ECOWind

Offshore Wind Policy and Delivery Landscape

April 2023 update

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THE CROWN ESTATE

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ECOWind Programme: Offshore Wind Policy and Delivery Landscape – April 2023 update

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2 Introduction

The Ecological Consequences of Offshore Wind (ECOWind) Programme is a four-year programme (2022 – 2025) which seeks to address critical gaps in understanding how large-scale expansion of UK offshore wind infrastructure affects marine ecosystems. In doing so, the programme seeks to inform decision making and outcomes which minimise negative impacts and harness positive impacts and opportunities. ECOWind is a co-designed partnership between the Natural Environment Research Council (NERC), the Crown Estate (TCE) and Defra.

ECOWind has three core objectives:

- To understand how interactions between species are affected by offshore wind, and what this means for populations.
- To enhance marine observations through innovative technology to inform understanding of the effects of offshore wind on marine life.
- To use the knowledge gained from these first two objectives to inform marine policy and management, including net gain and marine environmental restoration.

This report identifies existing and upcoming offshore wind policies and projects, their timelines and opportunity areas for research impact in the UK. It covers the following:

- An overview of the offshore wind-related policy and project delivery landscape in the UK, setting out key changes and targets across departments and delivery bodies.
- Timelines for delivering these policies and projects.
- Key opportunity areas and stakeholders to engage with for offshore wind research/ECOWind to create impact and add value for optimal outcomes for offshore wind farm delivery, climate and marine life.

3 Offshore wind projects and delivery landscape

2.1 UK Offshore Wind Pipeline Summary

Aspirations for offshore wind in the UK are high, both to meet the demands of the British Energy Security Strategy and the UK's international climate change obligations. The UK offshore windfarms already in operation, construction and planning will help put the UK on track to meet the government target for 50GW of offshore wind capacity by 2030.

In addition to this government target there is a potential need for up to 140GW of offshore wind by 2050 to meet the requirements identified by the Climate Change Committee[1]. This additional aspiration means that more than 50% of the future offshore wind portfolio has yet to be identified within an increasingly busy sea space (Figure 1). In order to meet these targets without significantly impacting biodiversity and affecting other sea users will require coordinated and strategic approaches to understanding our marine environment in decision making.

[1] https://www.theccc.org.uk/publication/sixth-carbon-budget

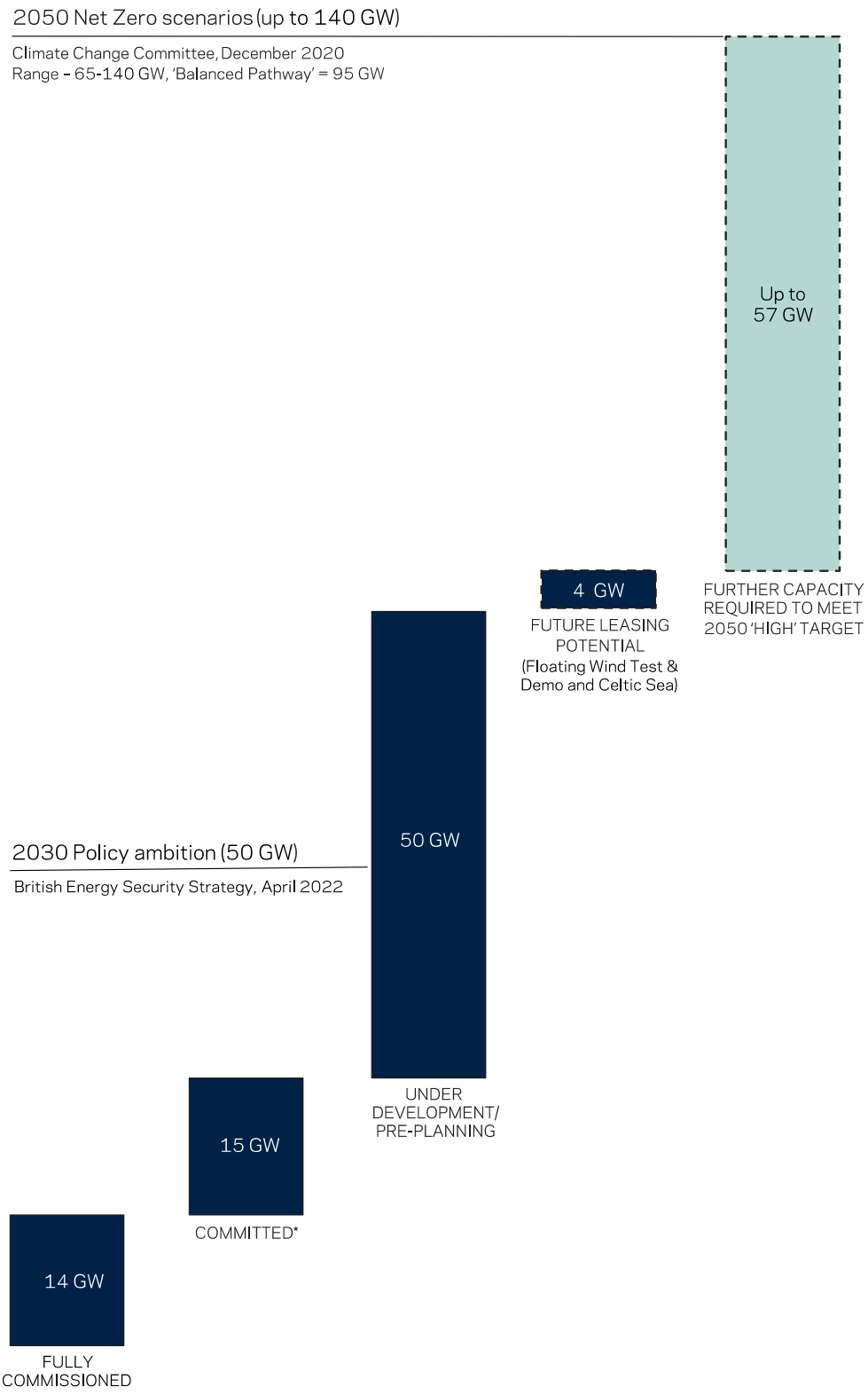


Figure 1. 2050 Net zero scenarios[2]

[2] https://www.thecrownestate.co.uk/media/4213/overview-of-uk-offshore-wind-portfolio.pdf

In 2020 TCE undertook a key resource area study to determine where future potential might lie for both fixed and floating wind[3] in England, Wales and Northern Ireland. Data and insights from this study have informed conversations about the sustainable growth of the offshore wind industry in these areas. In 2020, Scottish Government published an updated sectoral marine plan for offshore wind energy in Scotland which aims to identify sustainable plan options for the future development of offshore wind farms in both inshore and offshore waters[4]. The plan provides the spatial strategy to support the Crown Estate Scotland's (CES) ScotWind leasing round, the first offshore wind leasing round to be administered in Scotland. It is also important to be aware that Round 1 offshore wind farms will be considering repowering or decommissioning options over the next decade. A full list of UK offshore wind farm projects, from leasing rounds through to operational phases can be found on TCE website, including rights granted by CES[5].

