed research;
2. Developing **national data-sharing infrastructure** to enable open access (where appropriate) to research findings; and
3. **Resourcing First Nations communities** to build internal capacity and support Indigenous leadership in culturally appropriate research co-design.
4. **Establishing meaningful community engagement**, helping to both support regional communities through initiatives like deliberative democracy activities, citizen science programs and ocean literacy projects. These activities will help to both support regional communities in co-designing the broader energy transition within their communities, whilst also addressing public concerns about the potential risks and benefits of offshore wind development.

Once these foundations are in place, a further investment will be immediately necessary to support independent **baseline assessments** across all OIEZs, prioritised by expected deployment timelines, alongside appropriate control sites, ideally within marine parks, to enhance broader understanding of deep-water environments and contribute to effective marine park management. Additional funding should be allocated to foster meaningful **community engagement** through initiatives like deliberative democracy activities, citizen science programs and ocean literacy projects, helping to both support regional communities in co-designing the broader energy transition within their communities, whilst also addressing public concerns about the potential risks and benefits of offshore wind development.

In the medium term, investment should be dedicated to advancing experimental research that supports ecosystem-wide and community-level modelling of offshore wind farm (OWF) impacts, including demonstration projects consistent with international best practice. A further investment is needed to establish effective decision-support mechanisms, including Marine Spatial Planning and Population Viability Analysis on listed and culturally significant species, ensuring that the best available knowledge is embedded into regulatory and planning processes.

Finally, safeguarding Australia's offshore future requires a long-term funding commitment for continuous monitoring, assessment, and adaptive management, ensuring that offshore energy development is both sustainable and equitable for all Australians.

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Abbreviations

ABS	Australian Bureau of Statistics
ACOWE	Australian Centre for Offshore Wind Energy
AIATIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
ALA	Atlas of Living Australia
ARDC	Australian Research Data Commons
AUCHD	Australasian Underwater Cultural Heritage Database
DCCEEW	Department of Climate Change, Energy, Environment and Water
EEZ	Exclusive Economic Zone
EMF	Electromagnetic Fields
EPBC	Environmental Protection and Biodiversity Conservation Act
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
MCDA	Multi-Criteria Decision Analysis
MPA	Marine Protected Area
MSP	Marine Spatial Planning
NESP	National Environmental Science Program
NOAA	National Ocean and Atmospheric Administration
NOAA	National Oceanic and Atmospheric Administration
OBIS	Ocean Biodiversity Information System
OBP	Ocean Best Practice
OEI	Offshore Electricity Infrastructure Act
OEIZ	Offshore Electricity Infrastructure Zone
OSW	Offshore Wind
OWF	Offshore Wind Farm
PVA	Population Viability Analysis
PCoD	Population Consequence of Disturbance
RAD	Resist-Accept-Direct Framework
ROSA	Responsible Offshore Science Alliance
SDG	Sustainable Development Goal
SNES	Species of National Environmental Significance
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples

Leafy sea dragon and weedy sea dragon amongst kelp © Scott Portelli

1. Introduction

1.1 Report objectives and purpose

The report outlines the requirements for the development of a rigorous, independent evidence-base to support best practice decision making in relation to offshore renewable energy in Australia. It highlights the key environmental, social, economic, and cultural knowledge required to underpin this decision making. It also provides key recommendations about how knowledge and data should be used to support decision making under the framework established in the Offshore Electricity Infrastructure (OEI) Act and highlights additional regulatory and policy tools which could be used to maximise the effectiveness of this framework. This will help ensure the renewable energy transition can progress whilst minimising impact on high conservation value areas or culturally significant species, whilst increasing the likelihood of support by host communities.

1.2 About the authors

This report is a collaborative effort involving over 20 contributors representing a range of scientific disciplines and institutions from across Australia, as well as two major research entities – the Australian Centre for Offshore Wind Energy (ACOWE) and the Biodiversity Council Australia.

Australian Centre for Offshore Wind Energy (ACOWE) – A national interdisciplinary research and training partnership to enable sustainable offshore wind development in Australia. ACOWE is a collaboration of universities partnering with stakeholders to deliver impact.

The Biodiversity Council Australia – The Biodiversity Council is an independent expert group founded by 11 Australian universities to promote evidence-based solutions to Australia's biodiversity crisis. The Biodiversity Council is a trusted voice in communicating information on Australia's most pressing biodiversity issues to the community, business and governments to ensure biodiversity and Country prosper.

The core authorship team consisted of Dr Freya Croft (UOW), A/Prof Michelle Voyer (UOW), Prof Daniel Ierodiaconou (Deakin) and A/Prof Camille Goodman (UOW).

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1.3 Background

Climate change is having devastating effects on the world's oceans, driving marine heatwaves, sea level rise, acidification, shifts in ocean currents and changes in species abundance and distribution (UN Climate Action). In Australia, the impact of climate change on the oceans is already evident, with mass coral bleaching events on the Great Barrier Reef occurring in 2016, 2017, 2020, 2022, 2024, which caused the loss of 50% of hard coral cover in shallow waters (Australian Institute of Marine Science, CSIRO 2024), and now, in 2025, widespread bleaching on Ningaloo Reef (NOAA Coral Reef Watch 2025). Additionally, rising sea levels and more frequent severe storm surges are accelerating coastal erosion (Clark et al., 2021). However, the consequences of climate change extend far beyond the ocean itself. As the Intergovernmental Panel on Climate Change (IPCC) (2023) highlights, there is an inherent "interdependence of climate, ecosystems, biodiversity, and human societies," meaning that climate change does not only threaten marine and terrestrial ecosystems but also profoundly impacts human communities. These wide-reaching effects include risks to biodiversity, human health and wellbeing (such as mental health challenges, the spread of infectious diseases, displacement, and food and energy insecurity) as well as threats to infrastructure and industry (IPCC 2023). Furthermore, adverse impacts are intensifying (IPCC 2023). Given that Australia is the driest inhabited continent, it faces heightened vulnerability to these escalating climate risks (Australian Academy of Science 2021).

There is scientific consensus that climate change is caused from the greenhouse gas (GHG) emissions from historical and ongoing activities such as unsustainable energy use, as well as human patterns of production and consumption (IPCC 2023). The only way to reduce the risk of climate change impacts is to significantly reduce GHG emissions (Australian Academy of Science 2021). Decarbonising Australia's energy systems is essential to addressing the long-term impacts of climate change and to meet GHG reduction targets. The need for Australia to play its part in global action on climate change is clear. Australia has one of the highest per capita emissions globally and its climate response remains ranked as "insufficient" by the global Climate Action Tracker (Climate Action Tracker, 2024). There are growing concerns over whether Australia will meet its renewable energy targets, including achieving 82% renewable energy by 2030, as this will require substantial new renewable energy generation (Clean Energy Council 2023).

Offshore wind has been positioned as an important contribution to the urgent need for alternative energy sources due to its stronger, consistent winds and proximity to energy demands. Global offshore wind deployment is expanding rapidly, with capacity expected to grow from 75 GW in 2023 to 2002 GW by 2050 (IRENA 2021). In Australia, where 87% of the population lives within 50 km of the coast, offshore wind offers significant potential to power major industries like steel and aluminium manufacturing while supporting its 2050 net-zero emissions targets (Briggs et al., 2021). Unlike onshore wind and solar, which can be limited by land availability, competing land uses, and variable wind or sunlight conditions, offshore wind benefits from stronger and more consistent wind speeds at sea, which allows for higher energy generation capacity. Additionally, offshore wind can be deployed closer to densely populated coastal regions, reducing transmission losses and the need for extensive grid infrastructure (Briggs et al., 2021).

It is important to note that offshore wind constitutes just one component of the broader renewable energy mix required for the energy transition. Onshore wind and solar are already playing a significant role in Australian electricity generation, with renewable energy accounting for 39.4% of total generation in 2024 (see Figure 1) – a 9.7% increase from 2022. This increase was driven largely by rooftop solar and wind, which together made up 26.4% of this share (Clean Energy Council 2024). While the expansion of onshore renewables is promising, their scalability is constrained by availability of appropriate land and proximity to energy needs and existing infrastructure. At the same time, Australia's energy consumption is rising, with power-intensive industries requiring significantly more electricity to transition to green production (Christoper and Voyer 2024). Additionally, the increasing electricity demands of data centres, artificial intelligence and cryptocurrency are driving increased energy demands (Australian Energy Council). Offshore wind's large-scale power generation capacity will complement other renewable energy sources, enhancing grid resilience and ensuring Australia can meet its growing electricity demands. It is therefore expected that offshore wind will meet 5% of national energy needs by 2035 and 10% by 2040 (AEMO 2024).

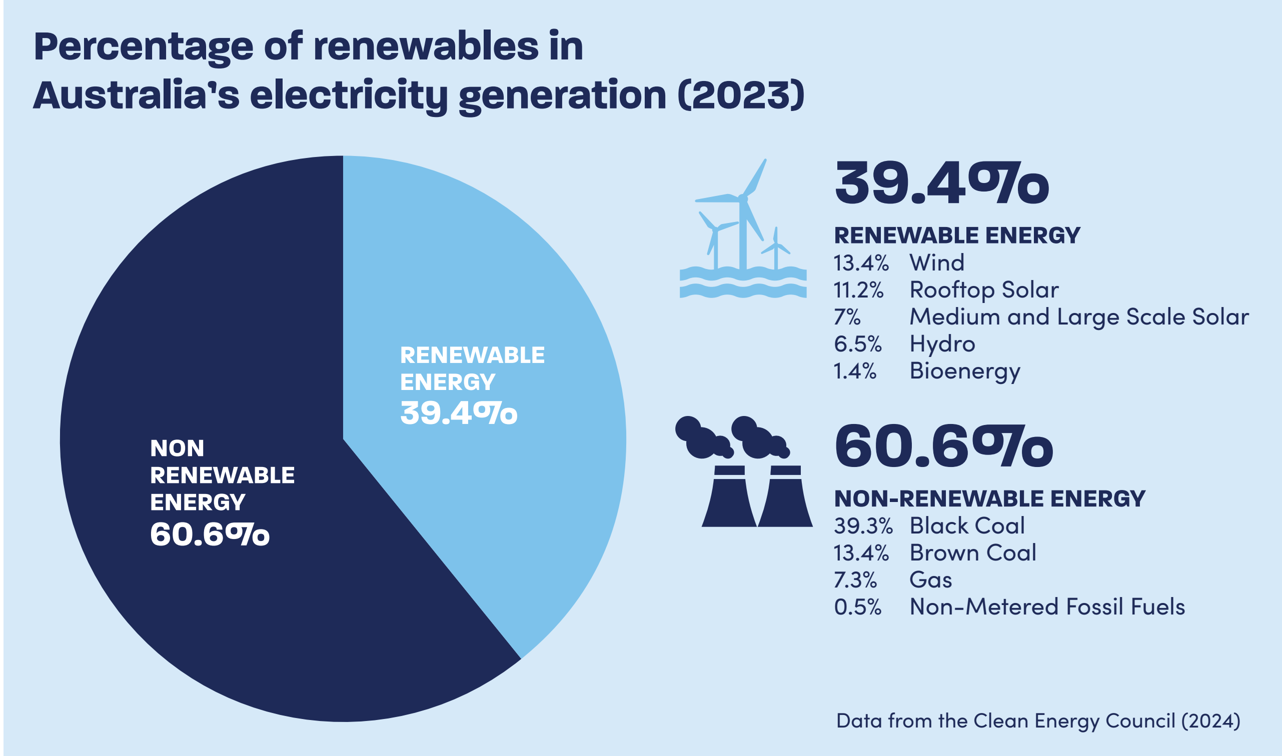

Figure 1: Percentage of Renewables in Australia's 2023 Electricity Generation (Data from Clean Energy Council 2024)

The Offshore Electricity Infrastructure Act 2021 (OEI Act) has provided a regulatory basis for the development of Australia's offshore wind industry, designating six priority Offshore Energy Infrastructure Zones (OEIZs) based on wind conditions, energy demand, and infrastructure (see Section 1.4). All six zones have now been declared: Gippsland, (VIC), Southern Ocean (VIC), Hunter, (NSW), Illawarra (NSW), and Bunbury (WA), and Bass Strait (TAS). More detailed proposals for offshore wind can now developed for these zones, with a number of feasibility licenses already issued – most notably in the Gippsland zone.

Careful planning is needed to collect, analyse and share relevant social, environmental and cultural knowledge and data and provide a strong foundation for participatory and evidence-informed consultation and decision-making in relation to offshore wind developments. Early feedback suggests there are high levels of community concern about the environmental impacts of offshore wind, and concern, or mistrust, around the process of developer led environmental assessments under the OEI Act (Gibson et al., 2024, Spencer-Cotton 2024). In addition, site-specific assessments are unlikely to capture the full range of cumulative and population-scale impacts (and benefits) of offshore wind developments. **Accordingly, there is a need to strengthen the evidence base that communities, government, and industry can rely on to support negotiations, engagement, and decision-making. Knowledge and data must be collected, analysed, and made available at a scale and in a format that maximises meaningful, equitable and culturally appropriate community engagement, ensures efficient data collection, and supports robust assessment, consultation, and decision-making.** We define meaningful engagement as actions/processes that support both equity and inclusivity (Breakey et al., 2024; Tafon et al., 2023; Croft et al., 2024).

This report collates some of the key research and knowledge needs, as well as decision support tools required to support participatory and evidence-informed decisions about the development of a sustainable and equitable offshore wind industry in Australia. The recommendations developed in this paper are designed to support a more 'hands on' role for Governments, independent research institutions, Indigenous Australians, and the broader community in the development of this industry.

