Attentive Energy Capstone Project:

Striving for No Net Loss/Net Positive Impact on Biodiversity in the Offshore Wind Industry

May 7, 2025

Claire Li, Neeti Sabnani, Jie Xi Goh, Kristina Frye

COLUMBIA | SIPA
School of International and Public Affairs

Meet the Team

Kristina Frye
MPA, Urban Policy & Sustainability

Claire Muxi Li
MIA, Climate, Energy & Environment

Jie Xi Goh
MPA, Climate, Energy & Environment

Neeti Sabnani
MPA, Climate, Energy & Environment

Contents

Project Context

Executive Summary

Research Question:

What does achieving no net loss (NNL) or net positive impact (NPI) look like in practice in the offshore wind industry? How can we leverage learnings to inform US state policy and guidance for offshore wind developers?

Key Findings:

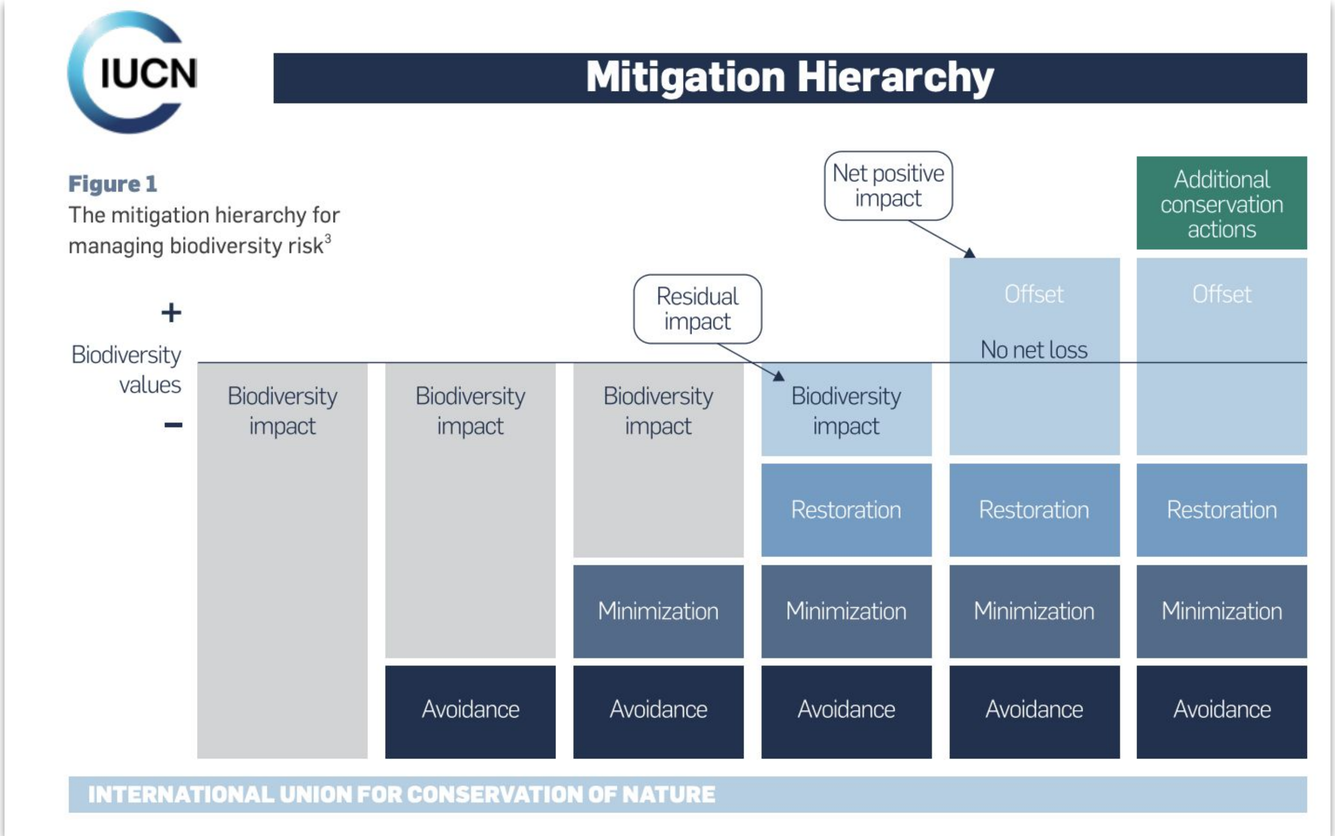
While many in the industry reference international frameworks such as The World Bank ESS6 / IUCN Review Protocol for Biodiversity Net Gain and agree NPI goes beyond the mitigation hierarchy, **measurement and implementation varies** across developers and countries.

US states and industry stakeholders must balance **six key trade-offs** (*see slide 17*) in developing frameworks for NNL/NPI. **Attribution** for NNL/NPI actions is a key consideration.

The government plays a critical role in providing the enabling environment for **decarbonization** efforts, stakeholder **communication**, and coordination of **research and data-sharing**.

Aligning on Shared Definitions

Term	Sample Definitions	Insights
Biodiversity	Convention on Biological Diversity (CBD): "Variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; **this includes diversity within species, between species and of ecosystems**"	● Most US and international frameworks/government bodies **use a version of this definition** (focusing on diversity of species, habitats, ecosystems) ● Variation occurs in determining **priority biodiversity features**
No Net Loss/Net Positive Impact	International Union for Conservation of Nature (IUCN): "[NNL and NPL goals call for] negative biodiversity impacts caused by the project to be either balanced (for NNL) or outweighed (for NPI, also referred to as net gain) by biodiversity gains through compensation measures implemented in the project region. The biodiversity gains are evaluated against a baseline (e.g. a reference point or trajectory without the project occurring, or prior to the project occurring) of the relevant biodiversity values being impacted by the project."	● Net positive impact/net gain **goes above and beyond** mitigation hierarchy ● Variation occurs in **measurement and implementation approaches** ● Some argue focus on biodiversity alone is **limiting** (not a complete picture of ecosystem functioning) ● Often **confused with nature positive** - efforts conducted at scale to halt and reverse global biodiversity loss (global, holistic, cumulative)


IUCN
Mitigation Hierarchy
Figure 1
The mitigation hierarchy for managing biodiversity risk3
+
Biodiversity values
−
Biodiversity impact
Biodiversity impact
Avoidance
Biodiversity impact
Minimization
Avoidance
Residual impact
Biodiversity impact
Restoration
Minimization
Avoidance
Net positive impact
Offset
No net loss
Restoration
Minimization
Avoidance
Additional conservation actions
Offset
Restoration
Minimization
Avoidance
INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Source: UNGC

Research Approach

Achieving NNL/NPI in the OSW Industry

What does this look like in practice?

U.S. Regulations & Practices

20+ Stakeholder Interviews

International Regulations & Practices (Europe focus)

Case Studies

Informed by: Potential Biodiversity Impacts of OSW & Mitigation Hierarchy

Summarizing Findings

1. Policy & Practice Landscape Analysis
2. Lessons Learned

Methodology Part I: Desk Research

Category	Key Sources
Academic Research Articles	Marine Policy ICES Journal of Marine Science
NGO/Industry Reports	International Union for Conservation of Nature (IUCN) International Finance Corporation (IFC) Performance Standards on Environmental & Social Sustainability IFC / World Bank Environmental, Health & Safety (EHS) Guidelines World Economic Forum (WEF) Convention on Biological Diversity (CBD) United Nations Global Compact (UNGC) Taskforce on Nature-Related Financial Disclosures (TNFD) The Nature Conservancy (TNC) The Nature Conservancy Marine Mapping Tool World Wildlife Fund: Non Price Criteria Wildlife Conservation Society (WCS): Conservation, Mitigation & Biodiversity Offsets (COMBO) Program
Developer Sustainability Reports	Ørsted 2024 Sustainability Report Avangrid 2023 Sustainability Report Iberdrola 2024 Sustainability Report SSE Renewables Biodiversity Net Gain Report
Government Regulations/Initiatives (including offshore wind solicitations)	European Wind Power Action Plan United Kingdom Environmental Act 2021 United Kingdom Biodiversity Metric Tool Dutch Governmental Offshore Wind Ecological Program: WOZEP New Jersey Department of Environmental Protection: Research & Monitoring Initiative New York Power Authority New York State Energy & Research Development Authority (NYSERDA) OSW Solicitation
Other Industry Case Studies	World Bank: Floating Solar United Kingdom: Biometrics Case Study

Methodology Part II: Interviews

Category	# of Interviews
Developers	12
NGO / Multilateral	9
Academia	1
Government	1
TOTAL	**23**

Policy & Practice Landscape Analysis

Relevant US Regulations & Practices: Summary

Federal Regulations:

1. Compensatory Mitigation under the Clean Water Act
2. Natural Resource Damage Assessment (NRDA)
3. Endangered Species Act
4. Environmental Impact Statement (EIS)

East Coast Offshore Wind Solicitations:

1. ***New Jersey:*** Requires Environmental Protection Plans / 30% non-price evaluation, including economic and environmental/fisheries impacts
2. ***New York:*** Requires Environmental Mitigation Plan / 70% offer price, 20% state economic benefits, 10% viability
3. ***Massachusetts:*** Requires Environmental and Fisheries Mitigation Plan / 30-point qualitative evaluation (Stakeholder & Mitigation Experience, Environmental Impacts, Environmental Justice Impacts, Fishing Impacts)
4. ***Maryland:*** Requires mitigation and creating net environmental and health benefits (qualitative evaluation)
5. ***Rhode Island:*** Requires Environmental Impact and Fisheries Mitigation Plan
6. ***Connecticut***: Requires mitigation hierarchy practices for wildlife, natural resources, ecosystems and water-dependent uses

US Regulations & Practices: Findings

No agreed upon metrics, frameworks, or standards for NNL/NPI: Broad use of mitigation hierarchy, but NPI must go further

Federal regulations as a starting point: Potential frameworks and applications for evaluating mitigation projects (compensatory mitigation, natural resource damage assessments, etc.)

Varying approaches to offshore wind NNL/NPI by state:
- Differing evaluation criteria for OSW bidding process but all use some non-price criteria (emphasis on economic factors overall)
- Requirements for environmental mitigation/protection plans and collecting/sharing baseline environmental data
- Use of payments-based approach (ex: Massachusetts In-Lieu Fee Program)

Reported challenges:
- Voluntary implementation of NPI likely to occur only at project or site levels (need for systems-level approach)
- High cost of initial investment and continued monitoring of biodiversity impacts

International Regulations & Practices: Summary

International Frameworks:

1. IFC/World Bank Performance Standard 6
2. IUCN Biodiversity Net Gain Protocol
3. World Economic Forum Nature Positive Five-Pillar Framework
4. EU Wind Power Action Plan 2023

Highlighted Countries:

1. ***United Kingdom:*** UK Environmental Act 2021
   a. Achieve Net Positive Impact (NPI) on biodiversity by ensuring habitats are enhanced and restored
   b. 10% Biodiversity Net Gain (BNG) requirement in planning and development
2. ***Netherlands:***
   a. WOZEP: Wind Energy at Sea – Ecological Programme: Collect long-term ecological data, predictive impact models, ecological mapping, open data sharing; Directly informs Dutch OSW permitting, auction design, and marine spatial planning.
   b. EU Wind Power Action Plan 2030: National framework aligned with EU regulations on OSW development

International Regulations & Practices: Findings

Emphasis on Mitigation Hierarchy: Avoid, Reduce, Compensate

Compared to the US, more focus on the environmental conservation:

- Green financing - EU
- Protected Marine Area - World Bank, Germany, Netherlands, Norway
- Strict Turbine Shutdown Protocols - Norway

Reported challenges:

- Monitoring & Evaluation - Lack of comprehensive and effective monitoring and evaluation system, lack of standardization in methodologies and format of reporting from developers
- Effects of Climate Change - Uncertain biological impacts
- Spatial Competition with Stakeholders - Commercial fishing, marine defense, etc.
- Data Collection & Analysis - Siloed data, lack of standardization for baseline data collection and methodologies

Lessons Learned & Looking Forward

What can the US learn from existing NNL/NPI efforts in the OSW industry?