3.2 Round 3

TCE offshore wind leasing Round 3 was launched in 2008 with the ambition to provide up to 25GW generating capacity in fixed offshore wind across England, and Wales. There are currently the following projects within Round 3:

- SSE Renewables, Equinor and Vårgrønn
  - Dogger Bank A, B and C
- Ørsted
  - Hornsea 1 – East, Central, West
  - Hornsea Project Two, Three and Four
- Iberdrola group
  - East Anglia One, One North, Two and Three
- Vattenfall
  - Norfolk Vanguard East and West
  - Norfolk Boreas
- RWE Renewables
  - Rampion
  - Sofia

The majority of these projects are in the North Sea[6] and have either been consented, are under construction, or are going through the planning system. In Scottish waters, two round 3 sites are being progressed; The Firth of Forth Offshore Windfarm Zone and the Moray Firth Offshore Windfarm Zone.

3.2.1 Developer timelines

See Appendix 1.

3.2.2 Entry points for research impact

The priority opportunity areas where ECOWind can create impact include:

[3] https://www.thecrownestate.co.uk/media/3642/broad-horizons-offshore-wind-key-resource-area-summary-report.pdf
[4] https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/documents/
[5] https://www.thecrownestate.co.uk/media/3954/offshore-wind-project-listing.pdf
[6] https://www.thecrownestate.co.uk/media/2970/ei-round-3-offshore-wind-a4.pdf

- Contributing to the evidence base behind project level Habitats Regulation Assessment (HRA) undertaken as part of Development Consent Order (DCO) determination. This also strongly links to strategic compensation agreement discussed in section 3.6.
- Understanding how monitoring of sites and regions can be done in a more strategic, cost-effective manner.
- Sharing data between operators and ECOWind projects to develop a more robust, unified evidence base.

3.3 Round 3 extension

In February 2017 The Crown Estate launched an opportunity for existing wind farms to apply for project extensions[7]. This opportunity closed in May 2018, with eight project applications received. Since then, The Crown Estate has undertaken a plan level HRA, to assess the possible impact of the proposed windfarm extensions on relevant nature conservation sites of European importance.

In August 2019, The Crown Estate announced the conclusion of the HRA, confirming that seven of the 2017 extension application projects, representing a total generating capacity of 2.85GW, would progress to the award of development rights.

These projects are:

- Sheringham Shoal offshore wind farm
- Dudgeon offshore wind farm
- Greater Gabbard offshore wind farm
- Galloper offshore wind farm
- Rampion offshore wind farm
- Gwynt y Môr offshore wind farm
- Thanet offshore wind farm

As part of the 2017 extension opportunity, The Crown Estate also received an application for Race Bank extension project. The majority of the site for this proposed extension sits within the Inner Dowsing, Race Bank and North Ridge Special Area of Conservation (SAC). Based on the best available evidence, the plan level HRA determined that it would not be possible to rule out an adverse effect on the integrity of the SAC. The Race Bank extension project will therefore not progress to the award of leasing rights as part of the 2017 extensions round. The developers of the seven approved extensions listed above are now progressing with project specific environmental assessments, surveys and planning applications to support planning consent for their projects through the statutory planning process.

3.3.1 Developer timelines

Round 3 extension projects are likely to be submitted for examination in 2023/24, with several having submitted planning applications as of Spring 2023. Timelines align with Round 3 (see Appendix 1).

[7] Previously, between 2014 - 2016, five round 1 and 2 offshore wind farm sites were granted extensions by TCE.

2.3.2 Entry points for research impact

The priority opportunities areas where ECOWind can create impact include:

- Contributing to the evidence base behind project level HRA undertaken as part of DCO determination. This also strongly links to strategic compensation agreement discussed in section 3.6.
- Understanding how monitoring of sites and regions can be done in a more strategic, cost-effective manner.
- Sharing data between operators and ECOWind projects to develop a more robust, unified evidence base.

3.4 Round 4

TCE's Offshore Wind Leasing Round 4 creates the opportunity for around 8 GW of new offshore wind projects in the waters around England and Wales by the end of the decade (see figure 2).

On 21st April 2022, The Crown Estate gave notice to the UK and Welsh Governments of its intent to proceed with the Offshore Wind Leasing Round 4 plan on the basis of a 'derogation', following the plan-level Habitats Regulations Assessment[8]. The documents associated with the HRA can be found on the Marine Data Exchange[9].

In July 2022, The Secretary of State for Business, Energy and Industrial Strategy provided agreement[10] that The Crown Estate could proceed with the plan on the basis of a derogation, and the Welsh Government did not raised any objections. This means the six Offshore Wind Leasing Round 4 offshore wind projects, representing almost 8GW of potential new capacity, advanced to the next stage of Leasing Round 4, the Agreements for Lease stage. The offshore wind leasing round 4 Agreements for Lease signing for the six new projects concluded in January 2023. Three of these projects are located off the North Wales, Cumbria and Lancashire coast, and three are located in the North Sea off the Yorkshire and Lincolnshire coast.

[8] https://www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/offshore-wind-leasing-round-4/round-4-plan-level-habitats-regulations-assessment/

[9] https://www.marinedataexchange.co.uk/details/3582/2022-the-crown-estate-2020-offshore-wind-round-4-plan-habitats-regulations-assessment/packages

[10] https://www.thecrownestate.co.uk/media/4189/tce-r4-letter-from-secretary-of-state-on-plan-level-hra.pdf