1.4 Australia's regulatory framework and requirements for information to manage risks and benefits

Key Points:

- The licencing process for offshore wind is underpinned by some key decisions – in particular, the approval of environmental assessments and management plans.
- Under the legislation, these decisions must be informed by engagement with rightsholders, stakeholders, local communities and in some instance the public at large.
- Accordingly, all these people need access to sufficient and trusted information on the potential risks and benefits that offshore wind developments pose to environmental socio-economic and cultural values.
- As a result, it is critical that the information required to support decisions on offshore wind development is:
  - Available to everyone (where appropriate)
  - Collected and analysed objectively (or independently)
  - Communicated and shared appropriately
  - Collected at scale (spatially and temporally)

The regulatory landscape in Australia surrounding the development of offshore wind legislates what information is needed, who is responsible for getting this information, who needs to be informed, and who makes the decisions. Of most relevance are the *Offshore Electricity Infrastructure Act* and the *Environment Protection and Biodiversity Conservation Act* (EPBC).[1] Under the OEI Act, developers can apply for four types of licences to conduct offshore renewable energy activities (see Figure 2).

The grant of these licences and prior to commencing feasibility activities under these licences, developers will first need to seek relevant environmental approvals under the Environment Protection and Biodiversity Conservation (EPBC Act)[2] and develop management plans for approval under the OEI Act (see Table 1). Feasibility and Research Licences allow proponents to commence their environmental assessments and proceed with obtaining environmental approvals and developing Management Plans. Commercial and Transmission Licences are required prior to any construction or operation of wind farms commencing.

The OEI Act and the EPBC Act have different requirements when it comes to consultation and decision making. Referrals and Assessments under the EBPC Act are led by the Government and include a period of public consultation that are open to everyone (for a period of approximately 10 days). However, under the requirements in the EPBC Act, relevant groups, and the public more broadly, can chose whether to respond to the public consultation.

In the OEI Act, consultation is largely developer led, and there is no formal requirement for coordination of consultation across multiple proponents. The Act requires that rightsholders and stakeholders receive enough information to assess the potential impacts of proposed activities on their rights or interests. However, developers are not obligated to disclose information that could harm their commercial interests. The OEI regulations provide that consultation must be undertaken before a management plan is submitted for approval (Section 48) and provide specific direction about who must be consulted and the 'manner of consultation' (Sections 64 and 65). Licence holders must make 'reasonable efforts to identify and consult' specified stakeholders, and they must 'give each person, organisation, community or group being consulted sufficient information to allow an informed assessment of any reasonably foreseeable effects that the activities subject to consultation may have' on specified rights or interests. They must allow a 'reasonable period' for the consultation.

1 In relation to cultural heritage legislation, our understanding is that relevant issues from the Native Title Act and the Aboriginal and Torres Strait Islander Heritage Protection Act would be brought in under the OEI Act and the EPBC Act.

2 Under the EPBC Act actions will require approval if it will, or is likely to have, a significant impact on a matter of National Significance. This will include all offshore wind development proposals as matters of national significance include nationally threatened species and ecological communities, migratory species and Commonwealth marine areas.

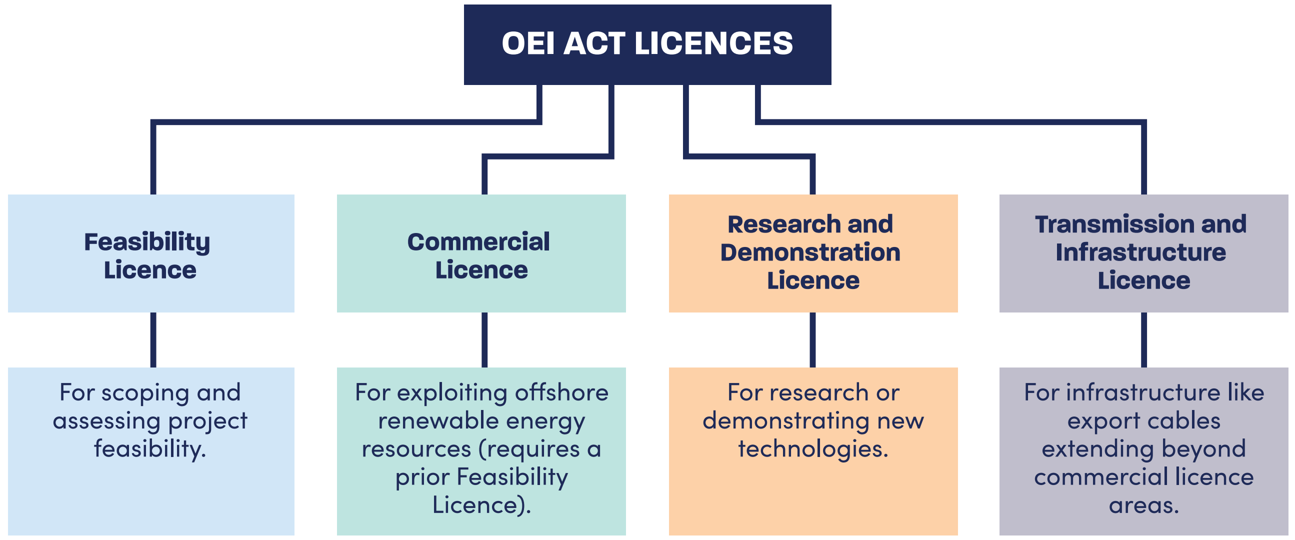

Figure 2: Licences to conduct offshore renewable energy activities under OEI Act.

Importantly, the Management Plan must describe how the consultation was carried out, who was consulted, the outcomes and how they were addressed (Section 81) and must include a Stakeholder Engagement Strategy for ongoing consultation (Section 82). Before approving the plan, the Regulator must be satisfied that the licence holder has complied with the consultation requirements (Section 71) and be satisfied with the outcomes reported under Sections 81 and 82.

Notably, the OEI Act does not address conflicts between offshore wind projects and other marine activities or industries, nor does it establish processes to manage these conflicts. Instead, developers must address such impacts through consultations during the preparation of Management Plans and Stakeholder Engagement Strategies. This involves coordinating with government agencies, marine industries, rightsholders, stakeholders, and community groups, often requiring these groups to engage with multiple developers due to the lack of a centralised consultation process.

These processes will involve a wide range of range of organisations, groups and individuals, all of whom will need access to data, information, analysis and assessments on a range of social, ecological and cultural issues. Accordingly, careful planning is needed to ensure a coordinated approach that respects diverse perspectives, ensures transparent information sharing, and prioritises meaningful involvement in an evidence-informed decision-making process.

To reach decisions under both the EPBC Act and the OEI Act, interested and relevant parties need to be adequately informed and consulted, and decision-makers need sufficient data and information.

Table 1: Approvals Required under EPBC and OEI

EPBC Act Decisions	OEI Act Decisions
Director of National Parks (DNP) Assessment *Only required if the licence area is within an Australian Marine Park (AMP*)* **Purpose:*** To ensure that activities are consistent with AMP management plans. **Decision by:** Director of National Parks (DNP) **EPBC ACT Referral** *To determine whether project requires approval under the EPBC Act* **Purpose:** To determine whether a project will have a significant impact on a matter of national environmental significance under the EPBC Act **Decision by:** Minister for the Environment Consultation: 10 business days for general public comment	**Management Plan Approval** *Required prior to the commencement of activities under a Feasibility or Research & Demonstration Licence.* *Required prior to the grant of a Commercial or Transmission & Infrastructure Licence.* *DNP Assessment and EPBC Act approvals must be secured prior to the approval of a Management Plan.* **Purpose:** To specify all measures to support compliance with OEI Act requirements, and show that EPBC Act approvals, DNP authorisations and other legal requirements have been fulfilled. **Decision by:** Offshore Infrastructure Regulator **Consultation:** During development of the management plan, developers must consult with stakeholders and include report on the outcomes of such consultation and how any adverse impacts on other uses and users are addressed. Management Plans must include a stakeholder engagement strategy to be made public after the Plan is approved. No general public consultation on Management Plans, or consultation in the approval phase.
EBPC Act Assessment *Only required if project is a controlled action. Assessment process can take various forms.* **Purpose:** To ensure that appropriate measures are in place to avoid, mitigate or offset the impacts of projects on matters of national environmental significance **Decision by:** Minister for the Environment **Consultation:** 10 business days for general public comment	**Grant of Licence** *For Feasibility and Research & Demonstration Licences, the licence is granted first, then EPBC Act approvals are sought and the Management Plan prepared.* *For Commercial and Transmission & Infrastructure Licences, EPBC Act approvals are sought first, the Management Plan is approved and then the licence application is made.* **Purpose:** To grant a licence for the conduct of offshore renewable energy activities, provided all relevant criteria are satisfied. **Decision by:** Minister for Energy **Consultation:** No public consultation in this phase. In making the decision, the Minister may consider a range of merit criteria including national interest criteria such as impact on the economy and local communities, national security, timing, efficient use of the licence area, conflicts with other uses or users of the licence area and measures proposed to mitigate such conflicts.

* There are no current intersections of AMPs and OEIZs. However, AMPs could act as control sites for ORE sector (discussed in report).

2. What are the environmental, socio-economic and cultural values of the Off-shore Energy Infrastructure Zones?

Key Points:

- Australia's marine and coastal ecosystems are among the most biodiverse in the world.
- The Offshore Electricity Infrastructure Zones are situated within three of Australia's marine bioregions, each with critical environmental, socio-economic and cultural values.
- The OEIZs are also situated within the Great Southern Reef – an 8000km long interconnected system of rocky reefs.
- There is an interconnected relationship between ocean ecosystems and human societies.
- Indigenous Australians maintain a deep connection to Sea Country. It is important that decisions made in relationship to the OEIZs, prioritise the rights, and needs of Indigenous Peoples, promote Indigenous leadership and ensure the wellbeing of Country.
- Australia's marine and coastal ecosystems deliver vital ecosystem service, underpinning the livelihoods and wellbeing of coastal communities.

Environmental, socio-economic and cultural values refer to the interconnected benefits and relationships between human societies and ecological systems. These values encompass the cultural, social, economic, and ecological importance of natural environments, highlighting how ecosystems support human well-being, livelihoods, and cultural practices. And similarly, how the actions of humans can impact coastal and ocean ecosystems. Understanding the impacts and benefits to environmental, socio-economic and cultural values from the development of offshore wind is crucial for evidence-based decision making.

2.1 Environmental and Biodiversity Values of Australia's Marine Bioregions

Australia's marine bioregions span an area of approximately 14.6 million square kilometres, making the exclusive economic zone (EEZ) the third largest in the world. These vast marine regions support rich biodiversity and significant marine habitats that have importance on a national and global scale (Convention on Biological Diversity). While 33,000 marine species have been recorded, it is estimated that Australia's oceans may have as many as 500,000 marine species (Williams et al., 2017). Notably, Australia's oceans have a high rate of endemic (naturally occurring) species and are also home to migratory species (Clark et al., 2021).

The OEIZs are located within the Great Southern Reef, a globally recognised biodiversity hotspot that encompasses highly productive seagrass meadows, kelp forests and sponge gardens (Victorian National Parks Association 2021). Spanning 8,000km, this vast reef system is home to unique species such as the weedy seadragon and ruby seadragon, boasts the highest diversity of seaweed species in the world, and is considered 'one of the most productive ecosystems on Earth' (GTA 2021).

The six zones declared under the OEI Act occur within three of Australia's Marine Regions, the Temperate East, South-east and South-west (See Figure 3).[3] Each of the three bioregions have protected species (including those listed by the EPBC and the International Union for Conservation

3 There are Marine Bioregional Plans in place for the Temperate East and South-west Marine Regions. The South-east Marine Region has a Bioregional Marine Plan prepared under the now defunct National Oceans Policy. The aim of the bioregional plans is to strengthen the EPBC Act in Commonwealth marine waters.

of Nature (IUCN) as endangered and critically endangered) and protected places (including sites of cultural significance and historically significant shipwrecks).[4]

Importantly, species may be culturally or socially significant but are not listed as so on the EPBC Act and this should be considered when assessing potential impacts and benefits.

Furthermore, each of the three marine regions incorporates diverse habitats, physical features (such as seafloor variations), and complex oceanography (such as the East Australian Current in the Temperate East and South-east, and the Leeuwin Current, which sweeps down Australia's west coast and extends as far as the south east coast). The oceanography and seafloor morphology have a significant influence on ecosystem structure and function in each of the marine bioregions.

