Submission to the Senate Select Committee on

INFORMATION INTEGRITY on CLIMATE CHANGE and ENERGY

Offshore Wind Developments: Microplastic Shedding, Phytoplankton Risk, and Associated Hydrogen and Ammonia Production

Executive Summary

This submission addresses environmental risk considerations associated with offshore wind developments, with a specific focus on:

- Microplastic shedding from turbine leading edge blade erosion
- Impacts of microplastics on phytoplankton and marine ecosystem functioning
- The escalation of environmental and safety risk where projects integrate hydrogen and ammonia production

Peer-reviewed research has quantified measurable plastic emissions from offshore wind turbine blades. A Danish modelling study published in Energies estimated that Denmark's offshore wind fleet (648 turbines) generates:

"approximately 1.6 tonnes of plastic per year from blade erosion,"
with roughly 1,000 kg annually attributable to offshore installations.

These emissions occur directly into marine systems. Unlike terrestrial plastics, they enter the ocean at the point of release.

Scientific literature further demonstrates that microplastics are biologically active contaminants capable of altering phytoplankton physiology, growth dynamics, and community composition. As phytoplankton underpin marine food webs and contribute significantly to global carbon sequestration, such impacts raise systemic ecological concerns.

Where offshore wind developments are integrated with hydrogen and ammonia export infrastructure, the environmental risk profile extends beyond renewable energy generation into industrial chemical production in marine environments.

This submission calls for evidence-based, lifecycle-informed regulatory scrutiny.

1. Quantified Microplastic Shedding from Offshore Turbines

Leading-edge erosion of turbine blades is a recognised operational phenomenon. Offshore environments accelerate erosion due to salt, rain, particulates and high wind speeds.

The Danish study published in Energies concluded:

“The total annual plastic emission from the Danish wind turbine fleet is estimated at approximately 1.6 tonnes per year.”

The authors further note that offshore turbines account for approximately 1,000 kg of this annual emission.

These findings establish three important facts:

1. Blade erosion produces measurable plastic emissions.
2. Emissions are continuous throughout operational life.
3. Release occurs directly into marine environments.

Over a 25-year project life, cumulative emissions from a single offshore wind zone may therefore be non-trivial.

These emissions:

- Occur continuously throughout turbine operation
- Enter the marine environment directly
- Are not recoverable once dispersed

Over a 25-year operational life, cumulative emissions from large offshore wind zones may be ecologically significant. Unlike visible blade waste at decommissioning, erosion-derived microplastics disperse incrementally and persist within water columns and sediments, increasing exposure pathways.

2. Microplastics and Phytoplankton: Foundational Marine Risk

Phytoplankton are microscopic photosynthetic organisms forming the base of marine food webs. They:

- Support fisheries
- Produce approximately half of global oxygen
- Regulate carbon sequestration through biological carbon pumps

Peer-reviewed experimental research published in Science of The Total Environment demonstrates that exposure to micro- and nanoplastics can:

- Reduce phytoplankton growth rates
- Induce physiological stress responses
- Alter cellular processes measured using DNA-based indicators

Further research published in Environmental Pollution reports that microplastics:

- Modify phytoplankton community composition
- Disrupt microbial interactions
- Alter nutrient cycling dynamics

These findings indicate that microplastics are not inert particles; they are capable of influencing biological processes at the base of marine ecosystems.

Impacts at the phytoplankton level propagate upward through trophic systems, potentially affecting:

- Zooplankton
- Fish larvae
- Commercial fisheries
- Carbon cycling efficiency

Microplastics and Combined Stressors Act on Phytoplankton

Emerging research published in *Marine Pollution Bulletin* suggests that microplastic pollution can intensify the effects of other environmental stressors such as warming. Under projected future warming and microplastic exposure scenarios, phytoplankton biomass was found to **decrease by**

41% and diversity by nearly 39%, relative to controls. While this study demonstrates **interactive stressor effects**, it underscores how microplastic pollution can compromise phytoplankton resilience in a changing climate.

The introduction of persistent composite microplastics into high-energy offshore environments therefore warrants precautionary assessment.

3. Lifecycle Governance Questions

Given quantified blade erosion and known biological sensitivity of phytoplankton, several regulatory questions arise:

- What is the projected cumulative microplastic release over a 25–30 year operational lifespan for proposed Australian offshore wind zones?
- What baseline phytoplankton monitoring exists prior to installation?
- How will long-term microplastic concentrations within wind farm boundaries be measured?
- What thresholds trigger mitigation or operational adjustment?
- Who bears liability if measurable ecological harm is demonstrated?

Without defined monitoring protocols and financial accountability mechanisms, environmental externalities risk transfer to the public.

4. Hydrogen and Ammonia Risk Escalation

Many offshore wind proposals are structured not solely for electricity supply, but for integrated hydrogen and ammonia export.

This materially alters the risk profile.

Hydrogen production via electrolysis at industrial scale requires significant infrastructure and introduces:

- Leakage risk
- Infrastructure embrittlement
- Explosion hazards

Hydrogen is frequently converted to ammonia (NH_3) for transport.

While ammonia may be low-carbon when produced renewably, it is:

- Highly toxic to marine organisms
- Capable of causing acute fish mortality
- Associated with eutrophication and oxygen depletion
- Persistent in shallow or semi-enclosed waters

The integration of ammonia production transforms offshore wind projects into marine-adjacent chemical processing operations.

This raises a regulatory integrity question:

Should such projects be assessed solely as renewable energy infrastructure, or as offshore industrial chemical facilities?

5. Information Integrity Considerations

Public discourse often frames offshore wind as inherently benign due to its renewable classification.

However:

- Quantified blade erosion demonstrates ongoing plastic emissions.
- Peer-reviewed studies demonstrate biological impacts of microplastics on phytoplankton.
- Integrated hydrogen and ammonia production introduces industrial hazard complexity.

Information integrity requires that lifecycle impacts, cumulative modelling, and ecological uncertainties be transparently communicated.

Renewable classification does not eliminate environmental trade-offs.

6. Recommendations

1. Mandate cumulative microplastic modelling for all offshore wind approvals.

2. Require baseline and ongoing phytoplankton monitoring within development zones.

3. Establish public reporting requirements for blade erosion and material composition.

4. Require full lifecycle environmental assessment of hydrogen and ammonia integration.

5. Implement binding financial assurance mechanisms covering microplastic monitoring, remediation, and decommissioning.

6. Ensure projects integrating ammonia infrastructure are assessed under industrial chemical risk frameworks.

Conclusion

Climate mitigation is essential.

However, decarbonisation strategies must not create parallel marine ecological crises that remain unquantified or under-regulated. This is crucial as the eye cannot see these risks therefore the Offshore Wind farm proponents are not presenting this data.

Research shows microplastics are a serious long-term threat to marine ecosystems and human health, and that there's been a strong global effort over the past two decades to reduce their spread into our oceans.

Offshore wind infrastructure introduces additional polymer-based materials into the marine environment particularly blade coatings, leading edge protection, marine paints, cable insulation and protective sealants which are exposed to constant salt, wind and wave action and can gradually wear over time. Even small amounts of surface erosion from these components have the potential to contribute to cumulative microplastic load.

Microplastic emissions from turbine blade erosion are measurable.
Phytoplankton are demonstrably sensitive to microplastic exposure.
Hydrogen and ammonia integration increases industrial complexity in marine environments.

A transition to clean energy must protect both atmospheric stability and ocean ecosystem integrity.

Australia should proceed with rigorous lifecycle assessment, transparent information standards, and enforceable accountability mechanisms before permitting large-scale offshore industrial developments.

We all live downstream.