OVERALL CHALLENGES:

- **NPI Definition:** Net positive impact focuses on biodiversity from a conservation perspective, but challenging to weigh all costs and benefits of a project without including community and economic impact
- **Marine Environment**: Ocean is dynamic and impacted by numerous factors aside from offshore wind projects (shipping vessels, tourism, fishing, climate change)
- **Cumulative Impact**: Need a systems-level approach → mitigation efforts limited to the project site are only one part of the picture and will not deliver net gain
- **Lack of Standardization:** Differing metrics, methodologies and regulatory schemes for achieving NNL/NPI
    - State governments could offer a standard approach but cannot be too prescriptive as biodiversity priorities and actions will vary from site to site
    - State actors need to consider attribution, as developers still need to report sustainability efforts to shareholders/consumers

What can the US learn from existing NNL/NPI efforts in the OSW industry?

OPPORTUNITIES:

- **Community Input/Localization**: Importance of input from local community, Tribes, fisheries, etc. (ex: defining priority biodiversity features)
- **Measuring Ranges/Variation:** Focusing on ranges/scales of variation when assessing biodiversity features and establishing baselines (long-term trends)
- **Power of Solicitation Process:** Increasing value of non-price criteria could advance biodiversity/environmental priorities and ensure all developers on the same page (ex: Netherlands)
    - Co-creating requirements with developers and industry stakeholders key for buy-in and confirming requirements are not so cumbersome they will prevent companies from bidding
- **Prioritize Avoidance**: Avoiding impacts to ecologically sensitive areas through siting is best, most cost-effective, and quantitatively successful measure for achieving NPI (permitting process)
- **Transparent Data-Sharing & Collaboration:** Systems-level approach requires intentional communication and data-sharing between developers, government agencies, nonprofits and impacted communities
- **Continued Investment in Research**: Need for continued investment in research and development to understand changing marine environment (ex: payments-based approach)

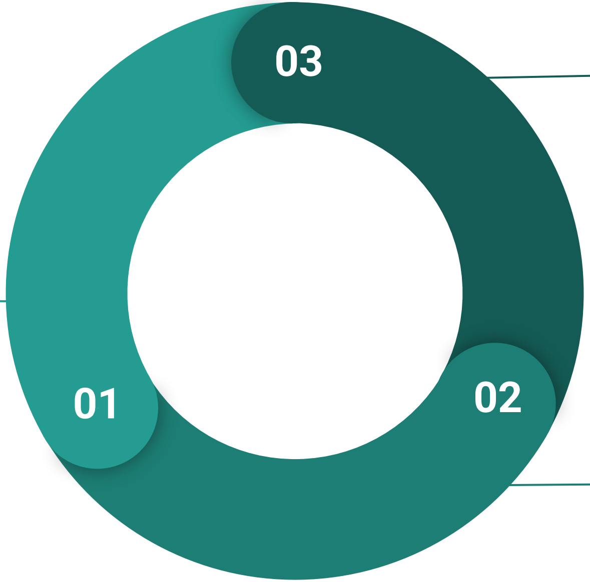
Key Trade-Offs: Summary

01	**Avoidance** (time and investment to avoid impact & enhance biodiversity upfront)	VS.	**Offsetting** (reliance on biodiversity offsets due to feasibility)
02	**Ecosystem Disruption** (short-term damage - i.e. pile driving, cable lying)	VS.	**Biodiversity Gains** (potential long-term habitat creation/reef effect)
03	**Quantification Rigor** (effective baseline assessment and monitoring system)	VS.	**Practical Feasibility** (cost and urgency to meet renewable targets)
04	**Development Scale** (economies of scale and grid efficiency)	VS.	**Site Sensitivity** (increased environmental and social footprint in ecologically sensitive areas)
05	**Climate Mitigation** (efforts to reduce global emissions)	VS.	**Localized Environmental Harm** (localized ecological disruption - ie. seafloor disturbance)
06	**Global Standards** (global consistent NPI standards)	VS.	**Local Contexts** (local ecological, legal, and cultural factors)

Striving for NNL/NPI in OSW: Framework Overview

Baseline Assessment

- **Biodiversity Definition -** Characterize existing biodiversity & ecosystem conditions.
- **NNL & NPI Goals -** Identify critical habitats, species of concern, and ecosystem services.
- **Monitoring & Evaluation Baseline -** Establish reference points for impact prediction, mitigation, and future monitoring.



Monitoring & Evaluation

- **Adaptive Management-** Continue monitoring across project phases.
- **Stakeholder Collaboration -** Facilitate communication and data-sharing.

Measures to Achieve NNL / NPI Goal

- **Mitigation Hierarchy & Beyond-** Avoid, Minimize, Restore, Offset.
- **Cost -** Consider roles of each stakeholder in bearing the cost of mitigation measures.
- **Policies/Regulations -** Consider integrating measures into solicitation non-price criteria, permitting.

Phase 1: Baseline Assessment

Short-Term

Recommendations:
- Determine **critical species, habitats, and ecosystem services** through baseline assessments and community engagement
- Focus on **ranges/scales of variation** when assessing biodiversity features and establishing baselines

Stakeholder Involvement:
- Developers and state government could leverage **payments-based approach** to set up research team/resources for baselining tool (collecting data across developers)

Reference:
New Jersey's Research & Monitoring Initiative

Long-Term

Recommendations/Stakeholder Involvement:
- Government could eventually **own baseline assessments** and maintain **open source data** on species, habitats, etc.
- Baseline data would be helpful for government decision-making **across industries**, and developers would have equal access to information

Reference:
Netherlands (government performs all site investigations before issuing tender)

Definition Alignment

<table>
<tr><th>Terms</th><th>Considerations</th></tr>
<tr><td>Biodiversity</td><td>While most currently assess biodiversity based on species diversity/abundance in the ocean at a given time and location, it may be beneficial to expand this definition to include other habitat and ecosystem indicators long-term (more holistic approach).</td></tr>
<tr><td>No Net Loss (NNL) / Net Positive Impact (NPI)</td><td>NNL:
Determine critical species/habitats for conservation through baseline assessment
Implement mitigation/conservation measures that ensure any negative impacts to critical species/habitats due to OSW development are balanced by positive impacts
NPI:
Determine critical species/habitats for conservation through baseline assessment
Implement conservation measures that outweigh negative biodiversity impacts and could improve the sustainability of the critical species/habitats
Trade-Offs:
Focusing on a certain species/habitat would neglect the well-being of other species/habitats
Feasibility of mitigation/conservation actions on project site vs. off-site</td></tr>
</table>

Phase 2: Measures to Achieve NNL / NPI Goal

Short-Term

Recommendations:
- **Mitigation Hierarchy** - Avoid, Minimize, Restore, Offset should be the minimum required effort to achieve NNL / NPI goals.
- Consider re-evaluating **non-price criteria** weights, increasing the value of required measures to achieve NNL / NPI goals.

Stakeholder Involvement:
- **Developers** - Implement measures according to **mitigation hierarchy**; submit report to the state government.
- **Government** - **Assess and monitor the effectiveness** of developers' efforts; invest in **infrastructure** to minimize offshore wind impacts.

Reference: Netherlands

Long-Term

Recommendation: Establish **clear target for achieving NPI**

Stakeholder Involvement:
- **Government & Research / Academia -** Set up **research initiatives** to identify feasible target; revise target time to time to ensure progress aligns with evolving biodiversity concerns based on climate change
- **Developers -** Revise measures to achieve revised target; continuous **engagement with local communities** to capture local biodiversity insights and priorities

Reference: UK Environmental Act 2021

Phase 3: Monitoring & Evaluation

Short-Term

Recommendations:

- Invest and set up **research programs to gather evidence** on measuring biodiversity impacts quantitatively
- **Assess reporting on permitting requirements** to align with existing nature-related frameworks where possible

Stakeholder Involvement:

- **Government -** Facilitate funding and support for research institutions to advance evidence on biodiversity quantification
- **Research Institutions** - Provide evidence on scientific measurement frameworks and policy tools to implement

Reference: *UK Biodiversity Metric Tool*
Taskforce on Nature-Related Financial Disclosures

Long-Term

Recommendations

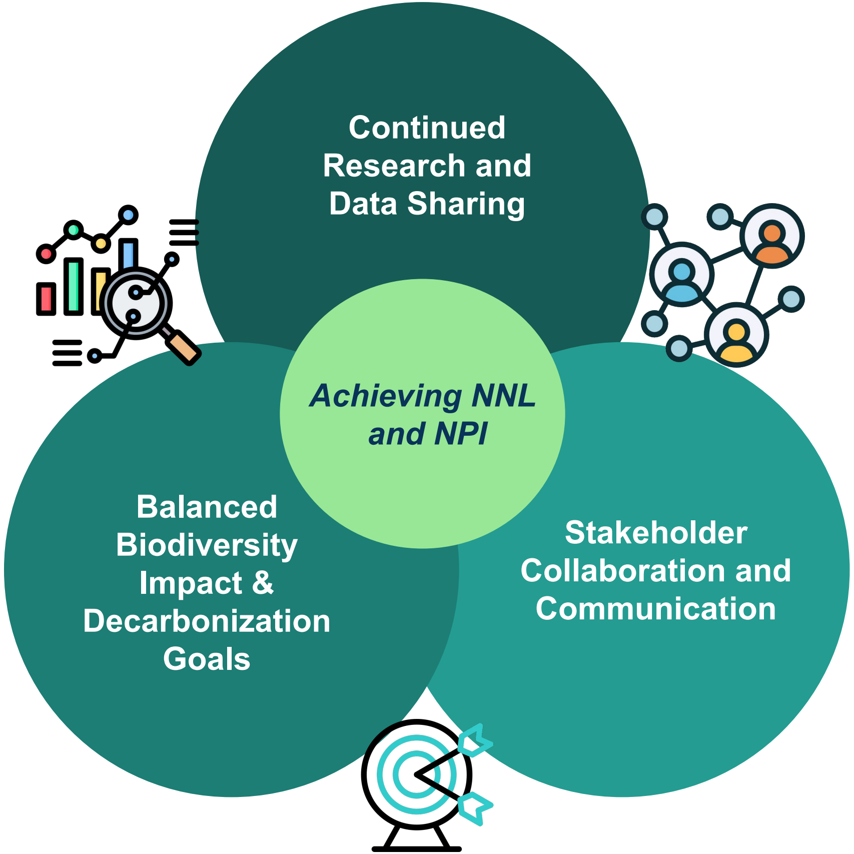
- Create a science-based **Measurement Framework** to assess biodiversity impacts (with consideration of variability/flexibility across ecosystems)
- **Continued investment** and facilitation of scientifically informed M&E of Biodiversity Mitigation Actions

Stakeholder Involvement:

- **International/ Intergovernmental Organizations -** Facilitate peer-reviewed research for OSW developers and regulators to consider M&E for NPI
- **Governments/ Developers** - Facilitate and adopt research findings into their practices and regulating conditions

Reference: *IUCN Net Positive Biodiversity Recommendations for Offshore Renewable Energy*
The Nature Conservancy Marine Mapping Tool

Overarching Priorities for Achieving NNL/NPI Goals



Appendix

Appendix Catalog

1. Interview Takeaways
2. Key Trade-offs
3. Regulations & Practices Related to NNL/NPI
    a. US (incl. Case Studies)
    b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. Baseline Assessment
6. Additional Resources

Appendix Catalog

1. **Interview Takeaways**
2. Key Trade-offs
3. Regulations & Practices Related to NNL/NPI
    a. US
    b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. Baseline Assessment
6. Additional Resources

Interview Takeaways*

Challenges	Areas of Emphasis	Good Practices
• Defining and quantifying net positive impacts in complex, dynamic marine ecosystems • Establishing accurate, up-to-date baselines • Translating research findings into practical, regulatory-compliant actions • Reconciling voluntary initiatives with existing state and federal permitting requirements	• Developing and **standardizing science-based metrics and reporting frameworks** to ensure consistency across projects and regions • Integrating adaptive management practices, including **ongoing monitoring** and **regular data sharing**, to respond to cumulative impacts over time • **Early stakeholder engagement**—from federal agencies and state regulators to local communities and NGOs—is viewed as essential for successful implementation • **Aligning global best practices** (especially from European models) with the U.S. regulatory framework to drive cohesive, impactful biodiversity strategies	• Using **integrated accounting frameworks** that set clear pre-project baselines, track post-construction changes, and plan mitigation actions accordingly • **Piloting** measurement frameworks and gathering industry feedback to continuously refine biodiversity targets • Leveraging **partnerships with research institutions** and established databases to inform ecosystem assessments • Implementing **comprehensive permitting processes** that incorporate both ecological and socioeconomic criteria to guide site selection and project feasibility

**Additional details in external document*

Appendix Catalog

1. Interviews Takeaways
2. **Key Trade-offs**
3. Regulations & Practices Related to NNL/NPI
   a. US
   b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. Baseline Assessment
6. Additional Resources

Key Trade-Offs in Detail

Trade-Off	Description	Challenge	EU Example
Avoidance vs. Offsetting	Developers tend to rely on biodiversity offsets due to feasibility vs. goals to achieve biodiversity enhancements	Offsets can be seen as a "license to degrade" unless tightly regulated	Good Practice: Shift toward nature-inclusive design, like eco-friendly scour protection or turbine spacing that benefits marine ecosystems.
Marine Ecosystem Disruption vs. Biodiversity Gains	Short-term damage from pile driving, cable lying, noise pollution, etc. vs. potential long-term habitat creation	Balancing short-term disturbance with long-term regenerative potential	EU's “nature-positive” energy infrastructure disrupts marine life, especially in shallow, ecologically rich North and Baltic Seas.
Quantification Rigor vs. Practical Feasibility	Effective baseline assessment and monitoring system vs. urgency to meet 2030 renewable targets	● Balancing climate goals and long-term ecological impact studies ● Lack of standardized tools or methodologies for quantifying NPI in marine environments	The Marine Spatial Planning Directive mandates environmental assessments, but in practice, these can delay projects.