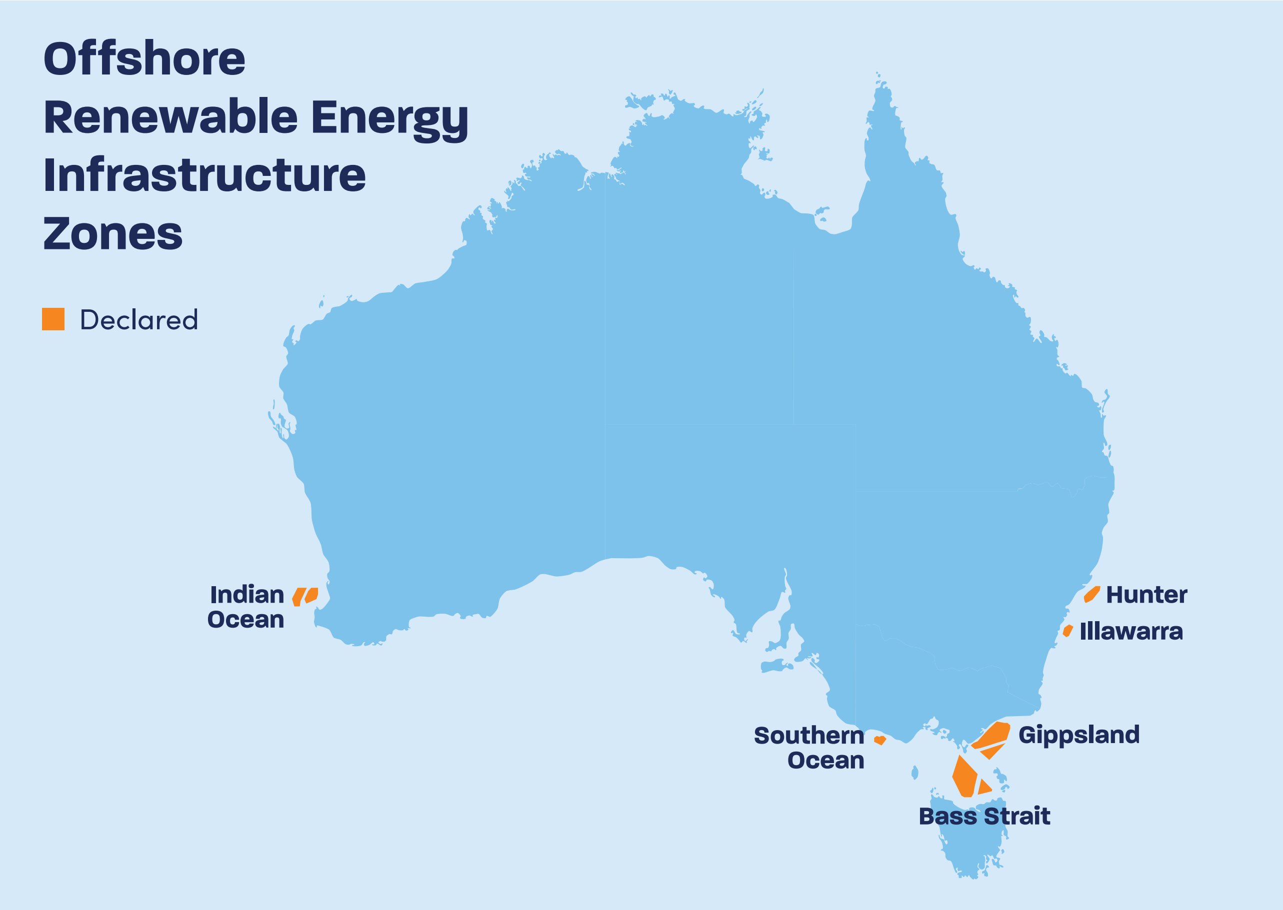

Figure 3: Map of Australia showing OEIZs (in orange) and highlighting marine regions and significant species.

Aside from the environmental and biodiversity values (discussed above) and the intrinsic value of Australia's marine bioregions, it is also important to recognise the significant ecological functions and services these provide. Australia's marine environments provide benefits from ecosystem services such as carbon sequestration, coastal protection, climate regulation, food security, nutrient cycling and habitat provision. It is estimated that Australia's coasts provide $25 billion worth of ecosystem services per annum (DCCEEW 2024, Centre for Policy Development 2011).

4 See McLean et al. (2024) for detailed information about the ecological values in each of the declared zones.

2.3 Social and Economic Values

As an island nation, Australia has deep marine connections. With 87% of Australians living near the coast the marine environment holds vital social and cultural value, offering recreational opportunities, natural beauty, cultural heritage, and significance for conservation and scientific research (Clark et al., 2021). Australia's oceans are not only home to an incredible diversity of marine ecosystems but also support a variety of industries that make a significant contribution to the national economy. For example, it is estimated that the Great Southern Reef contributes $11.56 Billion AUD per year to the national economy (Eger et al., 2022). These industries include commercial and recreational fishing, aquaculture, petroleum and mineral exploration, shipping, ports and tourism. Social and cultural values ascribed to the marine environment in Australia may include visual aesthetics (seascapes), sense of place and place attachment, cultural heritage, identity and image, inspiration, recreation, knowledge systems, and habitat and species values (Burkhard and Gee 2012).

Offshore wind developments often face resistance locally, as communities are concerned about negative impacts to the environment and marine life (ecological values) and to the seascape, cultural practices and heritage, identity, recreation activities and work activities (social values) (Haraldsson et al., 2020). There is currently a lack of place specific knowledge to adequately explore these concerns and inform community.

2.4 Cultural Values – Connection to Country (Land and Sea)

As the oldest continuing culture in the world, Indigenous Australians[5] have a deep, enduring connection to Country – Land, Sea and Sky. This connection encompasses cultural identity, health, and wellbeing. For Indigenous Australians, Country refers to more than a physical or geographical area. Rather, it encompasses the interconnectedness of 'all living things on the land and in the seas, and it also includes connected language, knowledge, cultural practice and responsibility' (Janke et al., 2021). Country is 'not only a place of belonging, but also refers to an interdependent relationship between Traditional Owners and their ancestral lands and seas' (GBRMPA 2024) – an ongoing and unbroken cultural connection.

Indigenous Australian communities are incredibly diverse, encompassing over 300 language groups, but the reciprocal relationship of caring for Country as kin is a shared core cultural relationship (Janke et al., 2021). For thousands of years, and across generations Indigenous Australians have actively cared for Country. However, Indigenous Knowledge systems have largely been neglected in environmental management practices and policies (Trisos et al., 2021). The health and wellbeing of Indigenous Australian Peoples is deeply connected to the health and condition of Country (Janke et al., 2021). Decisions that negatively impact Country directly harm the wellbeing of these communities. As a settler-colonial nation, Australia must acknowledge the enduring consequences of colonisation on Indigenous Australians and their ability to care for Country. Recognising this history underscores the shared responsibility we all have to make thoughtful, sustainable decisions for the environment that supports us all.

Each designated zone for offshore wind development is situated on Sea Country, holding deep cultural significance and rich cultural heritage, including submerged cultural landscapes on the continental shelf. For example, of particular significance is the Bass Strait which was exposed as dry land over a period of thousands of years in which there was human habitation in Australia (Cameron 2011). Land-bridges are key global regions of connectivity and played a significant role in human migration and adaption (Hamacher et al. 2023). The Bass Strait land-bridge is critical Sea Country, indicating a rich history of occupation and use for Australia's first inhabitants. It is important that decisions made in relationship to the OEIZs, prioritise the rights, and needs of Indigenous Australians, promote Indigenous leadership and prioritise the wellbeing of Country.

5 We recognise the significance of language, both in its historical and colonial contexts and in its potential to be discriminatory or disrespectful. We also acknowledge the complexity of terminology when referring to Aboriginal and Torres Strait Islander Peoples, as there is much diversity and difference in opinion. We took guidance from the Australians Together Language and Terminology guide and the Australian Government. See: https://australianstogether.org.au/assets/Uploads/General/AT-Language-and-Terminology-Guide-2020.pdf

3. What are the potential risks and benefits to environmental, socio-economic and cultural values from offshore wind?

Key Points:

- The exploration, construction, operation, and decommissioning of offshore wind farms pose potential risks to the environmental, socio-economic and cultural values of Australia's marine ecosystems. However, further research is needed to better understand, assess, and mitigate these risks effectively.
- It is crucial to balance the potential risks of offshore wind development against the risks of inaction on climate change, recognising that maintaining the status quo will ultimately pose the greatest threat to ocean and terrestrial ecosystems, as well as human society.
- Offshore wind farms also offer potential environmental, socio-economic and cultural benefits. These benefits should be carefully weighed alongside the risks to support balanced and informed decision-making.

Given the significance of the environmental, socio-economic and cultural values outlined in Section 2, it is critical that any potential risks and benefits are carefully considered in decision making process for offshore wind. Studies from overseas can provide examples on the kind of research that has been undertaken to assess impacts occurring from the development of offshore wind in areas such as marine species and habitats (Bergström et al., 2014; Maxwell et al., 2022; Lloret et al., 2022), marine protected species (Farmer et al., 2023) including seabirds of high conservation concern (Garthe et al., 2023), marine protected areas (Püts et al., 2023), ecosystem services (Hooper et al., 2017) and wildlife conservation (White et al., 2024). Such examples can provide a useful framework when considering research design and assessing potential impacts.

The risks associated with offshore wind development should be evaluated within the broader context of climate change, which is widely acknowledged as the greatest threat to our oceans and, more broadly, to humanity (UN 2021; European Environment Agency 2024). Consequently, any potential risks of offshore wind must be carefully weighed against the risks of continuing with current electricity generation methods. While offshore wind developments do present ecological and social impacts, the IPCC emphasises that the net environmental benefits, particularly in terms of reducing emissions, represent a significant advantage of this industry (Wiser 2011). Additionally, existing processes tend to assume that the development of offshore wind infrastructure conflicts with biodiversity goals. However, it is crucial to evaluate both the risks and benefits within the broader context of the increased ecological risks posed by climate change (OWIC 2024), and the risks associated with the uptake of alternative renewable energy sources.

Public perceptions of environmental impacts are crucial in shaping the social acceptance of these projects. For example, globally, there has been strong interest in the impact of offshore wind on charismatic species such as whales, which has become a key factor influencing community support. In the USA, for instance, whale strandings have been linked to offshore wind development in public discourse. However, the US National Oceanic and Atmospheric Administration (NOAA) has stated that there is no scientific evidence connecting offshore wind noise to whale deaths or strandings, with vessel strikes and fishing gear entanglement remaining the primary human-related threats to whales (NOAA 2024). Nonetheless, uncertainties remain regarding potential impacts on whale populations, underscoring the need for further research, both to safeguard marine life and to build public confidence in offshore wind projects.

It is critical that we have Australia specific research, as much of the current research is based in the North Sea, or other global contexts that do not necessarily translate to an Australian context. The marine ecosystems of the North Sea (and other global contexts) differ significantly from that of Australia highlighting the need for locally relevant studies. For example, Australian waters support large baleen whale migrations from multiple species (including endangered blue whales and southern right whales). These species hear in low frequencies, which differ from species found in the North Sea, (such as the higher frequency specialists like harbour porpoises), which are not found in Australian waters. Extensive studies have been conducted on harbour porpoises, and this knowledge can be applied to Australia, however it is not directly applicable.

It is important to recognise that significant knowledge gaps exist regarding the global impacts of offshore wind, including the lack of sufficient baseline knowledge, which is crucial for assessing these impacts (Briggs et al., 2021; Draget 2014). **The information presented in Table 2 highlights potential risks; however, further research is needed to evaluate their likelihood and the potential consequences if they occur.** Environmental impact assessments, conducted as part of the licensing process, provide a framework for assessing both the likelihood and the potential outcomes.

The information in Table 2 is based on a number of sources, including guidance provided by the Department of Climate Change Energy, the Environment and Water (DCCEEW) for assessment under the EPBC Act. This document includes information on the types of impacts that may be expected when developing offshore wind in Australia and includes guidance on measures to avoid and mitigate significant impacts. In addition, a 2024 research project on offshore renewables conducted as part of the National Environmental Science Program (NESP) has developed a comprehensive impacts inventory which has informed this table (McLean et al., 2024). Whilst both these reports primarily focus on a number of biophysical, ecological and cultural impacts, international experience and community feedback suggests that a range of social and economic impacts are also critical to consider, as such the list of impacts has been adapted to incorporate a more comprehensive range of potential stressors. Table 2 also highlights the types of knowledge (broadly categorised by disciplinary areas) which would be required in order to better understand, measure and mitigate the potential impacts, which has directly informed the recommendations of this report.

Table 2: Potential risks to environmental, socio-economic and cultural values from offshore wind

Stressor	Potential impact	Key Risk period	Knowledge needs (category)
Underwater noise	Underwater noise may cause potential impacts such as mortality, injury, disturbance and behavioural effects on marine species. Noise is of particular concern in the construction phase, and especially for fixed turbines where pile driving is required, noting that floating turbines also require anchor points. Constant noise (although lower) during operation should also be considered especially with large-spatial-scales (i.e., cumulative noise from multiple turbines) and implications for migratory corridors. Significant progress has been made globally in developing mitigation measures to better understand and manage the impacts of underwater noise pollution. These measures can include scheduling construction and decommissioning activities at appropriate times (for instance, avoiding migration seasons), using underwater signals to deter marine life before pile driving begins, or gradually increasing pile driving intensity to allow marine animals time to move away (SEER 2021, Draget 2014). It is also important to acknowledge that existing ocean industries, such as offshore petroleum operations (including seismic blasting), generate substantial underwater noise pollution, often at levels greater than those associated with the construction and operation of offshore wind farms (Climate Council 2023).	Construction, decommissioning operation	• Seabed habitats and biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Marine geospatial data and marine cadastre and optimisation knowledge
Turbine interactions	When operating, wind turbines may cause injury and mortality to birds and bats. Negative impacts include disturbance and risk of collision with turbines, habitat loss and alterations, as well as cascading effects if foraging opportunities or prey abundance is affected by windfarms. Research into flight patterns and behaviours can assist in informing the design and operation of wind turbines, including through adjusting turbine height and location. Mitigation strategies may also be possible through slowing (or stopping) turbine speeds during peak migration periods and painting turbine blades, which can reduce collision risk with birds (Garcia-Rosa and Tande (2023).	Operation	• EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • All flying species that have flyways that overlap with wind turbine areas and heights – regardless of EPBC listing.
Electromagnetic fields (EMF)	Many invertebrates, fishes and elasmobranchs (sharks and their relatives) are sensitive to EMF and concerns have been raised about these emissions interfering with early developmental stages, their detection of prey and navigation. Laboratory experiments have been conducted on the impacts of EMF on crustaceans in Europe (Harsanyi et al., 2022), which would need to be replicated in Australia with Australian species. These experiments can be used to assist in designing appropriate levels of insulation of transmission lines in order to minimise exposure to EMF (Hutchison et al 2020).	Operation	• Seabed habitats and benthic biodiversity • • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species
Seabed disturbance	The development of offshore wind farms may cause loss of, or harm to, benthic habitats. The installation of piles for fixed turbines or anchor systems and mooring lines for floating wind turbines in the ocean can potentially disrupt the seabed, and this may pose risks to sensitive marine ecosystems, particularly biodiverse deep reefs with high conservation value. The use of scour curtains around piles can also result in habitat conversion (e.g., from soft to hard) and can disrupt recruitment processes into these habitats. Understanding baseline conditions and the characteristics of natural environments can help mimic these in ecologically engineered scour protection.	Construction, decommissioning	• Bathymetry • Geomorphology • Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species
Disturbance of underwater cultural heritage	**Cultural** The development of offshore wind may disturb, or damage underwater cultural heritage associated with ancient and contemporary coastlines. Intangible expressions of cultural connection with Sea Country, including Songlines, totems, and customs such as story and song may be disturbed through the development of large infrastructure in Sea Country. Co-designed, culturally informed research can assist in determining appropriate siting and mitigation strategies – including avoidance of culturally significant areas.	Construction, decommissioning operation	• Bathymetry • Geomorphology • Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Social and cultural values assessments