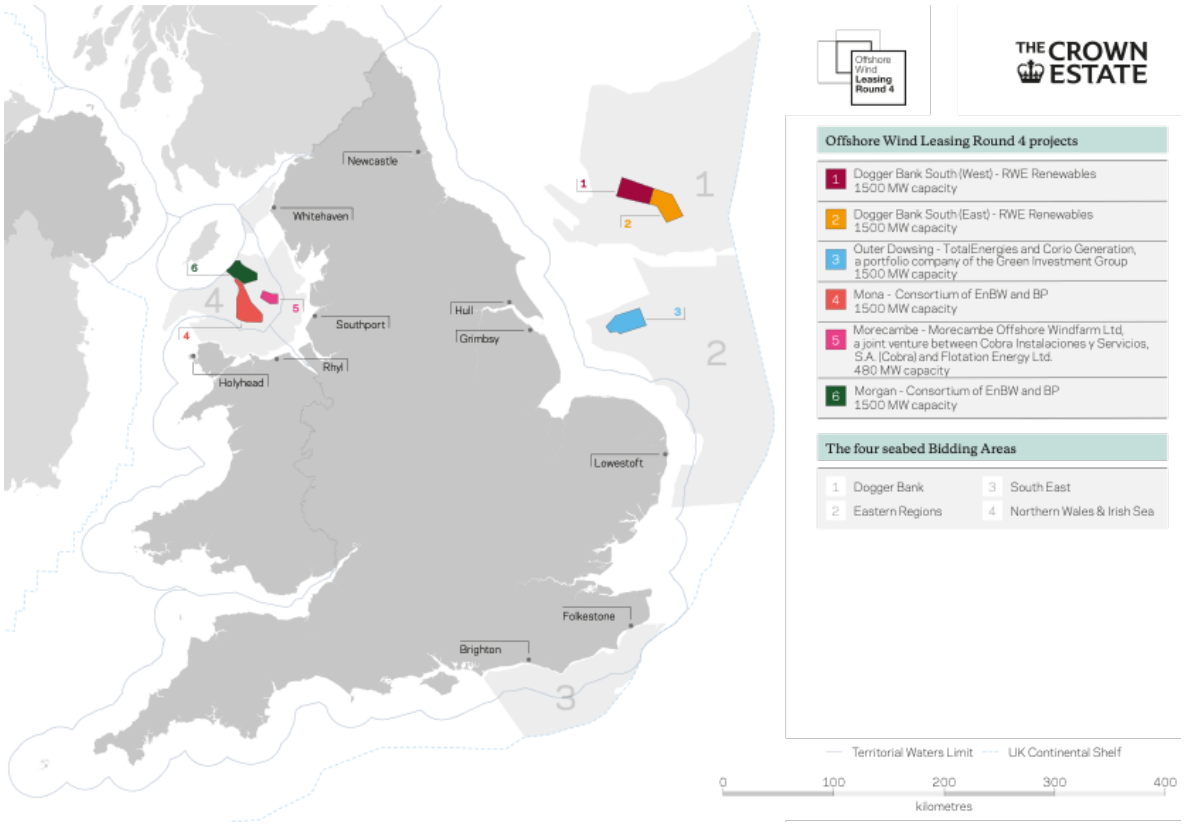


Figure 1. Offshore Wind Leasing Round 4 Projects[11]

3.4.1 Developer timelines

As the timelines for progressing the projects through design, planning and consenting are developer lead, the timelines detailed in Appendix 1 are based on a best guess and do not include any potential changes to the consenting process, namely the intention to speed up the Planning Act process as stated in the British Energy Securing Strategy discussed in section 3.1. Broadly, the consenting process is as follows, but current ambitions are likely to be faster:

- Development and Consenting – 5 years
    - This assumes roughly 3-4 years for EIA, (including the EIA scoping submission) and planning document development prior to the submission of DCO applications.
- Procurement and Contract for Difference (CfD) – 2 years
    - Following securing a DCO consent, projects will make their final investment decisions (FID) and bid for support to build and run wind farms through CfD auctions.
- Construction – 3 years
    - Construction and commissioning of array and export cable assets can be estimated at taking 3 years post CfD and FID.

3.4.2 Entry points for research impact

The priority opportunities where ECOWind can create impact include:

[11] https://www.thecrownestate.co.uk/media/3721/the-crown-estate-offshore-wind-leasing-round-4-selected-projects.pdf

- Plan level monitoring, modelling and assessment of cumulative impacts
- Plan level development of mitigation and compensation measures to address potential impacts
- Development of strategic monitoring approaches and monitoring technologies.
- EIA scoping where research outputs could help to scope project impacts based on enhanced understanding of the ecological impact of offshore wind structures.
- Contributing to the evidence base behind project level HRA undertaken as part of DCO determination. This also strongly links to strategic compensation agreement discussed in section 3.6.

3.5 Celtic Sea Floating Offshore Wind

The Celtic Sea Floating Offshore Wind leasing round (FLOW) aims to contribute to the Government's ambition to deliver up to 5GW of floating wind by 2030. TCE will be inviting full commercial scale, 1GW projects, which may be developed in a phased or 'stepping stone' approach. Recognising the need to develop the UK supply chain and supporting infrastructure for this nascent technology, this approach is deliberately intended to provide opportunities for growth and investment and to facilitate the co-ordination of the necessary infrastructure, such as ports and grid connections – all of which are key to the sustainable development of the UK floating wind sector over the long term.

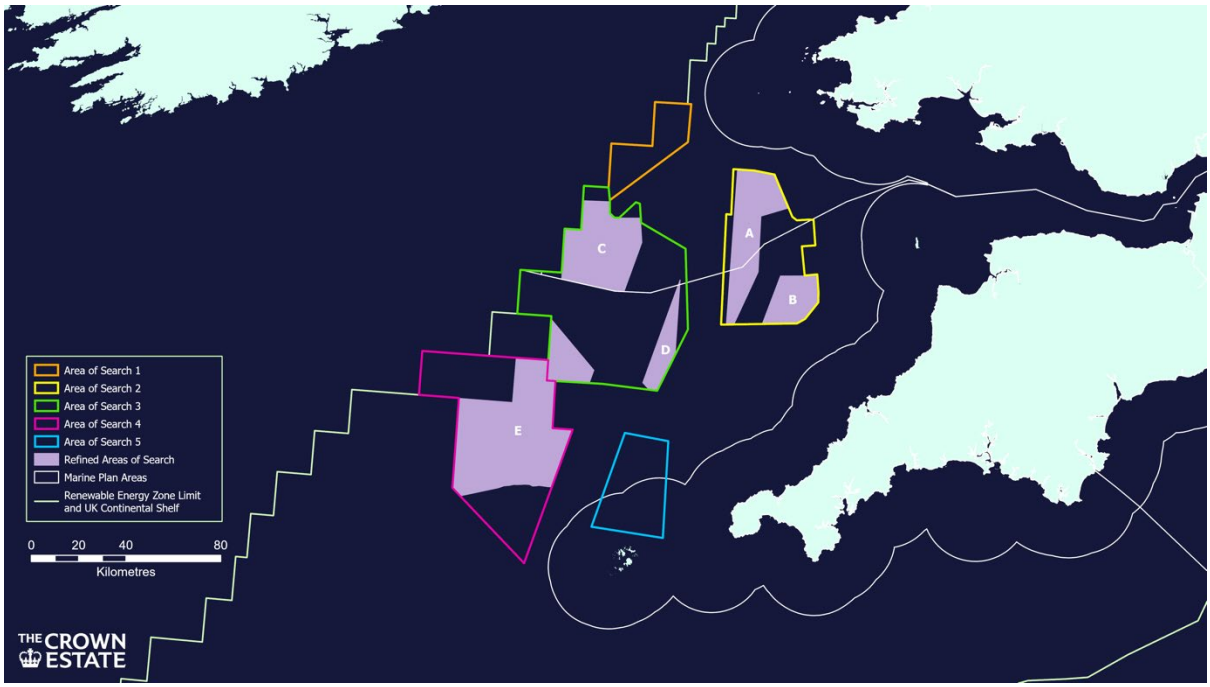


Figure 2. FLOW Areas of Search

Figure 3 above presents five Refined Areas of Search located within three of the original five broad Areas of Search. The initial broad areas of search were presented to stakeholders and

underwent further analysis to arrive at the refined areas[12]. More details on this map can be viewed via TCE's GIS portal[13]. Shapefiles can also be downloaded[14].