Key Trade-Offs in Detail

Trade-Off	Description	Challenge	EU Example
Development Scale vs. Site Sensitivity	Economies of scale and grid efficiency vs. increased environmental and social footprint in ecologically sensitive areas	Identifying low-conflict zones while also integrating communities' interests	Ambitions to scale up to over 300 GW of OSW by 2050 mean more competition for marine space.
Climate Mitigation vs. Localized Environmental Harm	Efforts to reduce global emissions vs. local ecological disruption (ie. seafloor disturbance)	Balance the interests of local communities - commercial fisheries, bird migratory routes	There are tensions in the North Sea where migratory bird routes overlap with wind farm expansion zones.
Global Standards vs. Local Contexts	Global consistent NPI standards vs. local ecological, legal, and cultural factors	Need for adaptive frameworks that align international best practices with local realities	EU seeks harmonized approaches to NPI and impact assessments, but implementation varies across Member States.

Appendix Catalog

1. Interview Takeaways
2. Key Trade-offs
3. **Regulations & Practices Related to NNL/NPI**
    a. US
    b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. Baseline Assessment
6. Additional Resources

Key Federal Agencies Involved in Offshore Wind Regulation

Agencies	Role	Responsibilities Related to OSW
BOEM	The lead federal agency responsible for managing the development of offshore renewable energy resources, including OSW.	● **Leasing** - Site Assessment, Lease Permit ● **Environmental Reviews** - Conduct EIS, Provide suggestions on mitigation measures ● Coordination with NOAA, USFWS & USCG for comprehensive review
NOAA	Managing and protecting U.S. marine resources and their ecosystems.	● **Marine Ecosystem Protection** - Assessing Effects of underwater noise & habitat disruption, Assess impact on habitat through scientific evidences ● **Fisheries Management** - Work with NMFS to minimize impact on commercial fisheries ● **Marine Spatial Planning** - Work with BOEM for site assessment to prevent marine spatial conflict.
USFWS	Protecting wildlife species and their habitats, particularly in regard to birds and other terrestrial species that might be impacted by offshore wind farms.	● **Endangered Species Protection** - Based on Endangered Species Act, assess potential impact on endangered species. ● **Migratory Bird Protection** - Provide guidance on mitigating risks to migratory bird species from turbine collusion and habitat disruptions.

Agencies	Role	Responsibilities Related to OSW
FERC	Regulating the transmission of offshore wind energy	● **Interconnection of Transmission** - Reviewing and approving transmission plans for OSW projects. ● **Power Purchase Agreement (PPA)** - Approve PPAs between OSW developers and utilities, setting the terms of sales of electricity generated by OSW projects.
USCG	Ensures the safety of navigational routes, vessel traffic, and other maritime activities.	● **Navigational Safety** - Ensure the OSW development does not affect important shipping routes or create obstacles for maritime navigation. ● **Marking and Lightning** - Require OSW infrastructure to be marked with lightning, signal, and signage to prevent ship collision.
EPA	Overseeing and enforcing environmental standards that impact offshore wind farms.	● **Water Quality Protection** - Ensure the construction and operation of OSW farms meet the criteria set out in the Clean Water Act to prevent water pollution. ● **Air Quality** - Ensure the construction and operation of OSW farms meet the EPA air quality standards to prevent air pollution.

Key Federal Regulations Impacting Offshore Wind Farms

Regulation	Purpose	Application
National Environmental Policy Act (NEPA)	NEPA is one of the most important environmental laws in the U.S. that requires federal agencies to evaluate the environmental impacts of their proposed actions.	● NEPA requires BOEM to prepare an **Environmental Impact Statement (EIS)** for offshore wind projects to assess the potential impacts on marine ecosystems, communities, and resources before any federal approvals are granted. ● **Process**: The NEPA process includes public hearings, environmental analysis, and stakeholder engagement, allowing for input from environmental groups, fishing communities, and local residents.
Endangered Species Act (ESA)	The **ESA** mandates the protection of species listed as endangered or threatened and their critical habitats.	Offshore wind developers must consult with NOAA and USFWS to ensure that their projects will not adversely affect protected species (e.g., whales, sea turtles, and seabirds). If any endangered species are present in the project area, developers may need to make modifications to reduce impacts.
Marine Mammal Protection Act	The **MMPA** prohibits the "take" (i.e., harassment, hunting, capturing, or killing) of marine mammals in U.S. waters without a permit.	Developers must conduct environmental reviews to assess the impact of noise from construction and turbine operations on marine mammals. If impacts are identified, they may need to apply for a permit from NOAA and implement mitigation measures such as noise reduction technologies.

Regulation	Purpose	Application
Clean Water Act (CWA)	The **CWA** regulates discharges of pollutants into U.S. waters and sets water quality standards.	Developers must comply with CWA provisions to ensure that discharges from construction activities (e.g., sediment or contaminants) do not degrade water quality in the marine environment.
Migratory Bird Treaty Act (MBTA)	The **MBTA** provides protection for migratory birds that travel across international borders	The development of offshore wind farms must consider the potential impacts on migratory bird species. Developers may need to implement bird-friendly turbine designs or take other measures to avoid bird collisions with turbines.
Outer Continental Shelf Lands Act (OCSLA)	OCSLA provides the framework for the management of offshore energy resources on the **Outer Continental Shelf (OCS)**, including offshore wind energy development.	BOEM oversees the leasing process for projects on the OCS under OCSLA, ensuring that offshore wind development is compatible with other uses of the ocean and respects environmental protections.
Coastal Zone Management Act (CZMA)	The **CZMA** aims to protect and manage coastal resources in the U.S.	Under the CZMA, offshore wind projects must be consistent with the coastal zone management plans of the states that will be affected by the project. Developers are required to consult with state coastal management agencies to ensure that projects align with state-level policies on coastal and marine resources.

US State Regulations & Practices

Key Regulations & Policies	Stakeholders, Incentive & Support
• **Clean Energy Standard (CES)**: Massachusetts has set ambitious clean energy goals, aiming for **net-zero emissions by 2050**. The state aims to procure **5,600 MW of offshore wind energy** by 2035. • **2016 Massachusetts Offshore Wind Legislation**: This law authorized the state to procure large-scale offshore wind projects. The state has held multiple procurement rounds for offshore wind, with the most significant contracts including the **Vineyard Wind Project** and **Mayflower Wind**. • **Massachusetts Offshore Wind Energy Regulations**: The state requires detailed **Environmental Impact Reports (EIRs)** for proposed offshore wind projects to evaluate environmental and social impacts, particularly related to marine life, fisheries, and shipping lanes. • **Massachusetts Environmental Protection Act (MEPA)**: All offshore wind projects in Massachusetts must undergo an environmental review under MEPA to assess impacts on local ecosystems, including fish habitats, birds, and marine mammals. • **Fisheries Compensation**: In line with environmental stewardship, Massachusetts mandates that developers compensate commercial fishing businesses if their operations are disrupted by offshore wind projects.	• **Offshore Wind Tax Credits**: Massachusetts has worked to incentivize offshore wind development with state-level tax credits, and there's a strong push for workforce development related to offshore wind jobs. • **Stakeholder Engagement**: Massachusetts emphasizes extensive public outreach and consultation with local stakeholders, including fishermen, coastal communities, and tribal groups. • **Massachusetts Clean Energy Center (MassCEC)**: The state agency that provides grants, financing, and other incentives to support offshore wind development, particularly in the manufacturing and supply chain sectors. • **Energy Facility Siting Board (EFSB)**: The EFSB is responsible for reviewing certain energy projects to determine their suitability. Offshore wind projects must receive approval from this board before moving forward with construction.

Key Regulations & Policies	Stakeholders, Incentive & Support

• **Renewable Energy Standard (RES)**: Rhode Island’s Renewable Energy Standard requires utilities to procure a certain percentage of energy from renewable sources. This standard supports offshore wind projects as part of the state's broader clean energy goals.
• **2016 Ocean Special Area Management Plan (Ocean SAMP)**: Rhode Island developed the Ocean SAMP, which designates areas in federal waters that are suitable for offshore wind development. This was the first comprehensive plan of its kind in the U.S.
• **State Permitting Process**:
    ○ Rhode Island requires developers to obtain both **state and federal permits**. While the federal government handles leasing and environmental review (via BOEM), the state manages coastal zone management and associated permits.
    ○ The **Rhode Island Coastal Resources Management Council (CRMC)** manages the permitting process for offshore wind, including impacts on coastal ecosystems and community concerns.
	• **Long-term Offshore Wind Procurement**: Rhode Island has procured significant offshore wind capacity, including the **Revolution Wind** project, a major offshore wind farm expected to provide power to both Rhode Island and Connecticut.
	• **Port Infrastructure Development**: Rhode Island is investing in port facilities to support offshore wind logistics, including the **Port of Providence** and **Quonset Point**, to serve as hubs for offshore wind turbine manufacturing and assembly.
	• **Fisheries and Environmental Review**: Rhode Island places a strong emphasis on ensuring that offshore wind development minimizes disruptions to fisheries and marine ecosystems. Public hearings and community consultations are a part of the permitting process.

Key Regulations & Policies	Stakeholders, Incentive & Support

• **New York State Energy Plan**: New York's energy policy includes a target of **9,000 MW of offshore wind energy by 2035**. This aligns with the state's broader goal to achieve **100% clean energy by 2040**.
• **Offshore Wind Master Plan**: This plan, developed by the **New York State Energy Research and Development Authority (NYSERDA)**, lays out the roadmap for offshore wind development in the state. It includes site identification for wind farms and policies to streamline permitting processes.
• **Environmental Reviews**:
    ○ New York follows the **State Environmental Quality Review Act (SEQRA)**, which requires environmental reviews for offshore wind projects to assess impacts on wildlife, habitats, and the surrounding community.
    ○ **Fisheries and Marine Life**: NYS is particularly focused on protecting local fisheries and marine ecosystems. Developers must submit Environmental Impact Statements (EIS) to evaluate impacts, including noise, water quality, and migration routes for marine life.
	• **Offshore Wind Tax Credits and Funding**: New York offers tax incentives and funding for offshore wind projects, including workforce training and local supply chain development.
	• **Local Job Creation**: New York emphasizes the creation of local jobs through offshore wind, with specific investments in port infrastructure and manufacturing facilities for wind turbine components.
	• **Public Utility Commission (PSC) Approval**: The state Public Service Commission must approve all contracts related to offshore wind energy procurement, ensuring alignment with state energy goals.
	• **Offshore Wind Procurement**: New York has issued **several rounds of offshore wind procurement**, resulting in major contracts with developers like **Equinor's Empire Wind** and **Beacon Wind**.
	• **Fisheries Mitigation**: Like Massachusetts, New York requires measures to mitigate the impacts on commercial fisheries, including compensation and access to affected fishing zones.