Stressor	Potential impact	Key Risk period	Knowledge needs (category)
Physical presence	The physical presence of infrastructure may cause effects on hydrodynamics and sediment transport processes (and transport processes for algal spores, seagrass and coral fragments and larval transport), including impacts on current profiles, ocean stratification and productivity. Research is required to understand whether these impacts are localised or significant at a system level, with consideration to the changes to these processes currently underway in response to warming waters and shifting climatic variables (Van Berkel et al., 2020; Brodie et al., 2023).	Operation	• Geomorphology • Oceanography
	Barrier effects and displacement of marine fauna through avoidance behaviours, which may have impacts on feeding and breeding patterns. Mooring lines (used in floating offshore wind) may also be an entanglement threat, especially for marine mammals such as large baleen whales. Current scientific knowledge suggests that the risk of primary entanglement (in cables or mooring lines) is low due to the size and structure of cables and lines. The risk of secondary entanglement (through the presence of ensnared debris on cables or mooring lines) can also be managed by monitoring and cleaning cables and lines frequently (Maxwell 2022).	Operation	• EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species
	Socioeconomic The physical presence of infrastructure may cause an interference to, or displacement of, existing uses through exclusion or loss of availability of areas for use. This is particularly relevant to commercial and some forms of recreational fishing, and potentially tourism. Shipping and recreational vessels may also be required to modify navigation channels. Coastal and onshore impacts associated with transmission line infrastructure also requires consideration. Social and economic use assessments can assist in minimising conflicts between uses as well as the identification or opportunities to grow co-benefits.	Construction, operation	• Seabed habitats and benthic biodiversity • Oceanography • Threatened and migratory marine species • Social and cultural values assessments • Marine geospatial data and marine cadastre and optimisation knowledge

Stressor	Potential impact	Key Risk period	Knowledge needs (category)
Physical presence continued	**Socioeconomic** Offshore wind farms may impact on the social values associated with seascapes, visual amenity and attachment to place. As offshore wind uses large scale infrastructure it is likely that there may be some visual impact from offshore wind farms which will modify local seascapes, causing potential impacts to place attachment values. Qualitative, place-based research can help to unpack the impacts on place attachment and assist in understanding the social and economic trade-offs between visual amenity and other impacts and benefits associated with OSW.	Construction, operation	• Social and cultural values assessments
Pollution	Offshore wind farms may cause light pollution. At night, navigation requirements mean some form of lighting will need to be mounted on the turbines. This may result in impacts on visual amenity and the movements and behaviour of marine species. Additional light could also affect predator-prey interactions amongst different species. Mitigation methods to avoid negative impacts of artificial light pollution on nocturnal flying species such as birds and bats in the North Sea have included siting infrastructure away from migration corridors, selecting least hazardous forms of lighting and shutdown periods, as well as only switching lights on when necessary for aircraft safety (Walsh et al., 2024).	Operation	• EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Seabed habitats and biodiversity
	Offshore wind infrastructure may have ecotoxicology pollution impacts. Potential chemical speciation changes of construction materials in response to local conditions with potential implications for bioaccumulation/ biomagnification.	Construction Operation	• EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Seabed habitats and biodiversity

Stressor	Potential impact	Key Risk period	Knowledge needs (category)
Vessel interactions	There is the potential for injury and mortality to marine fauna (e.g., ship/boat strike) because of increased vessel traffic during construction and maintenance. The increase of vessels also increases underwater noise increasing underwater noise pollution (inducing disturbance and behavioural changes). Cumulative impacts will require consideration as vessel traffic associated with multi-use port facilities fluctuates in response to shifting markets. For example, as vessels associated with OSW grow, other forms of shipping associated with fossil fuel exports may decline. As such research into vessel interactions should be conducted at a port scale rather than confined to an individual sector.	Construction, decommissioning	• Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Marine geospatial data and marine cadastre and optimisation knowledge
Invasive marine species	Use of vessels and equipment which makes direct contact with the seabed (e.g. pile driving equipment, dredges) are high-risk vectors for the introduction of invasive marine species. Service vessels that move from port areas (which are hotspots for established invasive species) may represent a threat to the transfer of invasive species. The physical infrastructure of the turbine may also provide a substrate for invasive marine species to colonise acting as stepping stones. Research from more established sectors such as oil and gas and shipping can be used to inform OWF design and maintenance to manage this risk.	Construction	• Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species • Marine geospatial data and marine cadastre and optimisation knowledge
Multiple impact pathways	Cumulative impacts associated with multiple stressors, across multiple zones and across a range of depths, may have a range of impacts of social-ecological values, including within Australian marine parks. Long term, national or bioregional scale research is required to contextualise the impacts of OSW across broad geographical and temporal scales within the suite of existing stressor, including climate change.	Construction, operation, decommissioning	All

Extensive research has been conducted on the environmental and social impacts of offshore wind development in various regions, particularly in the North Sea. These studies indicate that the introduction of offshore wind infrastructure, alongside significant changes to commercial fisheries, can have both positive and negative effects on marine ecosystems (Watson et al., 2024; Gusatu 2021; Bergström et al., 2014). Crucially, public perceptions of environmental impacts play a key role in shaping social acceptance of these projects, highlighting the need for comprehensive knowledge on both risks and benefits.

Understanding the nature and scale of benefits is crucial to underpin and support nature positive design principles and to ensure offshore wind development maximises benefits to local communities and environments. As such Table 3 highlights some of the potential benefits that offshore wind can provide marine ecosystems and communities, and the knowledge required to assess and monitor these benefits.

Table 3: Potential benefits to environmental, socio-economic, and cultural values from offshore wind.

Social-Ecological Factor	Benefit/ opportunity	Key benefit period	Knowledge needs (category)
Contributions to GHG emission reduction	The development of an offshore wind industry would help to facilitate the transition to renewable energy in Australia. Benefits to decarbonisation include minimising or mitigating the impacts of climate change, which will likely be felt on local, regional, national and global scales. The International Panel on Climate Change (IPCC) warns the global community to brace for more severe consequences if GHG emissions are not reduced by at least half this decade (IPCC 2022). Furthermore, the removal of carbon dioxide from the atmosphere has positive impacts on marine ecosystems, which absorb almost 30% of the carbon dioxide emissions caused from human activities, leading to ocean acidification, ocean warming, and changes to species distribution and diversity (NOAA 2024; IPCC 2019).	Operation	• Life cycle assessments
Cultural Benefits	Increases to the health and wellbeing for Indigenous Australian communities through community benefit schemes. Enhanced knowledge of cultural heritage through mapping of Sea Country.	Construction operation	• Seabed • Cultural Assessments

Social-Ecological Factor	Benefit/ opportunity	Key benefit period	Knowledge needs (category)
Artificial reef	Biodiversity increases have been documented in certain contexts, as the infrastructure becomes an artificial reef and has been shown to increase the abundance and diversity of some benthic and pelagic species (Pardo et al., 2023). Research suggests that the nature of the infrastructure, including the materials used to construct turbines and foundations can significantly alter the species settlement and composition (Pardo et al., 2023). However, it is important to note that some biodiversity assessments may not factor in the biodiversity loss from converting the habitat and may be simplistic in their evaluations. More research is needed in order to demonstrate if offshore wind farms can provide benefits through becoming artificial reefs.	Operation	• Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered), culturally significant and commercially and recreationally important species
Fish aggregation devices	Offshore wind infrastructure has also been documented to act as a fish aggregation device (FAD), which can increase the catchability of certain species (Fayram and de Risi 2007). This benefit accrues if fishing within wind farms is permitted, or biomass accumulates within windfarms leading to spillover.	Operation	• Fish movement, habitat use and residency data through time
Refugia	The infrastructure of offshore wind farms could contribute to Marine Protected Area planning if their design includes measures that restrict certain damaging activities, such as benthic trawling, while also introducing vertical structures that were previously absent. They may also act as refugia- for example seaweed may attach on the infralittoral sections of the structures (down to 20-30m). Being offshore may provide a cooler refuge for marine life as the areas may be buffered from increasing temperatures in the near coastal zone.	Operation	• Seabed habitats and benthic biodiversity • EPBC listed species including Marine, Cetacean, Migratory and Threatened (Vulnerable, Endangered and Critically Endangered) and culturally significant species

Social-Ecological Factor	Benefit/ opportunity	Key benefit period	Knowledge needs (category)
Co-location of complementary industries	Co-locating blue economy industries that are complementary, alongside offshore wind, can encourage the sharing of space and resources and can be mutually beneficial. Industries that have the potential to be co-located with offshore wind, based on international experience, include fisheries, hydrogen production, low trophic aquaculture, (including seaweed), marine protected areas, alternative offshore renewables such as wave, and floating solar (Stockbridge et al., 2024; Ali et al., 2024; Del Pozo Gonzalez et al., 2023, Christie et al., 2014; Ramakrishnan et al., 2024; Cheng and Hughes 2023; Bonsu et al., 2024; Stelzenmüller et al., 2021).	Operation	
Economic benefits and job creation	The development of an offshore wind industry holds significant potential for job creation both directly and indirectly (supply chain) (Global Wind Energy Council 2024). The High Level Panel for a Sustainable Ocean Economy found that offshore wind has a higher capacity for jobs than the fossil fuel industry and in general has a better gender balance (Lubchenco and Haugan 2023). Aside from job creation, offshore wind also has the potential for economic benefits through factors such as investment, revenue generation, and community benefits, particularly if local content standards are developed and maintained. By prioritising local workforce participation, supply chain development, and industry capability-building, offshore wind projects can generate long-term employment opportunities, support regional economies, and foster skills transfer across related sectors such as maritime industries and advanced manufacturing.	Construction and operation	• Economic assessments

Social-Ecological Factor	Benefit/ opportunity	Key benefit period	Knowledge needs (category)
Community benefit sharing	Community benefit sharing arrangements (the provision of a material or financial 'benefit') can enhance equitable outcomes for offshore wind developments, by working towards a fair and just distribution of harms and benefits and can also enhance social acceptability of projects. If handled appropriately, such arrangements can promote wellbeing and flourishing in coastal communities, particularly when communities participate in designing appropriate schemes (Hannon et al., 2024; Leer Jørgensen et. al., 2020).	Operation	• Social, cultural and economic assessments • Community engagement

Jervis Bay, Shoalhaven, NSW © Atilla Kuszo

4. What do we know? Knowledge to support best practice decision making for offshore wind in Australia

Key Points:

- Evidence based decision-making involves:
    - Gathering comprehensive information about potential impacts and benefits
    - Analysing this information
    - Transparently communicating this information
    - Engaging in meaningful consultation to gather feedback – including adapting methods of consultation to best suit the target audiences to enable them to participate
    - Making decisions based on the best available evidence.
- Place-based knowledge, and scientific data are essential for making informed and ecologically, socially, and culturally appropriate decisions about offshore wind development in Australia.
- As offshore wind is a new industry in Australia, our understanding of its impacts and benefits relies on existing research and international case studies.
- While global studies provide useful insights they will not fully account for Australia' s unique ecological, social and cultural conditions.
- Drawing on existing knowledge and information is important; however, substantial additional knowledge is required across all categories to support informed decision-making.
- While substantial knowledge is needed across every data category, there are some priority knowledge gaps which require dedicated research efforts.
- There are flow on benefits of offshore wind research – including building a knowledge base that can inform decision-making and management across multiple sections of government and society.

Decision-making, at its core, involves collecting all relevant information regarding potential benefits and impacts, effectively communicating this information to stakeholders, seeking their feedback through meaningful consultation, and ultimately making decisions grounded in the best available evidence. It is important to acknowledge the tension between balancing the need to act quickly to decarbonise, with the need to ensure this industry is developed and planned in a socially, culturally and environmentally responsible way. This report seeks to shed light on the kind of information we need, areas where critical information is currently lacking and to emphasise the importance of addressing these gaps, in order to make informed and appropriate decisions.

Collecting and analysing appropriate information and building a strong scientific, and place-based evidence and knowledge base is critical to make informed and environmentally, socially, and culturally appropriate decisions regarding the development and operation of offshore wind in Australia. As this is a new industry in Australia our understanding of impacts, and benefits is limited to our existing knowledge, and on the knowledge created globally, particularly in places with a mature offshore wind industry. However, international studies exploring both social and environmental impacts will not account for Australia's specific ecological conditions (Mclean et al., 2024) as well as Australia's social, economic and cultural contexts, and the regulatory and logistical landscape. As we move forward with this industry it will be important to draw on existing knowledge, as this will also assist in identifying priority knowledge gaps.

Table 4 collates information from a number of sources (outlined in Table) in order to identify existing knowledge that can be used to assess and monitor the impacts and benefits identified in Section 3 and identify future knowledge requirements. Information in this Table is drawn heavily from the National Environmental Science Program Report *Guiding research and best practice standards for the sustainable development of Offshore Renewables and other emerging marine industries in Australia* (McLean et al., 2024).