The Refined Areas of Search shown above will be further refined over the coming months into potential Project Development Areas, in order to ensure that developers have access to locations for floating offshore wind that are expected to be deliverable in the near term. This process will continue to be guided by continued engagement with stakeholders, including fishing communities and environmental groups. Identifying Project Development Areas is being undertaken simultaneously with the plan-level Habitats Regulations Assessment. In mid-2023, the tender process of seabed leasing for floating wind in the Celtic Sea is expected to begin.

3.5.1 Developer timelines

See Appendix 1.

3.5.2 Entry points for research impact

The priority opportunities areas where ECOWind can create impact include:

- Plan level monitoring, modelling and assessment of cumulative impacts
- Plan level development of mitigation and compensation measures to address potential impacts
- Development of strategic monitoring approaches and monitoring technologies.
- EIA scoping where research outputs could help to scope project impacts based on enhanced understanding of the ecological impact of floating offshore wind structures.
- Contributing to the evidence base behind project level HRA undertaken as part of DCO determination. This also strongly links to strategic compensation agreement discussed in section 3.6.

3.6 ScotWind

ScotWind is a programme and process led by Crown Estate Scotland (CES), which will lease areas of the seabed around Scotland for wind farm developments. Developers apply to the scheme and, if successful, are granted the rights to build wind farms in Scottish waters. CES hope that wind farms with as much as 27GW of new generating capacity will be built over the next decade as a product of ScotWind. Scotland already has 14 offshore wind farms with consent granted, six of which are currently operational, but ScotWind was the first round of offshore wind leasing in Scottish waters for a decade, and it is moving at pace.

The ScotWind leasing round has resulted in 20 projects securing seabed option agreements[15] that were announced in 2022, including 13 floating offshore wind projects (see figure 4). These agreements are for up to ten years. CES will offer a full seabed lease (enabling projects to be built and operated) once developers have secured the necessary consents, licences, and finance.

[12] https://www.thecrownestate.co.uk/media/4150/2022-floating-wind-site-selection-methodology-report.pdf
[13] https://thecrownestate.maps.arcgis.com/apps/webappviewer/index.html?id=ab2e4d32744248d98a07f5168f0e8981
[14] https://opendata-thecrownestate.opendata.arcgis.com/
[15] https://www.crownestatescotland.com/resources/documents/scotwind-briefing-november-2022

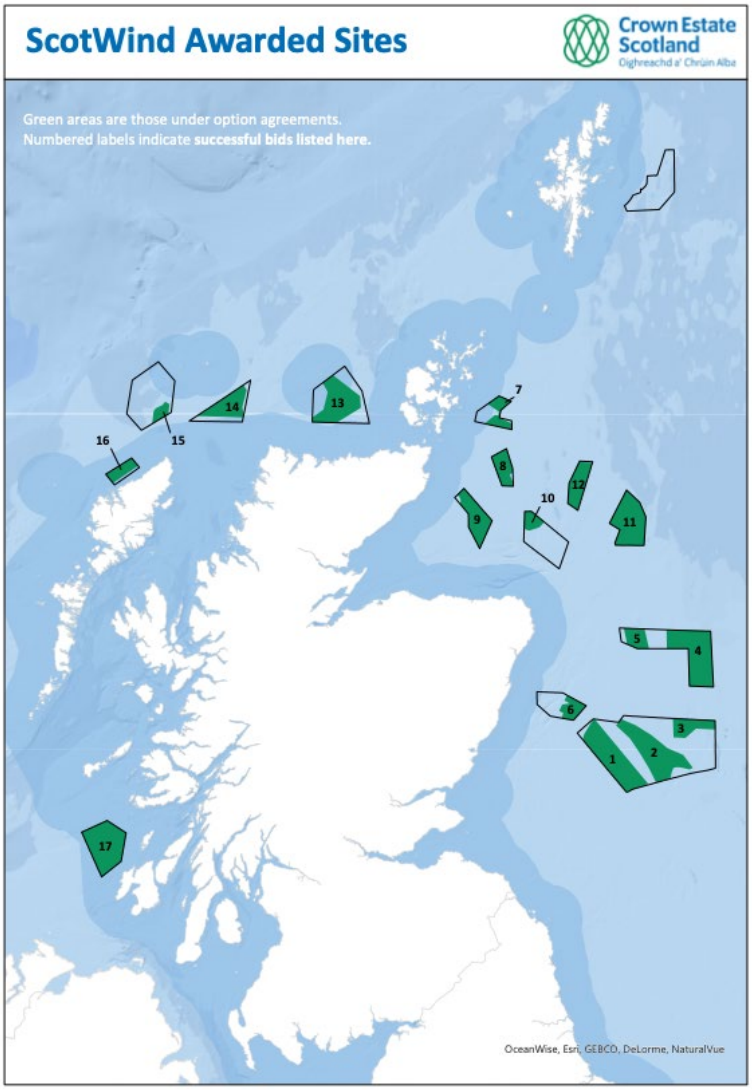


Figure 4. ScotWind awarded sites for future offshore wind farms in Scottish waters.

ScotWind is a 'plan-led' process of seabed leasing for offshore wind. This means that all sites are within the areas of seabed identified in the Scottish Government's Sectoral Marine Plan for Offshore Wind, which was updated and published in 2020.

3.6.1 Developer timelines

The ScotWind projects are expected to be built from the late 2020s onwards, for more details see Appendix 1.

3.6.2 Entry points for research impact

The priority opportunities areas where ECOWind can create impact include:

- Plan level monitoring, modelling and assessment of cumulative impacts
- Evidence into post adoption actions that feed into the iterative plan review process.
- Development of strategic monitoring approaches and monitoring technologies.
- EIA scoping where research outputs could help to scope project impacts based on enhanced understanding of the ecological impact of offshore wind structures.