Key Regulations & Policies	Stakeholders, Incentive & Support
● **Energy Master Plan (EMP)**: New Jersey's EMP sets a goal of **11,000 MW of offshore wind capacity by 2040**. The state has strong backing from the **New Jersey Board of Public Utilities (BPU)** to meet this target. ● **Offshore Wind Strategic Plan**: New Jersey's Offshore Wind Strategic Plan outlines the state's approach to siting, permitting, and development of offshore wind energy, including guidelines for environmental protections and stakeholder engagement. ● **Offshore Renewable Energy Certificate (OREC)**: To encourage offshore wind development, New Jersey created the **Offshore Renewable Energy Certificate (OREC)** program. This allows developers to sell renewable energy credits for offshore wind power generated. ● **Environmental Review**: New Jersey requires a full **Environmental Impact Statement (EIS)** for all offshore wind projects, focusing on the impact on marine life, birds, and local coastal habitats. This includes detailed consultation with agencies like NOAA and the U.S. Fish and Wildlife Service. ● **Fisheries Mitigation**: New Jersey is heavily focused on minimizing the impact on commercial and recreational fisheries. Developers must submit plans to mitigate potential disruptions and must compensate affected fishing communities.	● **Green Energy Incentives**: New Jersey offers a range of incentives to support offshore wind development, including tax credits, financing, and a **$100 million offshore wind innovation fund** for research and development. ● **Local Economic Development**: New Jersey places significant emphasis on local job creation and workforce development to drive economic growth in the region through investments in port infrastructure and supply chain networks.

Environmental Impact Assessments (EIA)

Reference: Environmental impact assessment framework for offshore wind energy developments based on the marine Good Environmental Status

Purpose

- Identify and evaluate the potential environmental impacts of a proposed offshore wind farm.
- Assess how the project may affect biodiversity, marine life, air and water quality, local ecosystems, cultural resources, and human activities (e.g., shipping, fishing, recreation).
- Propose measures to **avoid**, **minimize**, or **mitigate** adverse impacts on the environment.
- Provide a **transparent** and **scientific** basis for decision-making by regulators, stakeholders, and the public.

Legal Framework for EIAs in the U.S.

- **Federal**
  - National Environmental Policy Act (NEPA)
  - Environmental Evaluations within ESA, MBTA, MMPA
- **State**
  - Massachusetts Environmental Policy Act (MEPA)
  - State Environmental Quality Review Acts (SEQRA), NY

Reference: Environmental impact assessment framework for offshore wind energy developments based on the marine Good Environmental Status

Component	Description
Scoping	The first step in an EIA is **scoping**, which defines the scope of the assessment by identifying key issues, resources, and potential environmental impacts that should be evaluated. ● **Public and Stakeholder Input**: Public participation is encouraged during this phase, with agencies holding meetings and consultations with local communities, tribes, environmental organizations, and industry groups to gather input. ● **Key Areas of Focus**: The scoping process typically identifies critical issues such as: ○ Potential impacts on marine life (fish, mammals, birds, etc.) ○ Effects on sensitive habitats (coral reefs, fish spawning areas, etc.) ○ Underwater noise and its effects on marine mammals ○ Air quality, water quality, and sediment disturbance ○ Impact on human activities (fishing, shipping, recreation)
Baseline Environmental Data Collection	Developers are required to collect baseline environmental data on the area where the wind farm is planned. This involves extensive **environmental surveys** to understand the existing conditions, including: ● **Marine life surveys**: Including species composition, abundance, and migratory patterns of marine mammals, fish, and birds in the area. ● **Seafloor and habitat surveys**: To identify critical habitats such as coral reefs, seagrass meadows, and other sensitive ecosystems. ● **Water quality**: Assessments of water temperature, salinity, currents, and other factors that influence marine life. ● **Marine traffic**: Data on shipping lanes, fishing activities, and other human activities that could be affected by the wind farm.

Reference: [Environmental impact assessment framework for offshore wind energy developments based on the marine Good Environmental Status]

Component	Description
Impact Assessment and Analysis	Once the baseline data is gathered, the next step is to assess how the proposed project will impact the environment. This step includes: ● **Construction Impacts**: Analyzing the effects of construction activities (e.g., pile driving for turbine foundations) on marine life, water quality, and sediment disturbance. ○ **Underwater Noise**: Noise from pile driving, vessel traffic, and turbine operation can disrupt marine mammals and fish. The EIA evaluates the potential disturbance and recommends mitigation measures (e.g., noise reduction technologies like bubble curtains or soft start techniques). ● **Operational Impacts**: Assessing the long-term effects of the wind farm once it's operational. This includes the impact of turbine movement on birds (collision risks), disruption to marine mammal habitats, and changes to water currents. ● **Decommissioning**: Analyzing the potential environmental effects of decommissioning the wind farm at the end of its lifespan, including removal of turbines and potential disturbance to marine habitats.
Mitigation Measures	The EIA must propose measures to avoid, minimize, or mitigate significant environmental impacts identified in the assessment. Mitigation strategies might include: ● **Noise Reduction**: Using advanced noise abatement techniques during construction to protect marine mammals from harmful sound levels. ● **Turbine Design**: Installing bird-friendly turbine designs to minimize collision risks, such as adjusting turbine blade speeds or placement. ● **Scheduling**: Limiting construction activities during sensitive times, such as fish spawning seasons or migratory periods for marine mammals. ● **Fisheries Compensation**: Implementing plans to offset potential losses to commercial fishing, including providing financial compensation or supporting sustainable fishing practices. ● **Artificial Reefs or Habitat Restoration**: Using the structures of the wind farm itself to promote marine biodiversity, such as creating artificial reefs to enhance local fish populations.

Reference: Environmental impact assessment framework for offshore wind

Component	Description
Cumulative Impacts and Alternatives	The EIA must also consider the **cumulative impacts** of the proposed project, particularly when there are multiple wind farms or other industrial activities in the same region. ● **Cumulative Impacts**: This includes the combined effect of several projects on marine ecosystems, bird populations, and local fisheries. ● **Alternatives Analysis**: The EIA should evaluate different alternatives to the proposed project, including different turbine designs, locations, or construction methods, and explain why the chosen alternative was selected as the best option for minimizing environmental impacts.
Public Review and Comment	Once the draft EIS is completed, it is made available for **public review**. This phase allows stakeholders—including local communities, environmental organizations, and other concerned parties—to submit comments and feedback on the proposed project. ● Public hearings may be held, particularly if the project is controversial or has significant potential impacts. ● Developers are required to respond to public comments and revise the EIS if necessary to address concerns raised.
Decision and Permitting	After the public review process, the federal agency (typically BOEM) makes a decision on whether to approve the project. This decision is based on the findings of the EIA and public input. ● If the project is approved, permits are issued, and the developer is allowed to proceed with construction. However, **mitigation measures** may be required as part of the permit conditions. ● **Monitoring and Compliance**: The developer is required to monitor the environmental effects of the project during and after construction to ensure that mitigation measures are effective.

Reference: [Environmental impact assessment framework for offshore wind energy developments based on the marine Good Environmental Status]

Types of Environmental Reviews in Offshore Wind

Environmental Impact Statement (EIS)

- **Purpose**: A comprehensive, detailed analysis of the potential significant impacts of the proposed project. It is required for major federal actions (such as offshore wind farms) that have the potential for significant environmental effects.
- **Process**: Involves scoping, data collection, impact analysis, public review, and decision-making.
- **Examples of Projects Requiring an EIS**: Large-scale offshore wind farms, particularly those located in federal waters.

Environmental Assessment (EA)

- **Purpose**: A more streamlined review process used when the project is not expected to have significant environmental impacts. An EA determines whether an EIS is required.
- **Process**: Typically involves a simpler analysis, but if significant impacts are found during the EA, a full EIS may be triggered.
- **Examples**: Smaller projects or projects that are located in areas where the environmental impacts are expected to be minimal.

Reference: Environmental impact assessment framework for offshore wind energy developments based on the marine Good Environmental Status

International Regulations & Practices

International Regulations & Practices to NNL/NPI

Country / Region	Regulation / Practices	Key Mandates / Objectives	Case Examples	Opportunities / Limitations
UK	UK Environmental Act 2021	-Requires minimum of 10% Biodiversity Net Gain for all developments -Mandatory Biodiversity Credits System	-Norfolk Boreas & Norfolk Vanguard -Dogger Bank Wind Farm -Rampion 2 OWF -Hornsea 3 OWF -East Anglia 1 North & 2	Opportunities: -Strengthen Nature Recovery Networks to support wildlife conservation. -Develop Local Nature Recovery Strategies for ecosystem restoration. Limitations: -Enforcement & Monitoring -Measurement Accuracy
EU	-EU Birds & Habitats Directives -EU Biodiversity Strategy for 2020 -EU Taxonomy Regulation -Marine Strategy Framework Direction	-Mitigation Hierarchy: Avoid, Minimize, Compensate -Restore min 30% of degraded ecosystems -Conduct Impact Assessments		-Ensure enforcement by implementing biodiversity protection criteria for green financing.
World Bank	Environmental & Social Performance Standards	-Mitigation Hierarchy: Avoid, Minimize, Restore, Compensate -Marine Protected Area & No-fishing zones	-Hornsea Offshore Wind Farm (UK) -Hollandse Kust Zuid (Netherlands) -Saint-Brieuc OWF (France)	Challenges: -Underwater noise pollution -Seabird & Bat collisions -Monitoring & Enforcement

Key Provisions in the UK Environment Act 2021 Related to NNL

Provision	Description
Biodiversity Net Gain (BNG) Requirement	All new developments must deliver **at least a 10% biodiversity net gain** and maintain it for **30 years**.
Mandatory Biodiversity Offsetting	Developers must create or restore habitats **on-site** or **purchase biodiversity credits** to offset impacts elsewhere.
Biodiversity Duty for Public Authorities	All local councils and public bodies must **enhance biodiversity in decision-making** to prevent net loss.
Local Nature Recovery Strategies (LNRS)	Regional biodiversity plans ensure **NNL or NPI** by connecting wildlife corridors and restoring key habitats.
Biodiversity Metric for Impact Measurement	A standardized **biodiversity calculation tool** (see next page) is used to assess gains/losses before approval.

Source: https://www.legislation.gov.uk/ukpga/2021/30/contents

International Regulations & Practices to NNL/NPI

Country	Regulation / Practices	Key Mandates / Objectives	Case Examples	Opportunities / Limitations
Germany	-Marine Spatial Planning -Offshore Wind Energy Act -Renewable Energy Act	-Biodiversity Offsetting -Marine Life Enhancement -Environmental Impact Assessment (EIA) -Marine Protected Areas	-Kaskasi (2022) -Baltic Eagle (2024) -Borkum Riffgrund 3 (2025)	-Limitation on site (defined areas in North Sea & Baltic Sea) -Auction process ensuring higher compliance of developers -Delays in grid expansion
France	-Environmental Code -Multiannual Energy Plan -French Energy & Climate Law	-ERC principle: Avoid, Reduce, Compensate - EIA	Saint-Nazaire OWF (1st Operational Project, 2022)	-Artificial and oyster reef restoration -Co-management with fisheries for ecosystem balance -Strict Noise Reduction Measures -Monitor on fish stocks, seabirds & marine mammals.
Netherlands	-Climate Agreement 2019 -Dutch Offshore Wind Roadmap 2030 -Energy Act 2024 -Marine Spatial Planning Policy	-Mitigation Hierarchy: Avoid, Minimize, Restore, Compensate -Floating Wind Farm -Habitat Restoration -EIA	-Borssele Offshore Wind Farm (1st Large Scale Project, 2020) -Floating OSW: North Sea Floating Wind Farm (1st Floating OSW, 2026-2030)	-North Sea offshore wind hub (floating OWF) -Grid Congestion -Competition for North Sea space with shipping, fishing and defense activities

International Regulations & Practices to NNL/NPI

Country	Regulation / Practices	Key Mandates / Objectives	Case Examples	Opportunities / Limitations
Norway	-Offshore Energy Act 2020 -National offshore Wind Strategy 2022	-Biodiversity Offsetting -Marine Life Enhancement -Environmental Impact Assessment (EIA) -Marine spatial planning -**Strict turbine shutdown protocols**	-Sørlige Nordsjø II (2023) -Hywind Tampen (World's 1st Floating OSW for oil and gases) -Utsira Nord (1st Large Scale Floating auction, 2024)	-Strong wind resources & deep waters that enhance competitive advantage in floating wind -High costs of floating wind -Grid Bottlenecks
Denmark	-Danish Energy Agreement 2018 -Danish Climate Act 2020 -Offshore Wind Tender Model 2023	-**Low-noise piling** -Monitor Seabird Populations -Compensation: Artificial Reefs -Protected Marine Area	-Horns Rev 3(Largest Operational OSW) -Kriegers Flaks (Largest Baltic Sea Wind Farm)	-Strict noise mitigation -Artificial and oyster reef restoration -Co-management with fisheries for ecosystem balance -Monitor on fish stocks, seabirds & marine mammals.