Table 4: Existing knowledge and future requirements to support impact assessments and monitoring of offshore wind in Australia

Knowledge Category	Current data sources*	Knowledge Requirements*
Bathymetry & sediments	AusSeaBed portal	**Substantial additional knowledge required**, especially in relation to: • Full coverage, high resolution bathymetric data • Sub-bottom profile data is required to confirm the sub-seafloor structure across the continental shelf • Surficial sediments to understand their geotechnical properties and habitat potential
Geomorphology	AusSeaBed Portal MARS – Marine Sediments database: Geoscience Australia	**Substantial additional knowledge required**, especially in relation to • Seabed geomorphology mapping
Seabed habitats and benthic biodiversity	Seamap Australia	**Substantial additional knowledge is required**, especially in relation to: • Impacts of noise (e.g. soundscape baselines, source signatures, responses to other related sounds, species hearing sensitivities) • Mapping the distribution and extent of seabed habitat types, quantifying benthic biodiversity, and establishing baseline measures for indicators of condition
Oceanography	Australia's Integrated Marine Observing System including the AODN Australian Ocean Data Network	**Substantial additional knowledge is required**, especially in relation to: • Site specific oceanographic data • Anthropogenic mixing • Turbidity assessments • Benthic scour • Wind wake effects
Threatened and migratory marine species	BirdLife Australia, Global Archive Atlas of Living Australia (ALA), Ocean Biodiversity Information System (OBIS), Victorian Biodiversity Atlas (VBA) Species of National Environmental Significance (SNES) database.	**Substantial additional knowledge required:** • Regular updating of information on abundance and distribution, and detailed consideration of the ecology and biology of priority species is required • Community environmental concerns have primarily centred on the potential threats to seabirds and whales within the OEIZs, making this a key factor in social acceptance and social licence to operate. Consequently, prioritising research to assess the potential impacts on these species is critical and will support better decision making and help to address community concerns and mis/disinformation.
Cultural heritage mapping	The Australasian Underwater Cultural Heritage Database (AUCHD).	**Substantial additional knowledge required:** • Large areas of underwater cultural heritage mapping required
Social, cultural and economic values assessments	CSIRO Energy Transition Surveys, Blue Economy CRC, NSW Marine Estate (NSW), Australia State of the Environment	**Substantial additional knowledge required:** • Baseline knowledge socio-economic information, including on levels of ocean and energy literacy and on community perceptions, values, identity, and place attachment. • A need for more longitudinal studies on socio-economic impacts (European Commission 2016, Bingaman et al., 2023) Determining what 'benefit' means to communities (Hannon et al., 2024) – place based participatory research on community aspirations for the energy transition.
Nature positive design	Marine Pest Plan (Ecological engineering of marine infrastructure for biosecurity), Sustainable Ocean Plan, World Economic Forum, Nature Positive Plan (DCCEEW)	**Substantial additional knowledge required:** • Australia-specific engineering requirements and nature positive design opportunities

* Current data sources refer to research entities, data repositories and organisations. The lists of data sources in this table are not exhaustive. Data sources/organisations also may not have the capacity or scope to fulfil the additional knowledge requirement needs in each knowledge category. Knowledge requirements refer to whether the existing knowledge adequately covers the expected requirements for assessment of offshore wind impacts. This is based on the findings of existing studies, such as McLean et al., (2024) as well as expert opinions of contributing authors.

4.1 Priority Knowledge Gaps

As this is a new industry in Australia there is a lot that we do not know. While there is substantial additional knowledge required across all of the knowledge categories, there are certain **priority knowledge gaps** which require dedicated research efforts. As outlined in the NESP report (McLean et al., 2024) there are some key areas for which we **have limited environmental knowledge** in relation to OWFs, including:

- Toxicology and ecotoxicology
- Long-term and cumulative impacts
- Unknown impact pathways for Australian species
- The impacts of noise pollution
- Effects on electromagnetic fields on migrating and resident species and demersal electrosensitive species
- Limited knowledge on seabed characteristics on the continental shelf (Bathymetric data) including geomorphic characteristics and extent of benthic habitats and biodiversity values)
- Limited knowledge on sub-seabed characteristics
- Incomplete ecological baseline knowledge and timeseries data
- Limited technological experience with emerging technology, for example digital aerial surveys (used to measure seabirds and marine mammals) and application of radar technology to monitor birds in offshore wind farms)

Further to this, there is **limited social and cultural knowledge** in the following areas:

- Impacts of infrastructure development to Sea Country and connection to culture for Indigenous Australians
- Cumulative impacts on existing marine industries
- Cumulative impacts on communities from broader social and economic change
- Impact to local place attachment or place identity
- Baseline knowledge on energy and ocean literacy
- In-depth understanding on community responses and community engagement
- Community visions/aspirations of appropriate benefit schemes and non-acceptable ecological impacts (what do community want, and what will they not stand for)

4.2 The flow on benefits of offshore wind research

This report primarily focuses on the importance of appropriate and adequate information to inform every stage of decision making in regard to OWFs - from identifying suitable locations for wind farms to planning construction and operations. However, there are flow on benefits from establishing well-developed ocean observations and a national marine science program relating to offshore environments. These include reducing operational costs and building a knowledge base that can inform decision making across multiple sections of Government and society – including Marine Park management, defence, fisheries and disaster responses. There is an opportunity for the research associated with OWF to act as sentinel sites that can contribute to Australia's Integrated Marine Observing System including important observations for climate science in addition to supporting the specific needs of OEIZs.

5. Recommendations to support evidence-based decision making for off-shore wind in Australia

5.1 Recommendation 1: Research infrastructure and policy settings to support integrated, independent research on offshore energy in Australia

Key Points:

- There is strong support across sectors for offshore wind development to be guided by rigorous, independent science. A coordinated research framework would address knowledge gaps and enhance trust in planning and approvals.
- Offshore wind research is resource-intensive, requiring coordination across industry and government to optimise capacity, avoid duplication, and establish shared funding models based on international examples.
- A coordinated national research agenda, developed through a collaborative risk assessment process, would align research efforts with industry, government, and community needs.
- Standardised data protocols and governance frameworks will ensure best practices, secure sensitive data, and support broader marine monitoring efforts.

There have been calls from across industry, Government, conservation organisations, community groups and academics for the development of the offshore wind industry to be underpinned and supported by rigorous, independent science at arm's length from the individual developers. This is also supported by the NESP Report (Mclean et al., 2024), which puts forward a recommendation to develop a framework (developed in consultation with scientists, regulators and industry) to address identified knowledge gaps, which would provide an effective pathway for advancing research questions related to the impacts and benefits from offshore wind. This approach would enable research studies to be undertaken by research institutes (such as local universities) and collaborations of different sizes to contribute collectively to broader goals (Mclean et al., 2024). This approach would also support regulators to conduct demographic analysis, such as Population Viability Analysis looking at cumulative impact on listed and culturally significant species such as albatrosses, whales, sea lions, and orange-bellied parrots. By ensuring an independent source of information on the threats and benefits of offshore wind, the Australian Government can build trust within the community of the planning and approvals process, provide a foundation for ongoing monitoring and build the capacity for peer review and independent evaluation of impact assessment studies.

It is noted however that the cost of undertaking such extensive research is substantial, and in some cases may duplicate the work of private enterprise. This may place pressure on research capacity, including the limited number of research vessels and other speciality equipment. We therefore recommend **a coordinated and collaborative approach to undertaking the required research across industry and Government, supported by a range of policy settings which ensure independence where required, and encourage collaboration and data sharing where appropriate**. There are a number of international examples of shared funding models which Australia can draw from to establish a public-private research funding mechanism to support long terms research and monitoring programs. Examples include the model used in Belgium where developers contribute to a nationally coordinated programme that oversees monitoring, adaptive management advice, and cumulative impacts through a centralised database. Similarly, in Germany a percentage of auction proceeds were allocated to nature conservation and the promotion of sustainable fishing (Mclean et al., 2024). On a regional scale Horizon Europe, the EU's flagship research and innovation programme, is primarily publicly funded through the European Union's long-term budget. However, it also promotes public-private partnerships, encouraging industry co-financing to support collaborative research projects. In the US, the Regional Wildlife Science Collaborative for Offshore wind is a coordination hub for offshore wind research, which assists in bringing government agencies, environmental agencies, and industry together. The collaboration has coordinated regional research and monitoring and have put forward data standards, including for data sharing and transparency (Mclean et al., 2024). Other examples include the US National Offshore Wind Research and Development Consortium, a public-private partnership established in 2018 to drive innovation and advance offshore wind technology.

In order to drive a coordinated, national approach to research which meets industry, Government and community needs the work begun in this report could be leveraged to **create a national set of research priorities for offshore renewable energy.**[6] We recommend this be underpinned by a collaborative risk assessment process, drawing on the expertise of environmental, social, economic and political sciences. The National Marine Science Planning process, currently underway, would be an ideal mechanism to support this process.

As our knowledge base grows so too will the need to ensure this knowledge is appropriately managed, coordinated and disseminated. There is therefore a need to develop the appropriate policy settings and infrastructure to collate, take stock and make accessible (where appropriate) available data in an ongoing way. Building a national scale **Data and Information Supply Chain for OFW** will create a coordinated knowledge base, which will also provide opportunities to enhance monitoring needs in Australia's marine environments more broadly (beyond OWFs). The development of such a resource would enable further identification of knowledge gaps. This recommendation aligns with the Australian Research Data Commons (ARDC)'s project **Offshore Renewable Energy Trusted Environmental Data and Information Supply Chains.** The ARDC has invested $1 million to develop data, analytics and governance infrastructure in the Gippsland ORE. This infrastructure will support evidence-based decision-making through the provision of timely, reliable and shared information. This pilot project focuses on just Gippsland and could be scaled up to a national level. These data also have the opportunity to contribute to Australia's Integrated Marine Observing System (IMOS) and observation needs to inform climate science beyond the boundaries of the OEIZ.

Standardised data collection protocols and consistent data standards are necessary to integrate data from diverse sources for shared analytics. For example, national standardised sampling protocols and data management and delivery for seabird and marine mammals requires further development and investment to work towards Findable, Accessible, Interoperable, and reusable (FAIR) data (McLean et al., 2024). We therefore recommend investing in **best practice standards for data collection**. Additionally, a robust governance framework for shared data and analytics is critical to fostering trusted cross-sector partnerships, including the protection of sensitive data sets that are commercial in confidence or subject to cultural protocols. There is a need for improved coordination to implement standards and facilitate the efficient sharing of research data. This requires designing and developing data-sharing and analytics infrastructure to support government, industry and research sectors, which is important in ensuring that the data supply chain is consistent with the FAIR data principles.

Finally, cultural research is always about more than data collection. It is about knowledge sharing and co-production based on principles of reciprocity, respect and relationship building. As such investment is needed to establish the '**right way' for cultural research relating to OSW** as a matter of priority (Hunter et al., 2024). This includes through the establishment of an Indigenous research network which can oversee the development of research and co-design protocols, and lead or collaborate on relevant research. The Cultural Licence to Operate Framework should be drawn upon as a standard for industry and government when working with Indigenous Australians in order to earn trust and cultural legitimacy (Hunter et al., 2024).

6 The NOPSEMA Research Strategy (2024-2027) provides guidance on priorities, funding and designing research to deliver improved outcomes in the environmental management of offshore energy projects, including that for Offshore Renewable Energy. This includes information on key effects studies, improving monitoring and mitigation techniques, and priority avifauna species.

5.2 Recommendation 2: Gather new knowledge to support evidence based and integrated decision-making which balances environmental, socio-economic and cultural outcomes

Key Points:

- It is critical that we build a knowledge base that is centred around Australian specific data, that can provide an appropriate level of information on all stressors, impacts and potential benefits.
- It is important that baselines are established prior to development as this will ensure ongoing impacts can be successfully monitored.
- Once baseline data has been developed there is a need to deeply examine the ways in which OWFs may interact with and change these baseline conditions in advance of infrastructure being constructed.
- Ongoing monitoring can assess the actual impacts of offshore wind developments and guide strategies to mitigate adverse impacts.
- The success of ongoing monitoring programs is contingent on careful design to ensure that data collected equates to meaningful information.
- It is important to establish control sites to assess data (such as marine parks).
- Ideally monitoring programs should sample meaningful biological indicators, employ experimental designs capable of detecting changes, collect data comparable across projects and with regional long-term datasets, and ensure open transparent access to information for stakeholders.
- Successful monitoring programs should be coordinated by the government, or independent body (not developer led), with open access data.

It is critical that we build a knowledge base that is centred around Australian specific data, that can provide an appropriate level of information on all stressors, impacts and potential benefits (McLean et al., 2024). As highlighted in Recommendation 1, if this is coordinated and standardised across both public and privately funded research there is capacity for Government funds to be targeted at high impact research that directly informs the needs of Government, local communities, other stakeholders and Indigenous Australians. For example, coordinating data collection across Government, industry and research institutions in OWFs and marine parks will provide control sites to monitor disturbance.

Whilst considerable insights can be gained by making better use of available knowledge and data, it is clear there remain significant unknowns which undermine the ability of Government, community or industry to make a confident assessment of the suitability of ocean energy siting and impact mitigation strategies. As such we recommend substantial funding be dedicated to addressing the priority research gaps as a matter of urgency, ideally funded through dedicated funding arrangements (see Recommendation 1). It is critical that research spans the breadth of environmental, socio-economic and cultural considerations as identified in Section 2.

5.2.1 Priority Baseline Research

There is an urgent need to undertake baseline assessment in all OIEZ and appropriate control sites to underpin future impact assessment, ongoing monitoring and the development of impact mitigation strategies. This should be conducted as part of a **coordinated, and integrated research program incorporating environmental, social, economic and cultural assessments**. Priority baseline environmental, social and cultural knowledge gaps have been highlighted in Section 4 and are informed by the international research into likely impacts and benefits.

Research suggests that to effectively monitor the ecological impacts of offshore wind it is important to **collect 3–5 years of baseline data before construction** and to continue monitoring throughout the project's lifespan (Methratta 2024). This approach helps identify temporal patterns in ecological indicators, enabling the differentiation of OSW impacts from other environmental pressures (Methratta 2024). Furthermore, **collecting baseline data from adjacent areas, such as marine parks**, can be useful in providing control sites by which to measure disturbance. Collecting baseline social data would also be beneficial in order to measure cumulative social and economic impacts and track social acceptance as well as energy and ocean literacy over time.