- Contributing to the evidence base behind project level HRA undertaken as part of DCO determination. This also strongly links to strategic compensation agreement discussed in section 3.6.

3.7 INTOG (Innovation & Targeted Oil & Gas) Leasing Round

The CES-led INTOG leasing process enables offshore wind energy to directly supply offshore oil and gas platforms in the North Sea. The leasing round aims to attract investment in innovative offshore wind projects in Scottish waters, as well as helping to decarbonise North Sea oil and gas operations, and is the first of its kind in the world. Developers apply for seabed rights to develop offshore wind projects that either reduce emissions from the North Sea oil and gas sector by supplying renewable electricity directly to oil and gas infrastructure, or consist of small-scale innovative projects of 100MW or less. The successful applicants were offered initial agreements in March 2023, which, if accepted will allow them to begin development work. 13 out of 19 applications have been offered such initial exclusivity agreements and once the INTOG sectoral marine plan has been finalised, options agreements can be offered. The INTOG projects map is shown in figure 5 below.

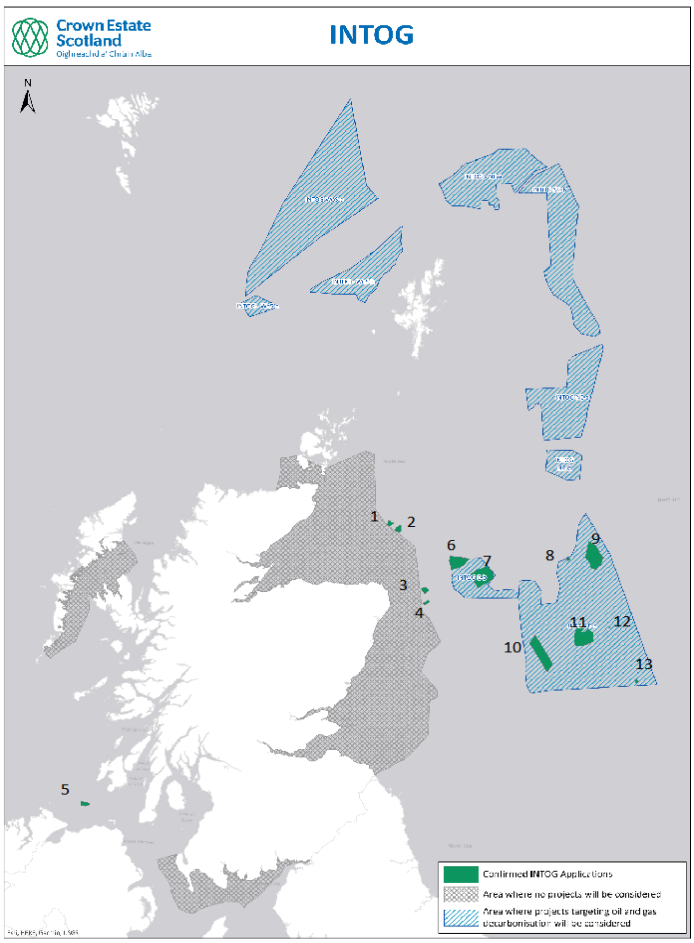


Figure 5. Map of INTOG leasing round offshore wind projects.

4 Offshore Wind Policy and Delivery Landscape

3.1 British Energy Security Strategy

The new British Energy Security Strategy (BESS) seeks to deliver up to 50GW of offshore wind in the UK by 2030, including up to 5GW of innovative floating wind. The UK Government is committed to delivering several policy and institutional changes to achieve this target. These include commitments to cut the process time for delivery by over half by:

- Reducing consent time from up to four years down to one year.
- Strengthening the renewable national policy statements to reflect the importance of energy security and net zero
- Making environmental considerations at a more strategic level allowing process to be sped up while improving the marine environment
- Introducing strategic compensation environmental measures including for projects already in the system to offset environmental effects and reduce delays to projects
- Reviewing the way in which the Habitats Regulations Assessments are carried out for all projects making applications from late 2023 to maintain valued protection for wildlife, whilst reducing reams of paperwork
- Implementing a new offshore wind environmental improvement package including an industry-funded marine recovery fund and nature-based design standards to accelerate deployment whilst enhancing the marine environment
- Working with the offshore wind acceleration task force; a group of industry experts brought together to work with government, Ofgem and national grid on further cutting the timeline
- Establishing a fast-track consenting route for priority cases where quality standards are met, by amending Planning Act 2008 so that the relevant secretary of state can set shorter examination timescales

The scale of offshore wind development and the introduction of new technologies such as floating offshore wind will require innovative approaches to assessing and modelling the impact of offshore wind development on the marine ecosystem including marine mammals, birds, and benthic habitats by examining predator-prey relationships. It is likely that there will be an increase in casework and gathering of evidence to accommodate the determination of projects within UK waters, and to stipulate mitigation, compensation measures and monitoring approaches to support strategic scale decisions.

4.2.1 Timeline for delivery

The Government published the British Energy Security Strategy in April 2022 and formed the new Department for Energy Security and Net Zero in February 2023. The strategy will inform new Renewable National Marine Policy Statements that will be published by the last quarter of 2022. These in turn will set specific targets for the delivery of renewable energy infrastructure and provide a clear indication of the Government's intention to deliver net zero as well as giving practical guidance to planning authorities and industry to facilitate the delivery of renewable energy infrastructure projects.

It is expected that an amendment to the Planning Act will be enacted by September 2023 to fast track the consenting route for priority cases, with approval times no longer than one year.

This will ensure that the relevant Secretary of State can set shorter examination timescales for applications.

The Offshore Wind Environmental Improvement Package (OWEIP) was also announced as part of the BESS and will help accelerate offshore wind deployment whilst continuing to protect the marine environment. The OWEIP will focus on:

- Habitats Regulations Assessment (HRA) reform: to encourage OSW developers to consider measures to mitigate and compensate for offshore wind developments earlier in the DCO process
- Strategic Compensation: to develop and secure adequate plan-level compensatory measures and enable these issues to be settled before a DCO is examined.
- Marine Recovery Fund: establish a fund based on financial contributions from OW developers that would cover the cost of delivery for the strategic compensation measures identified. To be operational by the end of 2023.
- Environmental design standards: design techniques (including a noise piling standard) that, when applied to OSW developments throughout project lifecycles, will result in an overall reduction in the ecological impact of the OSW.

Government is seeking amendments to the Energy Bill to allow these provisions to be delivered as part of the OWEIP.