Compatibility Between Netherlands & New Jersey

Category	Netherlands	New Jersey	Compatibility
OSW Ambition	21 GW by 2030, clear roadmap	11 GW by 2040	Ambition aligned
Grid Connection	Centralized (TenneT)	Developer-led interconnection	Could improve with coordination
Nature-Inclusive Design	Mandatory ecological enhancements	Emerging; not mandated	High potential for adoption
Permitting & Planning	Centralized, proactive site selection	Fragmented (BOEM, NJDEP, local)	Needs streamlining
Marine Spatial Planning	Advanced, data-driven MSP	Still developing	Can learn from Dutch MSP
Stakeholder Engagement	Structured, early engagement	Opposition from fishers, coastal communities	Needs stronger engagement

Source: *Offshore Wind: A European Perspective (NYPA)*

World Bank/IFC Standards & Offshore Wind Farm Biodiversity Protection

Source: IFC Performance Standards on Environmental and Social Sustainability

Environmental and Social Performance Standards (ESPS)

Standard	Objective	NNL/NPI Requirements
Performance Standard 6 (PS6) - Biodiversity Conservation	Protect sensitive ecosystems and marine biodiversity from offshore wind development.	Requires projects to demonstrate **No Net Loss (NNL)** and, where possible, achieve **Net Positive Impact (NPI)** through biodiversity offsets, habitat restoration, and conservation investments.
Performance Standard 1 (PS1) - Environmental and Social Assessment	Ensure offshore wind projects do not cause irreversible environmental harm.	Requires **Environmental Impact Assessments (EIA)** and biodiversity monitoring programs for all wind farm developments.
Performance Standard 3 (PS3) - Resource Efficiency & Pollution Prevention	Minimize pollution, including underwater noise and habitat disturbance.	Offshore wind farms must **reduce underwater noise, avoid marine debris, and use eco-friendly turbine foundations**.
Performance Standard 4 (PS4) - Community Health & Safety	Protect local fishing communities from economic displacement caused by offshore wind farms.	Requires developers to establish **Marine Spatial Planning (MSP)** to ensure coexistence with fisheries.

Source: *IFC Performance Standards on Environmental and Social Sustainability*

IFC/ World Bank EHS Guidelines & Offshore Wind Energy

Practices	Measures to Achieve NNL	Measures to Achieve NPI
● **Site Selection:** - Avoid protected marine areas, seabird migration routes, and fish spawning grounds. - Conduct cumulative impact assessment. ● **Mitigation Hierarchy:** - Avoid, Minimize, Restore, Offset ● **Monitoring & Adaptive Management:** - Use satellite tracking for seabird migration and real-time acoustic monitoring for marine mammals. - Establish long-term marine ecosystem restoration programs near OSW sites.	● **Eco-friendly turbine foundation designs** - mimic natural reefs. ● **Bird-friendly turbine operations** - e.g., automatic shut-off during migration seasons. ● **Restoration of seagrass beds** - offset habitat loss. ● **Artificial reef deployment** - enhance marine biodiversity.	● **Creation of Marine Protected Areas (MPAs)** ● **Establishing no-fishing zones** - allow fish stocks to recover. ● **Integrating offshore wind farms with aquaculture & marine conservation programs.**

Source: Environmental, Health & Safety General Guidelines (IFC/World Bank)

EU Wind Power Action Plan (2023)

- **EU Wind Power Action Plan (2023)**
  - **Objectives**
    - Address bottleneck in permitting
    - Address uncertainty in investment & market
    - Address supply chain challenges
    - Expand OSW development, aligning EU 2030 goal & REpowerEU Plan
  - **Aligned with EU Wind Charter**

Source: [European Wind Power Action Plan (European Commission)]

Key Pillars

1. Accelerating Permitting

- REPowerEU permitting reforms.
- Use of digital tools, one-stop shops, clear guidance - speed up approval processes.
- Promote the use of strategic spatial planning - early identification of low-conflict zones.

2. Enhancing Auction Design

- Improve predictability and transparency of auctions.
- Includes non-price criteria - Sustainability, Biodiversity Protection, Local Value Creation
- Prevent race-to-the-bottom bidding.

3. Strengthening Supply Chains

- Support domestic wind turbine manufacturing, ports, and logistics.
- Promote innovation - Next-gen wind technology & floating offshore wind.

4. Mobilizing Finance

- Expand financing access - Innovation Fund, InvestEU, EIB support
- Facilitate corporate PPAs

5. Skilling and Workforce Development

- Address skills shortages in the wind sector workforce.
- Partner with industry and academia to upskill/reskill labor forces.

6. Fair International Competition

- Ensure global trade rules and EU defense against unfair competition - e.g., subsidies from third countries

Source: European Wind Power Action Plan (European Commission)

Key Efforts to Achieve NNL

1. **Strategic Planning and Spatial Tools**

- Encourage early-stage **marine spatial planning (MSP)** - avoid ecologically sensitive areas.
- Support the use of **biodiversity datasets** - determine preferred development zones.

2. **Auctions with Non-Price Criteria**

- Incorporate ecological and sustainability standards into auctions - incentivize nature-inclusive development, ensure biodiversity enhancement commitments

3. **Financing Nature-Positive Projects**

- Support R&D and deployment of **eco-engineering** innovations - turbine bases that double as reef structures
- Include biodiversity-positive elements into funding requirements.

4. **Monitoring and Data Requirements**

- Facilitate standardization- Monitoring frameworks.
- Requires project to show biodiversity impact baselines & performance indicators.

5. **Stakeholder Engagement**

- Emphasizes community engagement and public trust, especially where ecological risks are perceived - lead to co-designed nature-positive outcomes.

Source: [European Wind Power Action Plan (European Commission)]

WOZEP: Wind Energy at Sea - Ecological Programme

Sources: [Offshore Wind Ecological Programme: WOZEP (Dutch Ministry of Infrastructure & Environment)]

Purpose	Key Research Themes	Tools & Output
1. Initiated by the Ministry of Economic Affairs & Climate Policy in Netherlands 2. Provide scientific basis for OSW related policies. 3. Evaluate ecological impacts of the OSW development in North Sea. 4. Monitor and guide the responsible deployment of OSW to ensure biodiversity commitment.	1. Birds and Bats - Study collision risks; Develop tracking technology; Focus on critical species like gannets, kittiwakes. 2. Marine Mammals - Research underwater noise disturbance; Focus on key species like grey seals, harbor porpoise; Develop mitigation strategies. 3. Benthic Ecosystems - Evaluate impact of scour protection and turbine to the seafloor; Assess biodiversity impact caused by artificial reef; Investigate potential habitat enhancement. 4. Hydrography and Geomorphology - Evaluate impact of OSW structures to water quality and sediment transport; Understand cumulative effects on ecological processes. 5. Cumulative and System Effects - Create ecosystem models for assessment; Support adaptive marine spatial planning and strategic environmental assessments.	Tools: 1. Ecological sensitivity maps of the Dutch North Sea 2. Predictive models for species disturbance & population-level effects. 3. Open datasets on species abundance, migration & behaviour. 4. Guidelines for incorporating biodiversity into OSW project assessments Output: 1. Establish permit conditions for OSW developers 2. Auction design criteria 3. Monitoring requirements

Sources: Offshore Wind Ecological Programme: WOZEP (Dutch Ministry of Infrastructure & Environment)

Key Insights for OSW Biodiversity Positive Impact	
1. Informed Site Selection ● Avoid critical habitats using species distribution models. ● Consider seasonal & migratory pattern during spatial planning. ● Reduce costly mitigation method post permitting. 2. Time-Restricted Construction ● Establish sensitive periods - noisy activities are prohibited during these periods. ● Use acoustic deterrents to prevent mammals from affecting by disturbance events. 3. Eco-Design of Infrastructure ● Encourage using reef-effect enhancement. ● Use nature-inclusive scour protection to increase habitat diversity.	4. Baseline and Continued Monitoring ● Continued monitoring facilitate detection of population trends. ● Facilitate adaptive management and responsive policy. 5. Model-Based Impact Assessment ● Implement scenario testing before construction - developers can simulate impact of layout, turbine density and operational noises.

Sources: Offshore Wind Ecological Programme: WOZEP (Dutch Ministry of Infrastructure & Environment)

Mitigation Hierarchy	Integration with Other Frameworks
1. Avoid - Spatial planning using sensitivity maps 2. Minimize - Minimize construction impact and timing; Implement eco-design 3. Restoration - Design foundations to enhance habitats 4. Monitoring - Develop high-resolution and long-term ecological tracking 5. Collaboration - Engagement with multi stakeholders for science-policy interface	1. WEF Nature Positive OSW Framework 2. EU Wind Power Action Plan 2021 3. North Sea Energy Cooperation (NSEC) 4. Dutch National Offshore Wind Roadmaps

Sources: Offshore Wind Ecological Programme: WOZEP (Dutch Ministry of Infrastructure & Environment)

Program	Country/Region	Main Focus Areas	Key Features	How it Informs Policy
WOZEP (Wind Energy at Sea Ecological Programme)	Netherlands	Birds, bats, marine mammals, benthos, hydrodynamics, cumulative effects	Long-term ecological data, predictive impact models, ecological mapping, open data sharing	Directly informs Dutch OSW permitting, auction design, and marine spatial planning
ORJIP (Offshore Renewables Joint Industry Programme)	UK	Collision risk (birds, bats), noise impacts on mammals, displacement	Industry-government collaboration, focus on risk-reducing technologies and monitoring	Outputs support streamlined impact assessments under UK's Habitats Regulations
BOEM Environmental Studies Program	US	Baseline data for leasing areas: fish, marine mammals, birds, noise, cultural sites	Large database of studies, partnerships with NOAA and universities, Indigenous consultation	Feeds into environmental assessments under NEPA and leasing area design
BSH Monitoring & Research	Germany	Monitoring of physical, biological, and chemical marine parameters	Legally mandated before/after construction monitoring; standardization across projects	Integral to EIA and SEA processes; BSH publishes monitoring guidelines and reports

Sources: [Offshore Wind Ecological Programme: WOZEP (Dutch Ministry of Infrastructure & Environment)]

World Economic Forum - Nature Positive: Role of the OSW Sector

A framework for achieving **Nature-Positive outcomes** and ways OSW development can support **global climate and biodiversity goals** simultaneously

Source: Nature Positive: Role of the Offshore Wind Sector (WEF)

Key Concept	Enabling Conditions	Case Studies
1. **Nature-Positive approach -** halting and reversing nature loss with measurable gains in biodiversity by 2030. 2. **Mitigation Hierarchy -** Avoid, Minimize, Restore, Offset / Compensate 3. Work beyond 'Avoid' to create positive impact in improving biodiversity outcomes.	1. **Policy Alignment -** Set clear biodiversity targets and relevant regulations 2. **Science and Data -** Accessible marine biodiversity data for developers 3. Collaboration - Engagement with local stakeholders (e.g. government, industry, communities) 4. **Financing -** Establish incentives and mechanisms to fund nature-positive actions. 5. **Innovation -** R&D into biodiversity-friendly OSW technologies and materials.	1. **Netherlands -** Mandated biodiversity enhancement in OSW bidding 2. **Belgium -** Design foundations to provide habitat for marine life 3. **Australia -** Engagement with local communities and co-management of sea country 4. **Germany -** Adaptive monitoring frameworks in OSW zones 5. **UK -** Nature-based design innovations and marine data platforms.