5.2.2 Experimental, collaborative and co-designed models of research to guide decision making and support nature positive design

Once baseline data has been developed there is a need to more deeply examine the ways in which OWFs may interact with and change these baseline conditions in advance of infrastructure being constructed.

From an environmental perspective understanding the impacts and benefits of OSW will require experimental design and forecast modelling projects (including pilot projects). **Pilot and demonstration sites are used globally to enhance knowledge of impacts, build technical and market knowledge, and develop community familiarity (legitimacy) and acceptance** (Petterson 2021). For example, the BLUE PILOT project in Netherlands is being used to verify predictions and test technology to significantly reduce underwater noise levels (Carbon Trust 2018). Demonstration projects have also been used in Spain, Japan, the UK and Norway. Currently in Australia the regulatory framework will not allow for pilot and demonstration sites outside of OEIZs. However, some flexibility in site locations may be required to provide more opportunities for trials to be cost effective and feasible. Any proposed research trial would require robust social and marine science engagement to ensure well sited and well-designed projects in keeping with community expectations. Nature positive design will also require significant focus on experimentation, prototyping and testing and this could be incorporated into, or conducted alongside, pilot projects.

Nature Positive Design in offshore wind farms could be a significant component in ensuring the development of renewable energy contributes to the restoration and preservation of marine ecosystems, rather than exacerbating existing environmental pressures. Integrating nature positive design principles is particularly beneficial in regions where habitats have been degraded, such as the North Sea. However, such principles are still beneficial in Australia, as there is potential to enhance OWF developments by creating suitable habitats for native species or supporting the abundance of key fishery species (McLean et al., 2024). By integrating nature-positive principles (such as design structures to mimic natural habitats or using specific material that enhance natural reefs) offshore wind projects can create synergies with marine environments, supporting the resilience of coastal and marine ecosystems. Current research and monitoring relating to nature positive design elements in offshore wind is sparce and there is a 'significant and concerning knowledge gap in the southern hemisphere' (Pardo et al., 2023, p. 11). Further research is needed in this space, to ensure that the design of OWFs have minimal environmental impacts and do not intensify existing environmental pressures.

Advanced modelling approaches may also assist in predicting likely impacts on (for example) migratory pathways, oceanographic conditions and movements of commercial or recreationally significant species. Demographic modelling has been widely used to identify where conservation efforts should focus to mitigate impacts. Tools such as Population Viability Analysis (PVA) use life-history data or population growth rates to parameterise models that estimate future population dynamics. When extensive and reliable data are available, PVAs can accurately predict extinction probabilities, provided that the distribution of vital rates among individuals and across years remains stable or that any changes can be accurately forecasted (Coulson et al., 2001). In Australia, PVAs have been extensively applied, including by regulators to estimate cumulative impacts and by recovery teams to guide conservation strategies. Additionally, PVAs help identify critical data gaps where uncertainties may affect population viability assessments.

Where limited data is available, expert opinion can be used to develop Population Consequences of Disturbance (PCoD) models, particularly for assessing non-lethal effects. The PCoD model is a conceptual framework used to assess the potential for population-level consequences following exposure of animals to a disturbance activity or stressor, using a four-step process: tracking changes in individual behaviour and physiology, assessing their impact on health, determining effects on vital rates, and ultimately estimating population-level outcomes (Dunlop et al., 2021). Internationally, the PCoD method has been used to assess the impacts of offshore wind development.

From a social perspective processes of **community engagement and co-design** will be essential to build understanding of the likely ways in which people may respond to the development of OWFs in their communities. It will also assist in understanding appropriate mitigation strategies. Co-design approaches can also be useful in engaging local communities in conversations about the types of nature positive outcomes as well as community benefits, they would like to see prioritised within their adjacent farms.

All these detailed studies can directly inform decision making at all stages of the licensing processes and associated planning exercises (see 5.4).

5.2.3 Establishing ongoing, long-term research and monitoring

Continuous monitoring and research programs are essential to **understanding the actual impacts** of offshore wind farms on environmental, social, and cultural values. **These programs play a crucial role in informing adaptive management strategies that can mitigate adverse effects** (where possible). We therefore recommend establishing **comprehensive and standardised monitoring and evaluation programs, that are rigorously designed and implemented**, as these are vital to providing the detailed data needed to assess ecological impacts and guide effective mitigation measures (Methratta 2024; McLean et al., 2024). Drawing on the effective monitoring programs undertaken throughout Australia's marine parks can provide guidance in the development of the offshore wind industry.

Information for monitoring

Effective monitoring is critical for ensuring the long-term coexistence of offshore wind farms with healthy marine ecosystems and thriving coastal communities. urthermore, leveraging the data and resources of the Australian Integrated Marine Observing System could provide a framework for ongoing research and monitoring. Under the OEI Act, the Offshore Infrastructure Regulator develops and implements monitoring and enforcement strategies to ensure that the developer complies with their obligations. Therefore, monitoring is legislated, reinforcing the importance of reliable data and information in decision-making throughout the lifespan of an OWF. However, a clear distinction must be made between data and actionable information**. The data collected must meet specific standards and possess key characteristics** to avoid the risk of being **"data-rich but information-poor"** (Methratta 2024, p. 1). An **Ocean Best Practice (OBP) Approach** outlines standardised protocols, and analysis approaches across scientific fields and should be used to reduce the bias and variance in sample data (Przeslawski et al., (2023). Data and information collected as part of long-term monitoring and research should be made publicly available to ensure transparency and to centralise existing data sources (Kershaw et al., 2023). Such an approach aligns with the work being done by Australian Integrated Monitoring Observing System (IMOS), who do long term monitoring, develop and deliver OBP, coordinate at a national scale and provide open access data.

Similar approaches elsewhere also offer useful guidance, such as the US-based Responsible Offshore Science Alliance (ROSA) *Monitoring Framework and Guidelines for OSW Projects*. According to this framework, monitoring programs should be designed to:

- Detect meaningful changes in the marine environment.
- Direct responses or actions to mitigate in response to adverse changes.
- Sample relevant biological indicators.

- Use experimental designs capable of detecting changes.
- Collect data that is consistent across projects and compatible with regional, long-term datasets.
- Ensure open and transparent access to information for all stakeholders (ROSA 2021).

It is also important to ensure that ongoing monitoring and research programmes do not solely focus on environmental indicators, but also monitor the ongoing and long-term impacts and benefits to social, cultural, and economic values – such as changes to the fishing industry (Willis-Norton et al., 2024). When designing monitoring plans, it is essential to account for other influencing factors to ensure that observed changes in socioeconomic and sociocultural indicators can be reliably attributed to offshore wind development (Willis-Norton et al., 2024).

Triggers for Action

Triggers for actions based on monitoring and evaluation in the context of OSW typically relate to identified thresholds, trends, or anomalies in environmental, social, or operational data. Triggers for action play a crucial role in monitoring and evaluation by establishing clear thresholds or conditions that prompt a response when key indicators signal change. These triggers ensure timely decision-making, allowing for adaptive management, course corrections, and proactive interventions. By defining when and how to act, they enhance accountability, efficiency, and responsiveness in projects, policies, and environmental management. Well-designed triggers help prevent delays, mitigate risks, and ensure that monitoring efforts translate into meaningful action. Importantly, triggers for action must result in a mandatory response under the EPBC or OEI Act, rather than being non-obligatory. **We recommend that triggers for action be identified, and mechanisms put in place to ensure these are acted upon.**

The Guidance developed by DCCEEW (2023) on the key environmental factors for OWF environmental impact assessment under EPBC provide guidelines for monitoring and mitigation, that includes examples of triggers for action. For example, in the best practice standards on mitigating risk for marine fauna such as whales it is suggested that "*a marine fauna monitoring program will be required to reliably detect and monitor the presence, behaviour and response of sensitive fauna within relevant effect ranges and trigger mitigation measures such as shutdowns and restart procedures.'* Similarly, their guidance for seabirds suggests *'implementing monitoring programs to verify collision risk prediction made during assessments and define management triggers that will be used to trigger adaptive management measures, may be an effective means to control uncertainty and prevent unacceptable impacts'* (DCCEEW 2023).

5.3 Recommendation 3: Communicate and share existing and new knowledge with key stakeholders and the broader community

Key Points:

- To improve decision-making there is a need for a more coordinated, transparent, and inclusive approach to community engagement and consultation in offshore wind projects.
- Ensuring that communities, stakeholders and rightsholders are sufficiently informed on the potential risks and benefits to ecological and social values of developing an offshore wind farm, is not only important to raise social acceptance, but is in the legislation.
- Securing a 'cultural license to operate' requires engaging with a rights based, self-determined process of co-design with Indigenous Australian communities.

Informed communities are able to make decisions based on evidence, rather than assumed knowledge (which may be built on misinformation). Programs to build ocean and energy literacy in the community should therefore be viewed as critical. Ocean literacy has been identified as a key priority with the Australian Government's Draft Sustainable Ocean Plan 2024 and has been highlighted as a topic of interest for the renewed National Marine Science Plan (currently under development), as well as the UN Ocean Decade. International examples of national **Ocean Literacy Strategies** have begun to emerge, including in the UK, and provide an example of how a coordinated approach that incorporates offshore renewable energy might be developed which meets multiple objectives (Shellok et al., 2024; McKinley & Burdon 2020; McKinley et al., 2023).

The emergence of ocean energy will benefit from this focus on ocean literacy but also requires consideration of its intersection with energy literacy. The establishment of **local energy hubs** is one mechanism that allows for a centralised and accessible sharing of trusted information around energy transitions and there may be opportunities to co-locate ocean literacy activities or materials within these hubs (or other trusted local community networks) within the OEIZ areas. **The creation of local energy hubs, and integrating these hubs with ocean literacy programs,** would allow for a coordinated approach to sharing data and information (particularly if sourced from an OSW knowledge base), that could work to minimise uncertainty, distrust and the spreading of false information.

Another important mechanism to support transparency and to aid dissemination of relevant information as it becomes available is through **citizen science activities**. There is significant capacity of greater community engagement in many of the priority research areas, including cetacean and bird monitoring and fisheries research. There is also a strong network of existing marine and coastal citizen science programs which could be leveraged to include priority research areas relevant to OSW.

5.3.1 Inclusive Decision-Making: genuine and culturally appropriate community engagement

Genuine and effective community engagement requires active negotiation and deliberation, acknowledging and addressing the diversity within and between community groups. The 2024 Senate Inquiry into community consultation processes in the development of offshore wind in Australia, revealed that sections of the community were highly critical of the consultation process to date. A significant reason for this was inadequate models of community consultation. The face-to-face engagements used in the OEIZ consultations provided little opportunity for two-way exchange or deliberation, did not appropriately recognise diverse opinions and values, and relayed often limited information to the public, many of whom had limited prior knowledge (Voyer et al., 2024). Building on experience, it is essential to ensure meaningful and appropriate consultation and engagement in future efforts.

Community engagement and participatory processes involve the active engagement of stakeholders, civil society, the private sector and the public more broadly. To ensure inclusivity and diversity in these processes it is important that engagement and participation are ethical and equitable – meaning that a wide range of voices are heard, and there is a safe and appropriate process and place for these voices to be heard, which may not be in a traditional government or institutional context (Croft et al., 2024). Often, community engagement processes are viewed as a 'box-ticking' exercise, rather than a productive and equitable process. It is important to recognise that in these highly charged debates, the voices of those with more moderate views can be lost (Voyer et al., 2024). Conflict is an inevitable component in decision-making processes and should not be considered as something to necessarily be avoided (Knol-Kauffman et al., 2023). Rather, processes of community engagement and decision making should be focusing on ways to make conflict respectful and productive, involving negotiation, and deliberation, rather than focusing on division and polarisation.

Currently, several factors hinder governments and industry from achieving meaningful engagement in offshore wind development. Insufficient and inaccurate information about offshore wind (a concept unfamiliar to many Australians) has left some community members feeling misinformed and distrustful. Environmental concerns are at the heart of current debates on offshore wind, shared by both supporters and opponents. Addressing these concerns constructively can elevate environmental and social standards beyond regulatory requirements, promoting greater public scrutiny and encouraging positive outcomes for all stakeholders and the environment.

Current regulatory and legislative frameworks for offshore wind have unintentionally created systemic barriers to effective community engagement. Fragmented jurisdictional responsibilities across government levels have caused confusion about how various aspects of the energy transition align. There is an urgent need to provide clearer information on how offshore wind fits into the broader energy transition, helping communities understand its role in climate action and the future energy system.

Furthermore, reliance on developer-led engagement and unclear accountability for delivering local benefits has eroded community confidence in promised economic outcomes. A more coordinated, transparent, and inclusive approach to community engagement in offshore wind projects is urgently needed.

Prioritising the rights and interests of Indigenous Australians, particularly their cultural connection to Sea Country, is essential in the energy transition. Appropriate support mechanisms must be provided to ensure Free, Prior, and Informed Consent, data sovereignty and co-design. Indigenous Australians have called for self-determination in relation to how they engage with developers, governments and the community. Developing pathways for self-determination should be a priority and aligns with Australia's endorsement of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). However, it is important to recognise that while Australia has endorsed UNDRIP it has not yet been implemented in Australian law and policy. However, the principles of UNDRIP, along with the principles for engagement developed by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) and the First National Clean Energy Strategy should provide important guidance throughout the development of this industry. A strong rights-based approach to offshore wind development, in partnership with Traditional Owners, Custodians, peak bodies, and cultural heritage alliances, is needed. This should include self-determined pathways for benefit-sharing, with a focus on Indigenous Australian leadership, co-ownership, and management of large-scale renewable energy projects, including offshore wind (Hunter et al 2024).

Overall, there is a need for a strengthened, coordinated approach to engagement with Indigenous Australians and the broader community that respects diverse perspectives, ensures transparent information sharing, and prioritises meaningful involvement in the decision-making process.