4.2.2 Entry points for research impact

The priority opportunity areas where ECOWind can create the most impact include:

- ECOWind can influence the transitioning of the policy and regulatory framework introduced by the BESS by developing a body of supporting research and optimising synergies with other programmes, both within and outside Government. This is a fast moving policy environment and there will be requirement from Government for expert support to inform policy development. This could be in the form of contribution to expert working groups, shaping emerging research to answer short term policy needs, or providing assurance that evidence needs are being met in the medium-long term.
- ECOWind can influence and support approaches required by industry and delivery bodies to adapt to policy changes introduced by the BESS. Evidence from ECOWind can inform mitigation/compensation strategies and facilitate coordination between developers, industry, and regulators.

3.2 UK Marine Strategy

The UK Marine Strategy (UKMS) is derived from the EU Marine Strategy Framework Directive, which itself was seen as the environmental pillar of the EU's Integrated Maritime Policy. The UKMS aims to provide the environmental framework for delivering marine policy at the UK level and sets out how to achieve the vision of clean, healthy, safe, productive and biologically diverse oceans and seas. It consists of a simple 3-part framework for achieving good environmental status (GES) as set out in Figure 6 below.

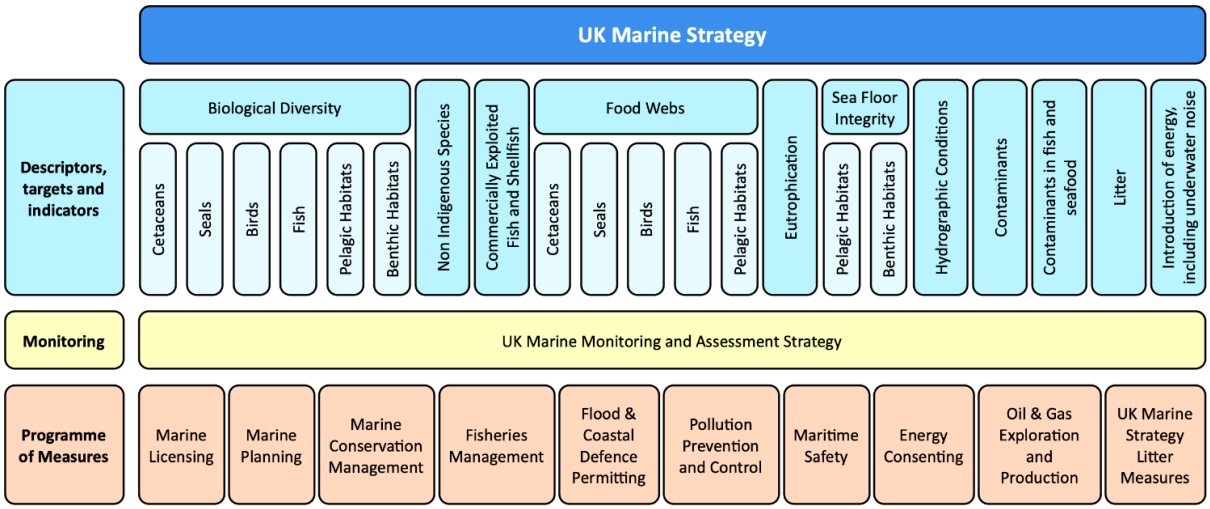


Figure 6. UK Marine Strategy

The three parts of the UKMS are:

1. Part 1 – UK Assessment & Good Environmental Status: 11 descriptors of GES, each with targets and indicators for assessing status. Some of these descriptors are further subdivided across key species groups or habitats.
2. Part 2 – UK Monitoring programmes: An approach to monitoring these key descriptors, targets and indicators across UK administrations, drawing on the existing UK Marine Monitoring and Assessment Strategy (UKMMAS).
3. Part 3 – Programme of Measures: A programme setting out the measures that contribute to the achievement and maintenance of GES in UK seas by 2020.

The majority of the focus of the UKMS to date has been on developing criteria, targets and indicators of GES, and ensuring the monitoring strategy to understand these is in place and adequate. The programme of measures was designed so that it signposted existing management regimes, as set out in Figure 6.

3.2.1 Timeline for delivery

The initial round of the UK Marine Strategy Part 1 (initial assessment), Part 2 (monitoring programme) and Part 3 (programme of measures) were published between December 2012 and December 2015. The second implementation cycle Part 1 and Part 2 were published in 2019 and 2020 respectively. Part 3 is expected to be published in 2022/23 and will define a programme of measures for assessing the status of the UK seas up to 2027. The third implementation cycle is however expected to start by 2024 (initial assessment) with the monitoring programme published by 2025.

3.2.2 Priority opportunity areas for research impact

The priority opportunity areas where ECOWind can create the most impact include:

- ECOWind can generate key evidence to inform UKMS assessments of GES and directly inform the programme of measures. Key knowledge gaps identified by the UKMS Part 2[16] where ECOWind can make an impact and contribution include:
    - changes in benthic food web structure (e.g. picoplankton), hydrodynamic conditions and human impact (e.g. on sea floor integrity),
    - the extent of changes in predator-prey interactions, and
    - the impacts of human activities on beaked whale species distribution, abundance and movements.
- ECOWind can test and strengthen the capability and confidence in modelling approaches to assessment and interventions, underpinned by robust monitoring and data collected using innovative methods.
- Areas where knowledge exists but greater coverage is needed include:
    - at-sea data collection of the abundance and distribution of sea birds and
    - the inclusion of a wider selection of waterfowl species in the marine birds indicators.
- UKMS processes are delivered jointly by the devolved administrations. There is an opportunity to use the outcomes from ECOWind to inform policy and decision making across UK administrations by facilitating cross-administration discussions and contributing to this joint policy implementation framework.

3.3 Highly Protected Marine Areas (HPMA)

Highly Protected Marine Areas (HPMAs) are areas of the sea designated to prohibit extractive, destructive, and depositional uses, allowing only non-damaging levels of activities to the extent permitted by international law for the protection and recovery of marine ecosystems. The UK Government committed to designating pilot HPMAs in 2022 in English waters based on recommendations of the Benyon Review (Benyon et al., 2020)[17] on the potential introduction of HPMAs.