Source: Nature Positive: Role of the Offshore Wind Sector (WEF)

Five-Pillar Framework	Details
Plan for Nature	● Include biodiversity and ecosystem value in early planning and site selection. ● Use **marine spatial planning**, cumulative impact assessments, and **ecological sensitivity mapping**.
Design for Nature	● Integrate **ecological engineering** into turbine and foundation design. ● Include features like artificial reefs or fish aggregation devices. ● Consider biodiversity in cable routing and decommissioning plans.
Build for Nature	● Reduce noise, sedimentation, and other construction-related stressors. ● Time construction activities to avoid breeding/spawning seasons. ● Use quieter foundation technologies (e.g., vibratory piling).
Operate for Nature	● Monitor biodiversity over the project lifecycle. ● Minimize vessel traffic and underwater noise during operations. ● Adaptive management to respond to unexpected biodiversity impacts.
Restore & Renew for Nature	● Restore degraded marine habitats, e.g., seagrass beds or oyster reefs. ● Consider **active restoration** as part of OSW project commitments. ● Partner with NGOs, fishers, and scientists.

Source: *[Nature Positive: Role of the Offshore Wind Sector (WEF)]*

Key Insights for Achieving NNL / NPI

1. **Prioritize Location & Planning**
- Avoid biodiversity hotspots, migration corridors, and critical habitats.
- Implement marine spatial planning & cumulative effects analysis.

2. **Incorporate Nature Into Infrastructure**
- Design turbine foundations, scour protection, substations to support marine habitats
- Enable habitat creation

3. **Minimize Harmful Construction Impacts**
- Use low-impact installation methods - i.e. suction buckets, vibratory pile driving
- Create seasonal periods to avoid activities that impact biodiversity - i.e. spawning, nesting

4. **Embed Biodiversity Monitoring & Adaptive Management**
- Develop long-term ecological monitoring systems
- Do adaptive adjustments over time.

5. **Commit to Habitat Restoration**
- Fund or develop marine habitat restoration in tandem with OSW development
- Link restoration efforts to offset residual impacts

6. **Use Regulatory and Market Mechanisms**
- Set biodiversity enhancement requirements in OSW auctions.
- Design credits mechanism to incentivize developers to meet baseline expectations.

7. **Stakeholder Engagement**
- Collaborate with local communities, indigenous groups, marine scientists, conservation NGOs.
- Ensure co-designed, culturally appropriate solutions.

8. **Leverage Data and Innovation**
- Invest in marine biodiversity mapping & real-time monitoring tech
- Promote open data platforms to reduce information barriers.

Source: [Nature Positive: Role of the Offshore Wind Sector (WEF)]

Mitigation Hierarchy	Integration with Other Frameworks
1. **Avoid** - Spatial planning using sensitivity maps 2. **Minimize** - Minimize construction impact and timing; Implement eco-design 3. **Restoration** - Design foundations to enhance habitats 4. **Monitoring** - Develop high-resolution and long-term ecological tracking 5. **Collaboration** - Engagement with multi stakeholders for science-policy interface	1. WEF Nature Positive OSW Framework 2. EU Wind Power Action Plan 2021 3. North Sea Energy Cooperation (NSEC) 4. Dutch National Offshore Wind Roadmaps

Source: *Nature Positive: Role of the Offshore Wind Sector (WEF)*

Appendix Catalog

1. Interview Takeaways
2. Key Trade-offs
3. Regulations & Practices Related to NNL/NPI
    a. US
    b. International (incl. Case Studies)
4. **Case Studies of Other Industries**
5. Baseline Assessment
6. Additional Resources

Other Industry Practices in Achieving NNL &Beyond on Biodiversity

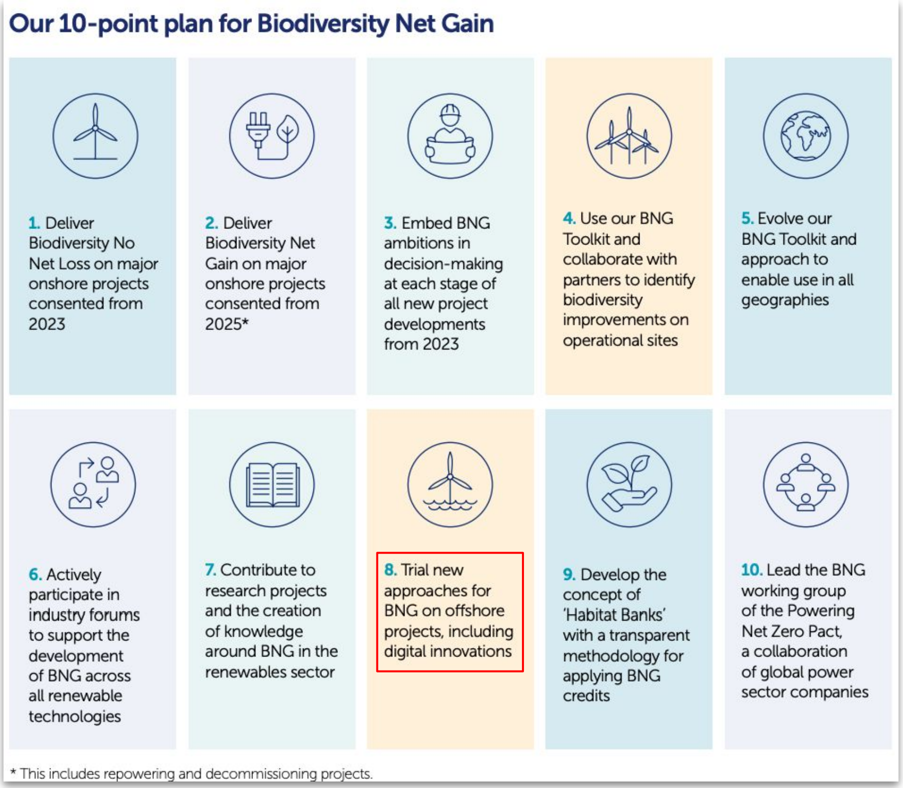
UK – SSE Renewable

- **Focus:** Achieving net-positive biodiversity in renewable energy projects (onshore and offshore wind, hydro, solar and battery storage)
- **Key Initiatives:** Biodiversity Net Gain (BNG)*, sustainable procurement, community investment
- **Impact:** Supporting clean energy, economic contributions, and ecosystem restoration

Source: https://www.sserenewables.com/media/vgsdoav3/sser-biodiversity-net-gain-report-nov-2022-final.pdf

Key Practices:

- **Biodiversity Net Gain (BNG) Commitment**: SSE Renewables has pledged to achieve no net loss in biodiversity by 2023 and a net gain by 2025 for all onshore large capital projects.
- **Development of BNG Toolkits**: To support their biodiversity goals, SSE Renewables has created toolkits to assess and enhance biodiversity impacts, ensuring projects contribute positively to local ecosystems.
- **Sustainable Procurement Strategy**: Aligned with the ISO 20400 Sustainable Procurement standard, this strategy ensures that environmental considerations are integrated into supply chain decisions.
- **Community Investment**: Direct investment of over £10 million in communities during the last financial year, supporting nearly a thousand community projects.



Source: https://www.sserenewables.com/media/vgsdoav3/sser-biodiversity-net-gain-report-nov-2022-final.pdf

Quantifying BNG: Earlier Development Stages Most Influential to Achieving Biodiversity Targets

Figure 1: SSE Renewables BNG Tool Scoring Baseline Matrix

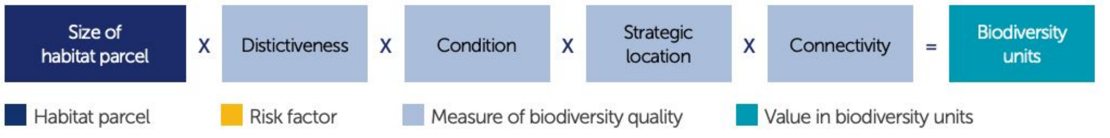


Figure 2: SSE Renewables Site Optioneering Toolkit Results

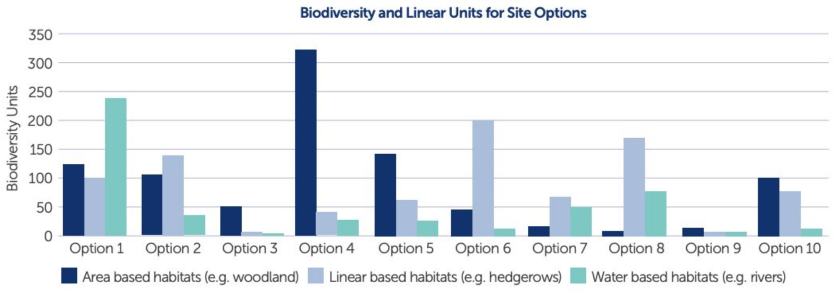
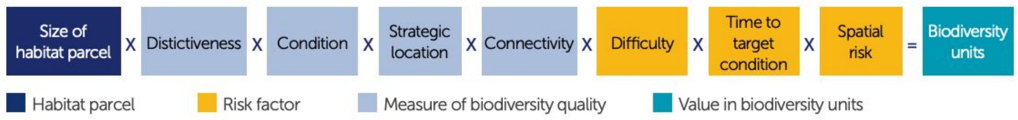


Figure 3: SSE Renewables BNG Toolkit Net Change Scoring Matrix

POST-intervention biodiversity calculation (for newly created habitat)



The final stage of the assessment is to compare the number of Biodiversity Units on the site before development against the number of Biodiversity Units after the development has been completed. This provides the overall percentage of net loss or net gain.

POST units - PRE units = Outcome

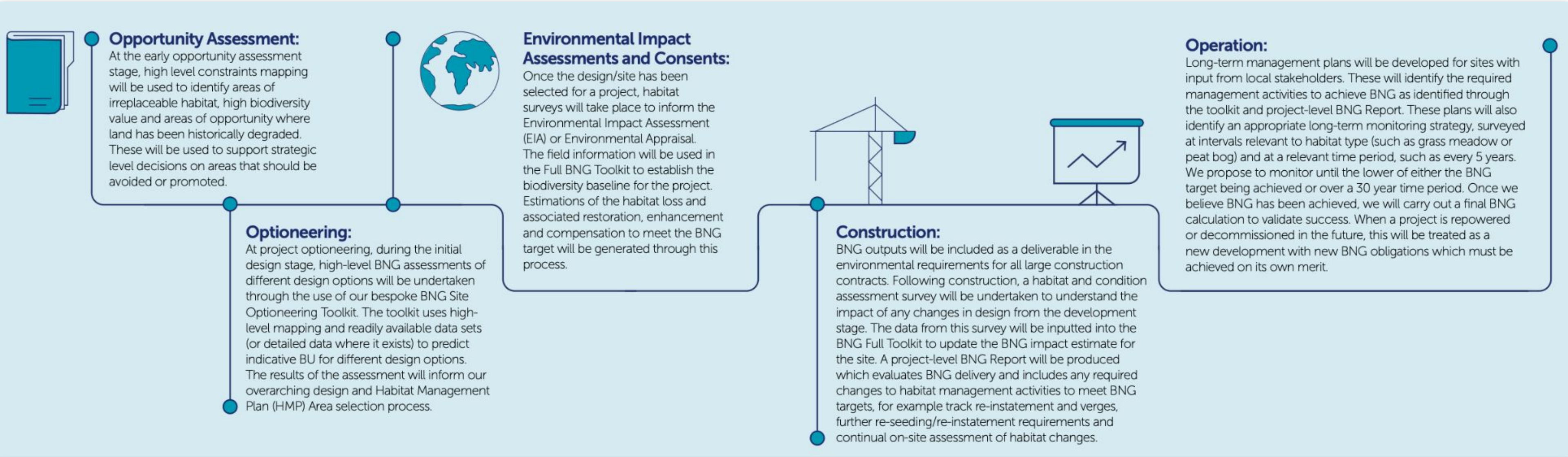
Establishing baseline

Using Site Optioneering Toolkit to compare estimation of habitat creation or enhancement required to meet NNL/NBG targets at each site and identify biodiversity hotspots

Calculate overall percentage of net loss or net gain

Source:
https://www.sserenewables.com/media/vgsdoav3/sser-biodiversity-net-gain-report-nov-2022-final.pdf

How SSE embeds BNG through Each Stage of a Project Lifecycle



High level constraints mapping	High level BNG assessments of design options	EIA info to establish baseline & ways to meet BNG target	BNG Report on delivery and required changes to meet target	Monitor & validate BNG success

Source: https://www.sserenewables.com/media/vgsdoav3/sser-biodiversity-net-gain-report-nov-2022-final.pdf

Floating Solar

Floating solar photovoltaic (FPV) systems, also called **floating solar farms**, are installed on water bodies such as reservoirs, lakes, and coastal areas. These systems help generate renewable energy while minimizing land use.