ACOWE social scientists have previously developed ten recommendations for the Australian Government, for consideration by the Senate Inquiry into Community Engagement on Offshore Wind. These are shown in Figure 4.

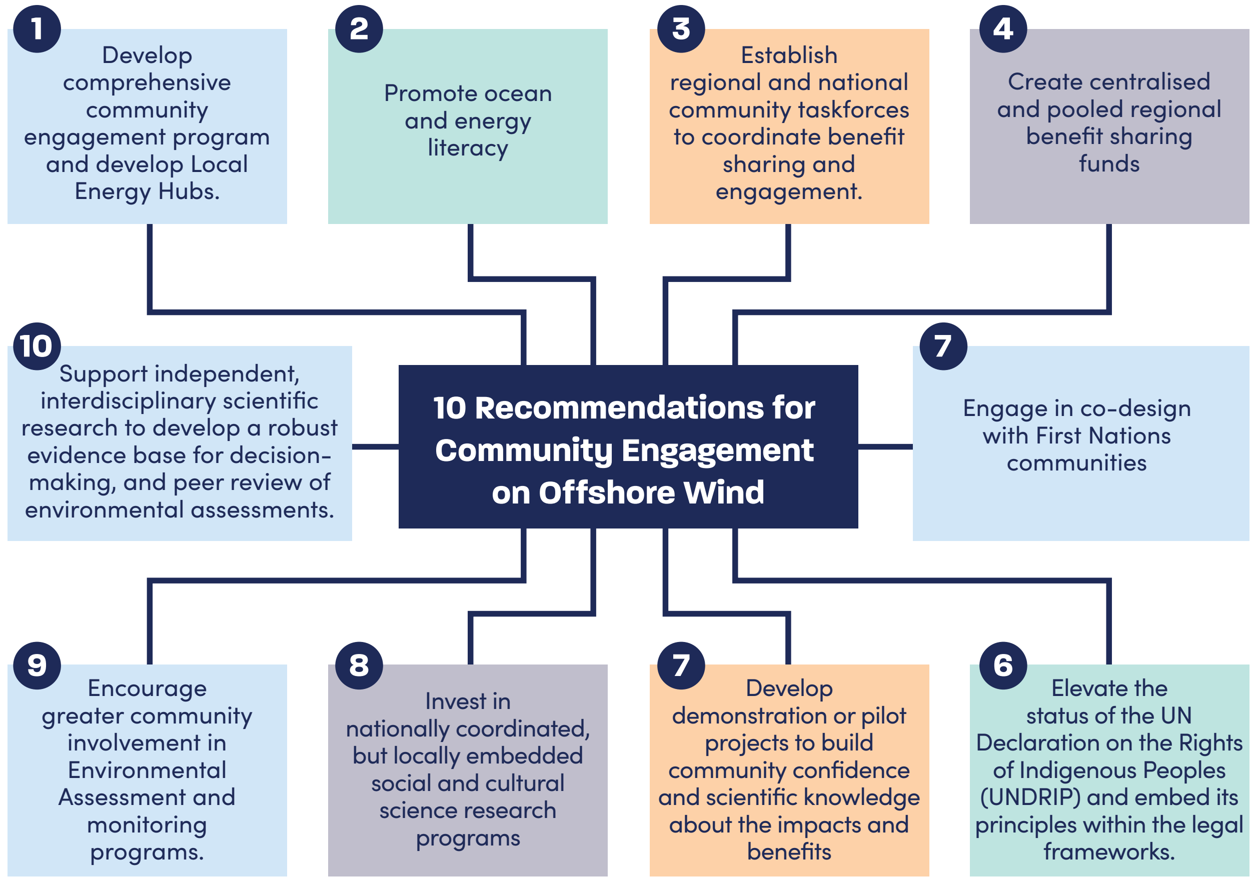

Figure 4: Ten Recommendations for Community Engagement on Offshore Wind

5.4 Recommendation 4: Apply existing knowledge to decision-making, including regional scale assessments, planning and monitoring

Key Points:

- Indigenous leadership and knowledge must be prioritised in the development of offshore wind in Australia (and this should be co-designed with Traditional Custodians).
- Integrated marine planning should be established to assist in the development of offshore wind in Australia.
- Additional policy tools can help decision-makers interpret data, ensure fairness and transparency, manage competing uses, support adaptive management, and enhance community participation. The suitability of these tools will depend on the specific context.

There is a need to prioritise and support Indigenous leadership and knowledge in the development, planning, implementation and operation of offshore energy. The exact form that this support takes should be co-designed with Traditional Custodians and may include the development of policy instruments such as Sea Country Management Plans. Such plans could enable science collaborations to promote and enhance Aboriginal science, researchers and capacity building.

More broadly there is an urgent need for coordinated and integrated marine planning to assist in the provision of standardised approaches to community engagement, inclusion and support for Indigenous Australians, data collection, monitoring and evaluation framework and minimum conditions around environmental approvals or management plans, as well as ecosystem-based management and cumulative impacts. The Blue Economy CRC have been exploring how Marine Spatial Planning (MSP) (or MSP-light) planning activities might be rapidly deployed to assist drive a more integrated approach, including through the development of a draft MSP National Framework (Griffiths et al., 2024).

5.4.1 What policy tools can support evidence-informed based decision making for offshore wind in Australia?

In addition to the formal approvals processes that regulate OWFs, a range of additional tools and frameworks are available (see Table 5) which would assist decision makers to:

- Make sense of the available data and information
- Ensure decision making is fair, inclusive and transparent
- Manage competing uses
- Evaluate decisions and assist adaptive management
- Ensure community engagement and participation

It is important to note that evidence-based decision making goes beyond collecting data and information, but rather the analysis of this information is a key part of the process. There are a range of tools that can help synthesise the information, helping to build a more comprehensive understanding of the outcomes. Some of these opportunities are discussed in further in the table below (see Table 5). It is important to note that not all these tools may be appropriate in the context, and the list is not intended to be exhaustive. However, the listed policy tools are illustrative of the mechanisms that are used to support decision-making currently being used both in Australia and overseas.

Eastern Yellow Nosed Albatross

Table 5: Potential policy tools to support decision making.

Policy Tools	Description	State of Play
Ocean Accounting	Ocean accounting is an internationally recognised and standardised framework for managing ocean and coastal ecosystems, supporting informed decision-making by governments, policymakers, industries, and communities. It integrates social, economic, and environmental data to aid policy development, marine spatial planning, environmental management, and international reporting. By tracking changes over time, it highlights the impacts of management interventions and ocean pressures, offering a globally recognised approach to managing ocean data (Perkiss et al., 2022).	The Australian Government is developing a National Ocean Ecosystem Account as part of its National Strategy and Action Plan for Environmental-Economic Accounting. Since October 2021, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the Australian Bureau of Statistics (ABS) have been working on Australia's first Experimental Account, focusing on mangrove and seagrass extent, condition, carbon stocks, and selected ecosystem service (ABS 2022).
Marine Spatial Planning	Marine Spatial Planning (MSP) is a key tool used globally to manage conflicts and promote sustainable blue growth, with its rise in Europe driven partly by the rapid expansion of offshore wind. MSP typically involves designating specific zones for different uses, providing a framework to balance environmental, social, and economic priorities for long-term sustainability. It is critical that MSP use advanced spatial zoning software in partnership with recognised experts in the field. Examples of where MSP has been used successfully overseas include the Rhode Island Special Area Management Plan (SAMP) which has supported offshore wind operation in the Block Island Wind Farm (https://seagrant.gso.uri.edu/oceansamp/) .	Australia currently lacks the legislative and regulatory frameworks to support MSP in Commonwealth Waters. The process for establishing MSP is inherently complex, requiring significant time and resources. While developing MSP frameworks would be highly beneficial, it is unlikely they will be implemented quickly enough to guide short- or medium-term decisions on offshore wind in Australia (at the Commonwealth level) (Griffiths et al., 2025). It should be noted that in state jurisdictions, such as Victoria, enabling legislation for MSP has been developed (although is yet to be implemented). The Blue Economy CRC have an ongoing Marine Spatial Planning project which has produced a number of reports which explore how existing MSP frameworks currently being implemented at the state level could be leveraged to provide a national MSP framework for Commonwealth waters (Griffiths et al., 2025)[7]. This framework is currently being finalised and will require federal and state Government support for implementation.

7 See https://blueeconomycrc.com.au/marine-spatial-planning/

Policy Tools	Description	State of Play
Regional Marine Planning	Marine Bioregional Plans differ from MSP in that they stop short of spatially designating zones of areas of activity. Instead, they provide a coordinating mechanism which can support integrated approaches to ocean governance and use. They are intended to support strategic, consistent and informed decision-making under Commonwealth environment legislation in relation to Commonwealth marine areas, and to promote the ecologically sustainable use of the marine environment and its resources. They do so by providing a framework for strategic intervention and investment by government to meet policy objectives and statutory responsibilities.	Regional Marine Plans (under the previous National Oceans Policy) and Marine Bioregional Plans (under the EPBC Act) were created between 2004-2012. None of these plans have been reviewed or updated since their release, well before any plans to develop an offshore energy sector developed in Australia. It is therefore unclear whether these existing plans have been successful in meeting their objectives or in informing critical decision-making functions. However, there may be an opportunity to review and update the Southeast, Temperate East and North-west Marine Bioregional Plans to address priority coordination measures.
Regional Planning	Regional planning takes a landscape/seascape approach to environmental planning to support nature positive outcomes in the rollout of new infrastructure. Regional plans seek to provide useful information that can assist in decisions relating to siting of infrastructure and can better manage cumulative impacts. Regional Planning approaches also look to minimise regulatory duplication.	DCCEEW are currently considering applying regional planning approaches to coastal and offshore waters to manage cumulative impacts and more integrated marine management approaches.
Strategic Impact Assessments	Strategic assessments are landscape-scale assessments defined under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). They allow a big-picture approach to protecting nationally significant (protected) animals, plants, habitats or places. Strategic assessments may also be beneficial to assist with sector wide assessments across multiple areas, such as offshore wind. This approach can be more efficient than doing project-by-project assessments and may assist in delivering a more standardised and consistent approach to emerging industries like offshore wind.	Strategic assessments are increasingly being implemented worldwide including in Australia. However, there is concern and criticism that this approach may not adequately deliver on environmental outcomes (Gutierrez et al., 2004)

Policy Tools	Description	State of Play
Demographic modelling and analysis	Demographic modelling tools such as Population viability analysis (PVA) can estimate the future size and risk of extinction for populations of organisms. PVA works by using life-history or population growth-rate data to parameterise a population model that is then used to project dynamics and estimate future population size and structure. PVAs are accurate at predicting extinction probabilities if data are extensive and reliable, and if the distribution of vital rates between individuals and years can be assumed stationary in the future, or if any changes can be accurately predicted (Coulsan et al., 2001). Where limited data is available expert opinion can be used to develop Population Consequences of Disturbance (PCoD) models, particularly when looking at non-lethal effects. The PCoD model is a conceptual framework used to assess the potential for population-level consequences following exposure of animals to a disturbance activity or stressor. This framework is a four-step process, progressing from changes in individual behavior and/or physiology, to changes in individual health, then vital rates, and finally to population-level effects (Dunlop et al 2021). The PCoD method has been used internationally to assess the impacts of offshore wind farm developments for cetacean species.	An interim Population Consequences of Disturbance (PCoD) model has been developed for blue whales and southern right whales in relation to one or multiple offshore wind farm developments off Portland and Gippsland, Victoria (Coast and Marine hub, National Environmental Science Project) The model follows decision pathways to consider factors such as the proportion and life stages of populations likely to be affected. The model can be used to predict the timing and location of cumulative impacts of the proposed activity or activities at a regional scale and will be able to be updated as new data become available.
The Resist-Accept-Direct (RAD) Framework	The RAD Framework is a tool for decision makers that helps to make informed strategies for responding to the ecological changes associated with climate change. This approach can help to evaluate risks and benefits in light of the ecological uncertainty posed by climate change. The Framework acknowledges the uncertainty related to climate change impacts and allows for a wide range of potential management options in response to this. The Framework offers three approaches for decision makers: Resist (resist changes by trying to keep ecosystems in their current state or restore to a previous state), Accept (accept changes for which it is not feasible to avoid, or that communities may find acceptable), and, Direct (direct changes to a different state in the acknowledgment that resisting the change may be unrealistic or not possible).	To date, the RAD Framework has been used to guide ecological based decisions and has not been used in a socio-economic context (Olsson et al., 2024). However, the framework is being used for decision making around climate adaptation in Australia, for example in the Murray-Darling Basin (Olsson et al., 2024).

Policy Tools	Description	State of Play
Adaptive Management	An approach based on learning and adjustment that can be applied to reduce scientific uncertainty and improve policy and practices. It is an iterative process that allows certain actions to be taken if there is uncertainty. This approach relies on detailed monitoring and evaluation to enhance data, improve decision making and take any necessary actions to mitigate impacts, through continually learning and adapting to changing conditions, knowledge or challenges.	Adaptive management is used by the Commonwealth Government in their management of water and is used in some branches of State Governments. For example, the Victorian Government use adaptative management in their management of marine resources – such as for the Victorian Marine National Park network.
Scenario Modelling	Scenario modelling analysis is a strategic tool used to explore and assess possible future developments by constructing multiple plausible scenarios based on key drivers and uncertainties. It enables decision-makers to evaluate potential risks, opportunities, and trade-offs under different conditions, helping to inform policy, planning, and adaptive strategies. Commonly applied in fields such as environmental management, economics, and governance, scenario modelling supports resilient and evidence-based decision-making in complex and dynamic systems	Scenario modelling is used in various Australian institutions and government departments. For example, the Australian Institute of Health and Welfare use scenario modelling to analyse the burden of disease. This type of analysis tool has also been used by the CSIRO in, modelling climate change simulations and projections and to model sectoral pathways to meet net zero. Scenario modelling has also been used by DCCEEW to better understand hydrogen growth and demand.
Multi-criteria decision analysis (MCDA)	MCDA is a structured decision-making approach that evaluates multiple, often conflicting criteria to support complex decision processes. By integrating quantitative and qualitative data, MCDA helps decision-makers systematically compare options, prioritise trade-offs, and account for diverse stakeholder values.	This decision-making tool has been used by the ACT Government in their treasury department. It has also been used by the CSIRO and the Department of Agriculture, Fisheries and Forestry.