The designation of pilot HPMAs has been delivered based on legislative requirements under the Marine and Coastal Access Act (2009). JNCC and Natural England, along with Cefas, developed ecological criteria to select inshore and offshore locations. Defra consulted on candidate HPMA sites including:

- Inshore waters
    - Allonby Bay (Irish Sea)
    - Lindisfarne (northern North Sea)
- Offshore waters
    - Dolphin Head (Eastern Channel)
    - Inner Silver Pit South (southern North Sea)
    - north-east of Farnes Deep (northern North Sea)

[16] Defra (2021) Marine Strategy Part Two: UK updated monitoring programmes. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/971696/uk-marine-strategy-part-two-monitoring-programmes-2021.pdf

[17] Benyon R., Barham P., Edwards J., Kaiser M., Owens S., de Rozarieux N., Roberts C., Sykes R. (2020)Benyon Review Into Highly Protected Marine Areas. Final Report.Defra. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/890484/hpma-review-final-report.pdf

Following consultation, on February 20th 2023, Government announced that it would designate the first three HPMAs in English waters before July 6th 2023. The three sites are North East of Farnes Deep, Allonby Bay and Dolphin Head[18]. The delivery of the HPMAs is a high priority area for alignment with ECOWind as it will identify areas where offshore wind development is prohibited as well as defining assessment requirements and evidence needs to allow the protection and recovery of marine ecosystems. It will provide an understanding of the recovery potential of different habitat types and ecosystems and help in defining what 'good' looks like in the absence of human activities and pressures.

3.3.1 Timeline for delivery

Consultation on candidate HPMAs in England ended in September 2022. Additional evidence gathering occurred throughout 2022, including site-specific engagement with local stakeholders to collect further evidence on the social and economic criteria. Based on this evidence, the first three HPMAs will be designated before July 6th 2023 and management measures are expected to be in place in early 2024. Defra's Secretary of State has asked Defra to explore additional options for HPMAs during 2023. In Scotland, guidelines for identifying and selecting HPMA sites were published in December 2022 and a consultation on the policy framework for future HPMAs is running until April 17th 2023.

3.3.2 Priority opportunity areas for research impact

The priority opportunity areas where ECOWind can create the most impact include:

- Developing evidence to understand the impact of offshore wind development (construction and operational phase) on species and habitats of conservation importance. This can inform decision making around site selection as well as the future monitoring, assessment and management of the HPMAs to promote recovery of features and ecosystem services such as blue carbon stocks.
- Identification of the relative contribution of species population trends (e.g. increase or decrease) to the coherence and functioning of the network of MPAs will allow an understanding of where management focus should be directed.

3.4 Strategic compensation

Where a plan or project is located close to, or within, an area designated or proposed under the Birds and Habitats Directives (European Sites) and/or the Ramsar Convention[19], a Habitats Regulations Assessment (HRA) is required. HRA includes a screening stage to determine Likely Significant Effects (LSE) and whether it is necessary to carry out an Appropriate Assessment (AA) of the plan or project.

Following screening, in cases where LSE cannot be excluded, AA is required to determine whether the plan or project will have an Adverse Effect On the Integrity (AEOI) of European sites, alone or in combination with other plans and projects. AA takes into account when effects are likely to occur, their duration and reversibility and the necessity for mitigation measures. Where LSE is identified, only when it is sufficiently certain that mitigation would make an effective contribution to avoiding or reducing harm can such measures be taken into

[18] https://www.gov.uk/government/publications/highly-protected-marine-areas

[19] As a matter of policy, Ramsar sites (which generally overlap with SPA boundaries) are also considered to be subject to the same strict legal protection as European designated nature conservation sites (JNCC 2019).

account in assessing whether there is an adverse effect on site integrity. If it cannot be concluded that there will be no AEOI, then compensatory measures may need to be considered, in accordance with the strict tests of Article 6(4) of the Habitats Directive. For offshore wind in England and Wales, HRA is undertaken at the plan level, led by the competent authority (The Crown Estate) and project level, led by developers and determined by the competent authority (Department for Energy Security and Net Zero), in consultation with SNCBs. In Scottish Waters, this is done through the Sectoral Marine Plan for Offshore Wind Energy, which has been developed to provide the spatial framework for the leasing programme for commercial-scale offshore wind by Crown Estate Scotland. A full Sustainability Appraisal (incorporating Strategic Environmental Assessment, Socio Economic Impact Assessment and Habitats Regulations Appraisal) was undertaken by Marine Scotland for the draft Plan and 17 Draft Plan Options selected by Scottish Ministers.

Given the scale of planned development for offshore wind and the likely implications for protected sites, it is probable that both plans and future projects will not satisfy the legal test addressing adverse effects on site integrity, and so will need to progress through derogation and require compensatory measures to proceed.

Individual offshore wind projects have encountered challenges around securing suitable and deliverable compensation measures, with questions outstanding on which measures are appropriate for impacts and areas, how to quantify benefits, what multipliers are appropriate, and suitable scales and locations, amongst others. Made up of Defra, the Offshore Wind Industry Council (OWIC) Derogation Subgroup, SNCBs and regulators, the Collaboration on Offshore Wind Strategic Compensation working group (COWSC), are currently discussing a more strategic approach to respond to evolving challenges at large spatial scales - for example, how many projects can secure a similar measure before it is not effective.

A strategic approach to both mitigation and compensation is critical in addressing cumulative effects, as there is a need to consider effects at an appropriate spatial scale and potentially in co-ordination across multiple projects, and across different sectors. However, specifically what that entails, and how to achieve this within the current policy and delivery landscape, has not been clearly defined.

Strategic compensation seeks to enable the pace and scale required for offshore wind deployment, in line with UK Government goals for decarbonisation and the Autumn 2021 Defra consultation on MPA compensation[20], by establishing a mechanism for and delivery of effective compensatory measures on a strategic scale. This can include measures which are taken to deliver compensation under the Habitats Regulations across two or more projects or at plan level, which have either already been identified as a legal requirement or which can reasonably be considered to be needed for future project or plan level requirements. It could include measures that are delivered through another marine industry sector e.g. fisheries, or through payment into the Marine Recovery Fund. This is an active area of discussion and policy development which is moving at considerable pace. The design phase of delivering strategic compensation is a high priority area for alignment with ECOWind as it will inform the scoping of compensation options, provide evidence of likely outcomes and define evidence needs.

[20] https://consult.defra.gov.uk/marine-planning-licensing-team/mpa-compensation-guidance-consultation/supporting_documents/mpacompensatorymeasuresbestpracticeguidance.pdf

3.4.1 Timeline for delivery

The timeline for delivery of strategic compensation measures can be considered in the short, medium, and long term. In the short-term (2022/23), an agreed delivery mechanism is expected to be established to provide compensation measures which can address impacts from Round 3, Extensions, Round 4 and ScotWind offshore wind projects. Defra is currently (March 2023) working in partnership with industry and wider stakeholders on pilot projects to identify effective compensatory measures, which will be added to the library of measures for consideration by developers.

In the medium-term (end of 2023), a mechanism will be developed from pilots to cover implementation at a UK scale and intended to support not just offshore wind industries but any other sector requirement that comes through compensation and also contribute to biodiversity targets including marine net gain and UKMS. The new Marine Recovery Fund is also planned to be operational by the end of 2023 to allow the delivery of future strategic compensation measures across the offshore wind industry. In the long term (by 2028), it is expected that net gain measures will be integrated into a transferable ecosystem benefits function and upscale the mechanism to cover all offshore activities.