Source: Floating Solar

International Standards & Guidelines	Regional Regulations	Measures to achieve NNL / NPI
1. International Energy Agency (IEA) Floating Solar Guidelines - Avoid ecologically sensitive areas - Requires biodiversity impact assessments before deployment	**1. European Union Renewable Energy Directive (EU RED II)** - Mandatory EIA assessment for project above 1 MW	**1. Co-Existence with Aquatic Ecosystems** - De Krim Floating Solar Farm (Netherlands) - use suspended anchoring system; includes aquatic corridors - Yamakura Dam Floating Solar (Japan) - installed artificial reservoir; use non-toxic and UV resistant floating platforms
2. World Bank Floating Solar Handbook for Practitioners - Guidelines on site selection, environmental impact & water resource management - Promotes co-existence of solar farms with aquaculture & wetland conservation	**2. U.S. Environmental Protection Agency (EPA) Water Quality Standards** - Prevent projects from harming aquatic ecosystems / reduce water oxygen level - Mandates stormwater runoff controls	**2. Sustainable Design & Material Use** - Tengeh Floating Solar Farm (Singapore) - uses eco-friendly buoyancy structures - Huainan Floating Solar (China) - integrate solar with aquaculture systems

Sources: Floating Solar

Appendix Catalog

1. Interview Takeaways
2. Key Trade-offs
3. Regulations & Practices Related to NNL/NPI
    a. US
    b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. **Baseline Assessment**
6. Additional Resources

Baseline Biodiversity Assessment Strategies

Purpose:

- Characterize existing biodiversity and ecosystem conditions.
- Identify **critical habitats**, **species of concern**, and **ecosystem services**.
- Establish a reference point for **impact prediction**, **mitigation**, and **future monitoring**.

Components of Baseline Assessment

Biodiversity Element	Key Consideration	Tools & Methods
Seabirds	Migration, foraging, nesting, flight altitude	Aerial Surveys, radar, satellite tagging
Marine mammals	Migration, feeding, breeding	Acoustic monitoring, boat surveys, tagging
Fish & Shellfish	Spawning grounds, nursery areas	Trawls, sonar, baited underwater video (BRUVs)
Benthic Communities	Coral, sponge, invertebrate habitats	Grab sampling, ROVs, sediment coring
Marine Flora	Seagrass, kelp, algae	Diver surveys, remote sensing, sonar
Habitat Mapping	Reefs, sandbanks, sediment types	Multibeam sonar, GIS habitat classification
Ecosystem Services	Fisheries, coastal protection, tourism	Stakeholder interviews, socio-economic analysis

Tools	Methods
1. Aerial Surveys	● Detect wildlife, especially seabirds and mammals through observation from aircraft ● Use for mapping species distribution, flight altitude, migration routes ● Helps identify collision risks and important foraging areas.
2. Radar	● Track flying animals through terrestrial/marine radar system ● Use for measuring flight height, direction, and density ● Helps understanding bird behaviour near collision risk zones
3. Satellite Tagging	● Attach GPS/satellite-based devices to animals ● Use for tracking long-distance movements and habitat ● Helps to identify key migratory corridors and stopover habitats impacted by OSW
4. Acoustic Monitoring	● Detect Vocalizations / echolocation clicks through hydrophones ● Use for monitoring marine mammal presence, behavior and noise disturbance ● Helps to detect elusive or nocturnal species in a non-intrusive way
5. Boat Surveys	● Count and identify marine fauna through visual line-transect surveys ● Use for estimating abundance and species distribution ● Helps to complement aerial and acoustic data
6. Tagging (Marine Animals)	● Attach physical / electronic tags to fish or marine mammals ● Use for tracking movements, migration, habitat use, depth profiles ● Helps to provide behavioral and spatial data across seasons and locations

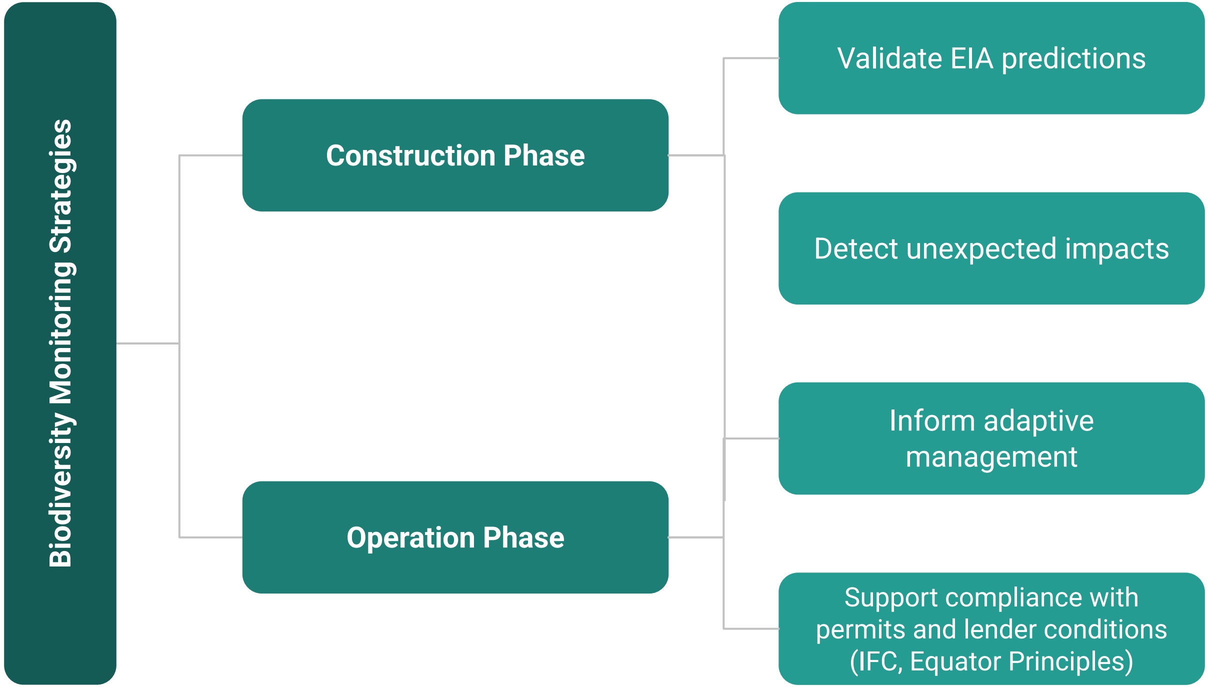
Tools	Methods
7. Trawls	● Capture fish and invertebrates by net dragged through water / along seabed ● Use for sampling species composition, size distribution, and abundance ● Helps define spawning and nursery grounds and assess fishery impacts
8. Sonar	● Map underwater objects or detect fish schools ● Use for locating fish, seabed features, and habitat structures ● Helps in habitat mapping and behavioral studies without capture
9. Baited Remote Underwater Video	● Attract and record fish and invertebrates through baited underwater camera ● Use for monitoring species diversity and behavior in a non-invasive way ● Helps to minimize disturbance while capturing data on cryptic/wary species
10. Grab Sampling	● Collect sediment and benthic organisms from seabed through metal grab/scoop ● Use to analyze benthic community composition and sediment types ● Helps to understand seafloor ecology and baseline conditions
11. Remotely Operated Vehicles (ROVs)	● Underwater robots equipped with cameras and sensors ● Use for visual surveys of hard-to-reach habitats ● Helps to observe with high resolution with minimal disturbance
12. Sediment Coring	● Cylindrical samplers that extract vertical sections of seabed sediment ● Use for analyzing sediment layers, chemical properties, and historical deposits ● Helps to assess sediment health, pollution levels, and habitat characteristics

Tools	Methods
13. Diver Surveys	● SCUBA divers visually inspect and record marine flora and fauna ● Use for assessing kelp forests, seagrass beds, and benthic liffe ● Helps to observe directly, particularly in shallow and high diversity zones
14. Remote Sensing	● Satellite or aerial imagery analysis for large-scale environmental data ● Use for monitoring vegetation, turbidity, water quality, shoreline change ● Helps to provide broad spatial coverage, especially useful for habitat change detection
15. Multibeam Sonar	● Create detailed 3D maps of the seafloor through emitting multiple sonar beams ● Use for bathymetric mapping and identifying habitat features ● Helps to plan turbine placement and understand benthic habitats
17. Stakeholder Interviews	● Engaging local communities, fishers, and marine users to understand localized knowledge from different aspects ● Use for identifying ecosystem services, cultural values, and local biodiversity knowledge ● Helps to incorporate socio-ecological dimensions and supports just transition principles
18. Socio-economic Analysis	● Quantitative and qualitative assessment of livelihoods, fisheries, and tourism ● Use for valuing ecosystem services, assessing potential impacts on human well-being ● Helps to ensure biodiversity protection aligns with community resilience and benefit-sharing

Scope

Scope	Details
1.Temporal Scope	● Multi-seasonal studies to capture seasonal migrations, breeding cycles, and interannual variability
2. Spatial Scope	● Project footprint + buffer zones ● Include cable routes, ports, and vessel corridors
3. Data Sources	● Field surveys (primary) ● Remote sensing (satelite, drones) ● Existing databases (IUCN, GBIF, EU Natura 2000) ● Traditional/local ecological knowledge

Biodiversity Monitoring Strategies



Construction Phase Monitoring

Impact Source	Monitoring Focus	Strategy / Technique
Pile driving (noise)	Marine mammal disturbance, injury	Passive Acoustic Monitoring protocols
Turbidity / dredging	Sediment spread, coral/sponge damage	Water quality sensors, turbidity buoys
Vessel Traffic	Collision risk, underwater noise	AIS tracking, marine fauna observation
Habitat Disruption	Seafloor disturbance, reef impacts	Benthic surveys before/after installation

Operational Phase Monitoring

Component	Focus	Methods
Turbine Presence	Bird collisions, displacement	Radar, GPS tagging
Electromagnetic fields	Fish behavioral change	EMF sensors, behavioral field experiments
Artificial reefs	Colonization by benthic organisms	ROV visual surveys, species counts
Vessel O&M impacts	Ongoing noise, pollution	Acoustic loggers, water sampling

Tools	Methods
1.Passive Acoustic Monitoring (PAM)	● Detect marine mammal vocalizations using underwater microphones (hydrophones) ● Helps to avoid harmful exposure through using non-invasive detection of dolphins, whales, porpoises during noisy construction.
2. Soft-start Protocols	● Increase construction noise gradually through ramping up pile driving ● Provide buffer time to allow marine animals to move away from the site before full-volume noise starts.
3. Water Quality Sensors	● Measure turbidity, pH value, salinity and other water properties ● Helps detecting sediment plumes and chemical changes caused by dredging or drilling - harm coral and benthic organisms
4. Turbidity Buoys	● Monitor water cloudiness through floating devices equipped with sensors ● Helps to provide real-time alerts if sediment go beyond environmental thresholds - protect sensitive habitats
5. AIS Tracking (Automatic Identification System)	● GPS-based tracking of vessel movements ● Helps to monitor and manage vessel routes to prevent collision with marine fauna and avoid sensitives area
6. Marine Fauna Observation	● Visual surveys conducted by trained observers onboard vessels ● Helps to detect presence of marine mammals or large fish in construction areas - shutdowns will be triggered if needed

Tools	Methods
7. Benthic Surveys (Before / After)	● Use grabs, core, or ROVs - Sampling & visual inspection of seafloor habitats ● Helps to assess the condition and changes to benthic communities due to seabed disturbance = cabling, foundation, placement
8. Radar	● Track bird and bat movements using terrestrial or marine-based radar ● Helps to measure flight height, direction, and density around turbines to assess collision or displacement risk
9. Carcass Searchers	● Systematic search for bird/bat fatalities beneath turbines - applicable on land/floating platforms ● Helps to provide direct evidence of mortality, often used with other data
10. GPS Tagging	● Small tracking devices attached to birds or marine mammals ● Helps to reveal habitat use, migration patterns, and interactions with wind farms
11. EMF Sensors	● Measure electromagnetic fields around subsea cables ● Helps to assess exposure of fish or invertebrates to artificial EMF that could affect navigation / behavior
12. Behavioral Field Experiments	● Controlled experiments or observational studies to see how animals react to EMF, noise or new structures ● Helps to identify subtle or chronic effects that are not visible in direct counts