6. Action items

We put forward the following recommendations based on immediate, short term, medium term and ongoing investment timeframes. The criteria for these timeframes are as follows:

1. **Immediate Investment** – Investment required to establish foundational research infrastructure and build capacity for offshore wind development.
2. **Short Term Investment** – Research investment needed over the next 1-2 years, prior to the development of offshore wind farms.
3. **Medium Term Investment** – Investment for research that should be undertaken within the next 2-7 years (aligns to the Feasibility Licencing stage of OWF – this is information required prior to commercial licences).
4. **Ongoing Investment** – Ongoing, long-term, and continuous investment in research throughout the lifespan of offshore wind farms in Australia. This includes efforts to ensure effective monitoring, adaptation, and the capture of longitudinal environmental, social, and economic impacts (Operational stage of OWF).

Alongside action items, we have included links to existing initiatives to demonstrate how offshore wind research in Australia aligns with current knowledge needs and policy initiatives, offering a wide range of benefits which extend beyond the scope of of offshore wind.

6.1 Recommendation 1: Research infrastructure and policy settings

Action items		Timeframe	Notes and links to existing initiatives
R1.1 Establish a public-private research funding pool, modelled on international examples and administered by an independent board, which leverages both industry and Government funding to support research priorities.	Design: Investigate best practice models internationally and co-design an Australian model in partnership with industry, the science community and other stakeholders Plan: Leverage the current National Marine Science Plan renewal process to develop a national set of research priorities for ocean energy Implement: Establish governance structures, administrative arrangements and office facilities	Immediate	The following polices support collaboration and partnership between governments, private sectors and research institutions: Sustainable Development Goal (SDG) 9 (Industry, Innovation and Infrastructure), SDG 12 (Partnerships for Goals), Net Zero Australia, Paris Agreement, Australia's Low Emissions Technology Statement. The National Marine Science Committee is overseeing a new planning process for national marine science, which incorporates consideration of ocean energy

Action items		Timeframe	Notes and links to existing initiatives
R1.2 Develop, refine and scale data repository and sharing infrastructure and protocols	Build on the NESP Impact inventory, and the work of IMOS, to establish a dynamic, Australian centred resource which contains up to date information on the impacts of offshore wind development over time Establish a national scale Data and Information Supply Chain for Offshore Wind modelled on the existing ARDC for the Gippsland OEIZ Establish protocols and standards of environmental and socio-economic data for assessment and monitoring across all OIEZ and control areas	Immediate	National Marine Science Plan Australian Integrated Marine Observing System Sustainable Ocean Plan The NESP Project 3.3 *(Guiding the sustainable development of offshore renewables and other emerging marine industries in Australia)* provides the basis for these recommendations as well as indicative costing
R1.3 Resource Indigenous Australian communities to establish the partnerships to support co-design and engagement	Develop and fund a National Environmental Indigenous Research Network	Immediate	Closing the Gap. First Nations Clean Energy Strategy The North Australian Indigenous Land and Sea Management Alliance provides a working model. A southern Alliance (SAALSMA) has recently been established but is as yet unfunded.
	Provided dedicated resourcing and support to enable co-design of Country specific First Nation protocols for engagement, Data sovereignty frameworks and community benefits sharing protocols, cultural heritage management and other self-determined models for managing, and benefiting from, offshore wind on Sea Country		AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research (2020) – Calls for Indigenous ownership of data and co-design of research. UNDRIP (Articles 19, 29, 32) - Supports Indigenous self-determination in managing resources and economic benefits. First Nations Clean Energy Strategy

6.2 Recommendation 2: Gather new knowledge

6.2.1: Baseline research actions

Action items		Timeframe	Notes and links to existing initiatives
R2.1 Undertake baseline environmental assessment of all OEIZs and nearby control sites (e.g. Marine Park).	Bathymetric data on continental shelf and slope in OWF regions and further sedimentary sampling on the seafloor	Short term	There are a number of existing institutional research support mechanisms which can assist in implementation and coordination of this research at a national scale. These include (but are not limited to) ACOWE, Integrated Marine Observing System, NESP, AIMS, CSIRO and the Blue Economy CRC.
	Seabed habitats and benthic biodiversity, including structured surveys to identify types of habitats, quantify benthic biodiversity		
	Oceanographic data		
	Migration patterns and behavioural patterns of priority cetacean species most likely to interact with OWFs		
	Ornithological studies including behaviour and flight height for priority (EPBC listed) Seabirds and migratory parrots		
	Fish and shellfish studies, including assessments of invasive species		
	Model cumulative impacts on threatened and culturally important species of concern to assess viability and identify priority data gaps		
R2.2 Build baseline social, economic and cultural data in all OEIZ host communities	Community perceptions, values, identity and place attachment, demographics and wellbeing	Immediate	National Environmental Science Program (NESP) Human Dimensions Research. Closing the Gap Deliberative democracy activities are currently underway in Gippsland through a partnership between Democracy co. and the Gippsland Climate Change Network. State based Marine and Coastal Strategies (e.g. NSW Marine Estate Management Strategy).
	Indigenous and non-Indigenous cultural heritage assessment		
	Deliberative processes to capture the aspirations for community benefits and engagement		
	Identification of meaningful socio-economic indicators to support long term monitoring of social impacts and benefits		
R2.3 Scope an atlas of Culturally Significant Areas, including support for community co-design of identification and management of them.	Community co-design workshops & traditional knowledge sharing	Immediate	UNDRIP (Article 25 & 31) Supports Indigenous Peoples' rights to define and manage culturally significant species. First Nations Clean Energy Strategy
	Seabed surveys and underwater archaeological assessments		

6.2.2: Experimental, collaborative and co designed studies (pre construction)

Action items		Timeframe	Notes and links to existing initiatives
R2.4 Geological and hydrological surveys (5 years prior to construction)	Geophysical surveys	Medium term	Australia's Integrated Marine Observing System
	Hydrographic surveys		
R2.5 Undertake ecosystem modelling to explore likely and possible whole-of-system effects of OWF infrastructure	Develop and implement ecosystem models to assess the potential whole-of-system impacts of OWF infrastructure	Medium term	Australia's Integrated Marine Observing System
	Collect and integrate ecological, environmental, and socio-economic data to inform and refine the modelling process		
	Conduct scenario analyses to evaluate likely and possible outcomes under different development and management strategies		
R2.6 Support nature positive experimental design	Establish mechanisms to support innovation, testing and accelerating of nature positive design approaches	Medium term	Ocean Impact Organisation and Southerly 10 have collaborated on a competitive design that could be replicated/scaled up
R2.7 Enable the development of research trials and pilot projects and collaborate with industry to develop pilot projects for floating technologies in selected OEIZ communities to support proof of concept.	Establish governance support systems for pilot and demonstration projects, including permitting, stakeholder engagement and experimental design	Medium term	A project run out of the Blue Economy CRC – TAS Demo – has been undertaking feasibility assessments and business planning for a demonstration site in Australia.
	Site selection in partnership with Indigenous Australians as well as key stakeholders, especially State Governments and port authorities		
	Deployment of demonstration infrastructure and associated environmental and social & cultural research		
R2.8 Develop place based participatory research projects	Co-design community priorities for nature positive design and community benefit sharing	Short term	There are a number of existing institutional research support mechanisms which can assist in implementation and coordination of this research at a national scale, including ACOWE, the Blue Economy CRC. As well as work on community engagement from the Clean Energy Council, and community level organisations.
	Explore best practice models of community engagement		

6.2.3: Ongoing long-term research and monitoring

Action items		Timeframe	Notes and links to existing initiatives
R2.9 Develop independent longitudinal studies to track changes in key environmental, socio-economic and cultural indicators over time	Seabed habitats and benthic biodiversity, including structured surveys to identify types of habitats, quantify benthic biodiversity	Long Term	Commonwealth of Australia 2024, Australia's draft Sustainable Ocean Plan Australia's Integrated Marine Observing System
	Oceanographic data (as part of Australia's Integrated Marine Observing System)		
	Migration patterns and behavioural patterns of priority cetacean species		
	Ornithological surveys for priority (EPBC listed) Seabirds and migratory parrots		Commonwealth of Australia 2024, Australia's draft Sustainable Ocean Plan Australia's Integrated Marine Observing System
	Fish and shellfish studies, including invasive species		
	Social, economic and cultural impacts and benefits		

6.3 Recommendation 3: Communicate, disseminate, share

Action items		Timeframe	Notes and links to existing initiatives
R3.1 Support the development of local energy hubs, with integrated ocean literacy programs, within each of the OEIZ communities.	Develop a national ocean and energy literacy strategy (incorporating consideration of offshore energy), including priority actions and strategies for pre-bunking and debunking mis/disinformation	Immediate	The UK have been active in developing Ocean Literacy strategies – the first in Wales, with planning underway in England. Local Energy hubs have been proposed by a consortia of NGOs led by Re-Alliance.
	Establish local energy hubs which incorporate ocean literacy objectives in all OEIZ communities in partnership with state Governments and NGOs		
	Develop a monitoring strategy to measure ocean and energy literacy over time (as part of action item R2.3).		
R3.2 Develop citizen science activities alongside the proposed environmental research priorities to engage communities in the scientific process and build trust in their outcomes	Develop a citizen science strategy for offshore wind identifying opportunities for community involvement and pathways for maximising transparency	Short term	There are many existing marine citizen science programs in Australia include RedMap, Reef Life Survey, Climate Watch & Project ORCA.
	Support existing citizen science programs to enhance and scale up their activities around priority areas (eg cetaceans, birds), in accordance with data standards and sharing protocols (see R1.2)		

6.4 Recommendation 4: Decision-making support

Action items		Timeframe	Notes and links to existing initiatives
R4.1. Support the co-design of appropriate governance mechanisms for engagement with Indigenous Australians, in development, planning, implementation and operation of offshore energy	Facilitate co-design processes with Indigenous Australian communities communities to develop culturally appropriate governance mechanisms for offshore energy projects.	Immediate	Commonwealth of Australia 2024, Australia's draft Sustainable Ocean Plan Cultural Licence to Operate in the Blue Economy has developed pathway planning for First Nations.
	Develop planning, implementation, and operational frameworks based on Indigenous Australian knowledge systems, such as through Sea Country Management Plans or Economic Development Business Cases.		
	Establish ongoing partnership planning, and if desired co-ownership, frameworks to ensure meaningful engagement with Indigenous Australians across all project stages.		
R 4.2 Marine Spatial Planning and demographic modelling of threatened and culturally important species.	Raise awareness of the National Marine Spatial Planning Framework currently under development by the Blue Economy CRC and seek wide stakeholder feedback	Short term	Sustainable Ocean Plan The Blue Economy CRC have developed a draft National Marine Spatial Planning Framework which can be leveraged to support these initiatives Leverage Australia's globally recognised experts in the field of MSP
	Undertake a pilot Marine Spatial Planning project within Australia to assess the risks and costs associated with adopting the framework. MSP must used advanced spatial zoning software in partnership with recognised MSP experts.		
	Explore opportunities to enhance policy mechanisms to support cross-jurisdictional coastal and marine management (states/Cwth)		

Shy albatross

Conclusion: road map

To ensure evidence-based decision-making for offshore energy development, we estimate that Australia must make a significant investment in marine environmental, social, and cultural research over the short to medium term. While industry will shoulder part of this responsibility, there is a clear need for **strong, independent national oversight** to guide this investment effectively. A roadmap for what this investment should look like is shown in Figure 5.

Figure 5: Offshore Wind Research Funding Research

An immediate investment is critical to lay the groundwork by:

- Establishing a **sustainable, long-term funding mechanism**;
- Developing **national data-sharing infrastructure** to enable open access (where appropriate) to research findings; and
- **Resourcing First Nations communities** to build internal capacity and support Indigenous leadership in culturally appropriate research co-design.
- **Establishing meaningful community engagement**, helping to both support regional communities through initiatives like deliberative democracy activities, citizen science programs and ocean literacy projects. These activities will help to both support regional communities in co-designing the broader energy transition within their communities, whilst also addressing public concerns about the potential risks and benefits of offshore wind development.

Once these foundations are in place, a further investment will be immediately necessary to support independent **baseline assessments** across all Offshore Energy Infrastructure Zones (OEIZs), prioritised by expected deployment timelines, alongside appropriate control sites, ideally within marine parks, to enhance broader understanding of deep-water environments and contribute to effective marine park management.

In the medium term, investment should be dedicated to advancing **experimental research** that supports ecosystem-wide and community-level modelling of offshore wind farm impacts, including demonstration projects consistent with international best practice. A further investment is needed to establish effective **decision-support mechanisms**, including **Marine Spatial Planning** and **Population Viability Analysis on listed and culturally significant species**, ensuring that the best available knowledge is embedded into regulatory and planning processes.

Finally, safeguarding Australia's offshore future requires a long-term commitment for continuous monitoring, assessment, and adaptive management, ensuring that offshore energy development is both sustainable and equitable for all Australians.

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The Report **Improving decision-making in relation to offshore wind: Priority knowledge and decision support needs for Australia** was commissioned by AMCS and authored by experts at the Australian Centre for Offshore Wind Energy and Biodiversity Council and is available here:
marineconservation.org.au/offshore-wind-report

Australian Marine Conservation Society

ACOWE Australian Centre for Offshore Wind Energy

Biodiversity Council