Tools	Methods
13. ROV Visual Surveys	● Inspect turbine foundations and seafloor using remotely operated vehicles ● Helps to monitor colonization by marine life or artificial structures, indicating potential reef effects
14. Species Counts	● Quantitative surveys of fish, invertebrates, or plants - using video, dive or sampling ● Helps to track changes in biodiversity and abundance due to habitat alteration or reef creation
15. Acoustic Loggers	● Track ambient and anthropogenic noise over time using stationary underwater recorders ● Helps to monitor operational noise levels from turbines and vessels, and long-term effects on marine animals
16. Water Sampling	● Collection of water for lab analysis of pollutants, nutrients, or biological indicators ● Helps to detect pollution from vessel operations or maintenance activities

Adaptive Monitoring & Management

- Monitoring data feeds into a **feedback loop**:

  1. Measure actual impacts
  2. Compare with predicted impacts
  3. Adjust mitigation measures
  4. Communicate findings to regulators and stakeholders

- Example: **If seabird collision rates are higher than expected**, project developers might:
  a. Adjust lighting to reduce attraction
  b. Shut down turbines during peak migration

Standards and Guidelines

- **Standards**
    a. **IFC PS6** – Critical habitat, ecosystem services, mitigation hierarchy
    EU Habitats/Birds Directives – Natura 2000 impact assessments
    b. **IUCN Guidelines** – Biodiversity Offsets, Red List species
    c. **Marine Strategy Framework Directive (MSFD)** – Baselines for GES

- **Guidance Documents**
    a. **IEA Ocean Energy Systems (OES)** guidelines
    b. **European Commission EIA Guidance for Offshore Wind Farms**
    c. **JNCC (UK): Post-construction monitoring protocols for seabirds/marine mammals**

Appendix Catalog

1. Interview Takeaways
2. Key Trade-offs
3. Regulations & Practices Related to NNL/NPI
   a. US
   b. International (incl. Case Studies)
4. Case Studies of Other Industries
5. Baseline Assessment
6. **Additional Resources**

International Regulations & Practices for Non Price Criteria

Country	Avoid & Reduce & Mitigate	Restore & Regenerate	Environmental Monitoring & Information Sharing
France	- ERC Criterion Avoidance (Éviter), Reduction (Réduire), and Compensation (Compenser) - Recycling and Reuse Targets (80-100%) - Carbon Footprint Requirement	- Monitoring in the environmental criterion (for floating wind) - Fund intended to finance actions to preserve the biodiversity potentially impacted by the project	
Germany	- Specific qualitative criterion for noise levels		
Netherlands	- Conservation of birds - Noise level threshold - Promote positive effects on the conservation of marine habitat in the Dutch North Sea	- Strengthening and restoring underwater nature, marine ecosystems and naturally occurring diversity of benthos in the wind farm area, and to contribute to knowledge development to reduce negative ecological effects and strengthen positive ecological effects in the wind farm area	- Knowledge and experience are shared to contribute to knowledge gaps (including EIA)
Denmark	- Noise level threshold	- Develop and complete nature positive initiatives	- Environmental impact monitoring program

Source: Non price criteria as sustainability and social measures in offshore wind prequalification and auction design

Residential Development & Biodiversity Metric Tool

Biodiversity metric (statutory biodiversity metric calculation) tool can guide residential developments to achieve biodiversity net gain by calculating changes in '**area habitat biodiversity units'** and **'hedgerow biodiversity units**' associated with on-site and off-site habitat loss, creation, and enhancement.

Source: Statutory biodiversity metric tools and guides - GOV.UK

This Case Study Demonstrates

- The use of the biodiversity metric tool to calculate changes in ‘area habitat biodiversity units’ and ‘hedgerow biodiversity units'.
- The use of the biodiversity metric tool to inform a project’s design choices.
- The use of off-site habitat creation and enhancement and the spatial risk multiplier in the biodiversity metric tool.
- The application of the 70:30 ratio of ‘developed land, sealed surface’ to ‘vegetated garden’ within the biodiversity metric tool when assessing habitats within areas outlined for housing.

Source: [Case Study]

Baseline Biodiversity Units: Any Expected Biodiversity Unit Losses and Gains Are Measured Against This Baseline

Habitat type	Area (ha)	Habitat Distinctiveness	Habitat Condition	Strategic Significance	Baseline biodiversity units
Modified grassland	2.6	Low	Poor	Low	5.20
Other woodland; broadleaved	0.53	Medium	Poor	High	2.44
Other neutral grassland	0.52	Medium	Poor	Low	2.08
Other woodland; broadleaved	0.19	Medium	Moderate	High	1.75
Bramble scrub	0.16	Medium	Condition Assessment N/A	Low	0.64
Total	4 ha	-	-	-	12.11

Table 1. Number of biodiversity units for area habitats on-site at baseline.

Source: [Statutory biodiversity metric tools and guides - GOV.UK](#)

Baseline Biodiversity Units: Any Expected Biodiversity Unit Losses and Gains Are Measured Against This Baseline

Habitat type	Length (km)	Habitat Distinctiveness	Habitat Condition	Strategic Significance	Baseline biodiversity units
Species-rich native hedgerow	0.14	Medium	Moderate	High	1.29
Species-rich native hedgerow with trees	0.04	High	Moderate	High	0.55
Line of trees	0.01	Low	Good	High	0.07
Totals	0.19	-	-	-	1.91

Table 2. Number of biodiversity units for hedgerows on-site at baseline.

Source: [Statutory biodiversity metric tools and guides - GOV.UK]

Scenario 1 vs Scenario 2 - Losses and Gains in Area Habitat Biodiversity Units

With Biodiversity Metric Tools

Table 3. Scenario 1 - Losses and gains in area habitat biodiversity units

Description	Area habitat biodiversity units
On-site baseline	12.11
On-site enhancement and creation of area habitats Habitat enhancement: • 0.53 ha of 'other woodland; broadleaved' from poor to moderate condition, of high strategic significance • 0.77 ha 'modified grassland' from poor to moderate condition, of low strategic significance Habitat creation – all low strategic significance: • 0.78 ha of 'vegetated gardens' – 'Condition Assessment N/A' • 1.82 ha of 'developed land; sealed surface' – condition 'N/A – Other' • 0.1 ha 'intensive green roof' in good condition	8.77
Net change in on-site area habitat biodiversity units	-3.33
Off-site baseline area habitat biodiversity units	2.40
Off-site enhancement and creation of area habitats Habitat enhancement – all low strategic significance: • 0.7 ha of 'modified grassland' in poor condition to 'other neutral grassland' in moderate condition Habitat creation: • 0.4 ha of 'other woodland; broadleaved' in moderate condition, of high strategic significance • 0.1 ha of 'mixed scrub' in moderate condition, of low strategic significance	7.17
Net change in off-site area habitat biodiversity units	+4.77
Total net gain in area habitat biodiversity units	+1.43
Overall percentage net change in area habitat biodiversity units	+11.83%

Without Biodiversity Metric Tools

Table 5. Scenario 2 – Losses and gains in area habitat biodiversity units

Description	Area habitat biodiversity units
On-site baseline	12.11
On-site enhancement and creation of area habitats Habitat enhancement: • 0.42 ha of 'other neutral grassland' from poor to good condition, low strategic significance • 0.16 ha of 'bramble scrub' to 'mixed scrub' in good condition, low strategic significance • 0.19 ha of 'other woodland; broadleaved' from moderate to good condition, high strategic significance • 0.53 ha of 'other woodland; broadleaved' from poor to moderate condition, high strategic significance Habitat creation – all low strategic significance: • 0.78 ha of 'vegetated gardens' – 'Condition Assessment N/A' • 1.82 ha of 'developed land; sealed surface' – condition 'N/A-Other' • 0.1 ha 'intensive green roof' in good condition	13.70
Net change in on-site area habitat biodiversity units	+1.59
Off-site baseline area habitat biodiversity units	+13.15%

Source: [Statutory biodiversity metric tools and guides - GOV.UK]

COL School

Scenario 1 vs Scenario 2 - Losses and Gains in Area Habitat Biodiversity Units

With Biodiversity Metric Tools

Table 4. Scenario 1 – Losses and gains in hedgerow biodiversity units

Description	Hedgerow biodiversity units
On-site baseline	1.91
On-site created and enhanced hedgerow habitats – all high strategic significance Hedgerow enhancement: • 0.05 km of 'species-rich native hedgerow' enhanced to good condition Hedgerow creation: • 0.07 km of 'species-rich native hedgerow with trees' in good condition • 0.08 km of 'species-rich native hedgerow' in good condition • 0.02 km 'line of trees' in moderate condition	2.15
Total net gain in hedgerow biodiversity units	+0.24
Overall percentage net change in hedgerow biodiversity units	+12.62%

Without Biodiversity Metric Tools

Table 6. Scenario 2 – Losses and gains in hedgerow biodiversity units

Description	Hedgerow biodiversity units
On-site baseline	1.91
On-site hedgerow creation and enhancement – all high strategic significance Hedgerow enhancement • 0.05 km of 'species-rich native hedgerow' enhanced to good condition Hedgerow creation: • 0.07 km of 'species-rich native hedgerow with trees' in good condition • 0.08 km of 'species-rich native hedgerow' in good condition • 0.02 km 'line of trees' in moderate condition	2.15
Total net gain in hedgerow biodiversity units	+0.24
Overall percentage net change in hedgerow biodiversity units	+12.62%

Source: [Statutory biodiversity metric tools and guides - GOV.UK]

What Makes the Difference

Scenario 1: The "Build First, Worry Later" Approach

- You **design the neighborhood** without using the **Biodiversity Metric Tool**.
- You **clear the land indiscriminately**, cutting down trees, removing hedgerows, and flattening the grasslands.
- After the houses are built, you realize that **biodiversity has decreased**, meaning fewer birds, bees, and natural vegetation remain.
- To fix this, the government **requires you to compensate** by creating or improving habitats **off-site** (on another piece of land somewhere else).
- This **costs extra money** and **adds complexity** because you now have to manage another area far from the development.

Scenario 2: The "Plan with Nature" Approach

- Before designing, you **use the Biodiversity Metric Tool** to analyze the land's biodiversity value.
- The tool **identifies high-value areas** that should be preserved (e.g., woodlands, important hedgerows).
- Instead of **clearing everything**, you **adjust the neighborhood design**:
    - Houses are placed where biodiversity loss will be minimal.
    - Key habitats (woodlands, hedgerows) are **retained and enhanced**.
    - Additional **green spaces and gardens** are included to **support biodiversity**.
- As a result, the development meets the **biodiversity net gain requirement on-site**, meaning:
    - **No need for costly off-site compensation**.
    - **A more nature-friendly neighborhood** with built-in green spaces.
    - The **government sees this as a well-planned, responsible development**.

Source: *Statutory biodiversity metric tools and guides - GOV.UK*

Key Takeaways

- Scenario 1 loses too much biodiversity and requires expensive off-site fixes.
- Scenario 2 preserves and enhances biodiversity on-site, making it more cost-effective and sustainable.
- Using the biodiversity metric tool early allows better planning, reducing environmental harm before construction begins.

Source: Statutory biodiversity metric tools and guides - GOV.UK

Integrating WCS COMBO Biodiversity Insights in Offshore Wind Projects

Holistic Data Collection:

- Include species, ecosystems, condition, conservation status, spatial relationships, and temporal trends.

Enhanced Baseline Assessments:

- Combine detailed inventories and ecosystem integrity metrics with spatial risk screening.

Gap Analysis & Data Expansion:

- Identify and address deficiencies in biodiversity data to inform better decision-making.

Collaborative Public Platforms:

- Develop and maintain accessible, regularly updated online biodiversity portals.

Informed Mitigation Strategies:

- Use integrated biodiversity data to refine site selection and tailor mitigation measures.

Source: WCS Combo