3.4.2 Priority opportunity areas for research impact

The priority opportunity areas where ECOWind can create impact include:

- ECOWind can contribute to addressing key evidence gaps on strategic compensatory measures and support pilot projects led by OWIC and Defra such as:
    - artificial nesting, for black-legged kittiwake benefit
    - Predator control, for seabird benefits
    - Habitat creation, primarily for benthic ecology benefits
    - Infrastructure repurposing or removal, primarily for benthic ecology benefits
    - Exploring fisheries management measures as strategic compensation options
- ECOWind can inform and streamline the overall strategic compensation governance structure and future guidance based on site specific evidence, information exchange and engagement with stakeholders.
- Enhancing intergovernmental collaboration by identifying strategic compensation measures from different cases studies and across jurisdictions. For example, evidence about the connectivity of bird populations can inform measures for seabirds across the entire UK waters and beyond.

3.5 Marine Net Gain (MNG)

The Net Gain concept as set out in the UK Government's 25 Year Environment Plan (25 YEP) intends to leave biodiversity in a better state than before development, promoting recovery and securing wider benefits for people and the environment. Application of net gain to the marine environment (Marine Net Gain – MNG) is at an early stage of development and there are important aspects still to be defined, including:

- How the approach considers wider benefits in the marine environment including ecosystem services and natural capital assets beyond biodiversity (environmental net gain vs biodiversity net gain);

- the approach to measuring, evaluating and determining MNG based on biodiversity losses and the offsetting contribution of habitat enhancement measures, including the interaction with any strategic compensation for offshore energy developments.

Through their Offshore Wind Enabling Actions Programme (OWEAP), Defra is in the process of developing principles for MNG and the delivery mechanisms, including a legal framework and guidance. Defra's objectives for their MNG workstream are:

- To establish high-level principles and objectives for Marine Net Gain, appropriate to the marine environment, the Government's conservation aims therein and the policy framework that covers it.
- To establish an approach for MNG that aligns with the terrestrial Biodiversity Net Gain policy.

Defra states that MNG will:

- secure positive outcomes for the environment by contributing to halting and reversing the longer-term trend of biodiversity decline through the restoration and creation of healthy and high-quality marine and coastal habitats, and protection of species;
- deliver lasting improvements, contributing to ocean recovery, and supporting efforts in climate change mitigation, resilience, and adaptation;
- enable the responsible and sustainable growth of marine industries and development activities, recognising their essential contribution to meeting the UK government's climate change commitments, whilst ensuring the protection of our marine environment;
- define strategic objectives and goals, increasing the potential for relatively small interventions to make a more significant collective contribution to improvements in the overall status of the marine environment.

3.5.1 Timeline for delivery

HMG's consultation[21] on MNG Principles closed for responses on 30th August 2022. The Environment Act 2021 makes biodiversity net gain mandatory from an as-yet unconfirmed date in November 2023. HMG are currently exploring whether delivery options for offsetting environmental impact or creating marine environmental net gain. This is an active and fast moving area of policy development that ECOWind projects are directly contributing to.

3.5.2 Entry points for research impact

The priority opportunities where ECOWind can create impact include:

- Understanding the baseline and future modelled climate change scenarios for key habitats and species to provide the context within which MNG may happen.
- Contributing to discussions on the development, monitoring and assessment of a marine biodiversity metric.

[21] https://consult.defra.gov.uk/defra-net-gain-consultation-team/consultation-on-the-principles-of-marine-net-gain/supporting_documents/Consultation%20on%20the%20Principles%20of%20Marine%20Net%20Gain.pdf

- Research outputs could help to scope project impacts based on enhanced understanding of the ecological cumulative impacts of offshore wind structures and inform MNG requirements or actions.
- Adding to the evidence base that supports the creation of a directory of strategic interventions and compensatory measures that will facilitate the acceleration of offshore energy deployment and support MNG interventions.

4 Industry led enabling work

4.1 Pathways to Growth

The Offshore Wind Industry Council (OWIC), a senior Government and industry forum, was established in May 2013 to drive the development of the world-leading offshore wind sector in the UK. It is comprised of members drawn from the leading UK and global firms in the offshore wind industry, including developers and original equipment manufacturers. The Council oversees and drives the implementation of the Offshore Wind Sector Deal, co-Chaired by Industry and the UK Minister of State for Business, Energy and Clean Growth.

Pathways to Growth (P2G) is the Sector Deal's workstream focused on identifying and addressing the key environmental and consenting challenges that will be a barrier to the UK meeting its offshore wind 2030 target and playing its full role in delivering net zero. Recognising the scale of the challenge, P2G brings together government representatives, Statutory Nature Conservation Bodies (SNCBs), and industry across the UK's Devolved Administrations to work together in partnership.

The work is supported by the P2G Coordination Group. This group have prioritised a list of the 10 biggest environmental and consenting challenges that are causing delays and uncertainty in offshore wind consenting and are working together to resolve these challenges by:

- Maintaining an overview of all the work in consents, licencing and the environment relating to P2G;
- Seeking feedback from their organisations on what is already being done or is needed to provide resolution to the identified barriers;
- Ensuring that these actions complement and enhance the work of existing work programmes and strategic groups;
- Defining a clear road map with commitments to meet the 2030 and net-zero targets;
- Initiating new work efficiently through existing groups and bodies where gaps emerge or, if this is not possible, identify and drive the relevant means to address the gap.

4.1.1 Timeline for delivery

The P2G Coordination Group have identified and prioritised issues below as key barriers causing delay and uncertainty in the consenting process:

Pathways to Growth: Prioritised Barriers to Growth

1. Derogations	There isn't sufficient UK Government and Devolved Administration guidance available to define how to present a Habitats Regulations derogation case, define and deliver compensatory measures or principles to enforce and adaptively manage compensatory measures.
2. Resources	There is a shortfall in the required volume and range of skilled resources within the SNCBs and regulatory bodies to meet the demand in case work to deliver offshore wind 2030 and net zero targets.
3. CIA on Seabirds	There is a lack of certainty and consistency in the approach taken to estimate cumulative impacts on seabirds during the construction and operational phase.
4. Biodiversity	Biodiversity policy targets may limit the amount of marine space available for offshore wind deployment required to meet 2030 and net zero targets.
4. Marine Spatial Planning	The existing approaches to marine spatial planning across the UK do not currently provide clarity on how decisions are being made about the use of marine space to ensure there is adequate area available to meet 2030 and net zero offshore wind targets.
6. Future Policy	Opportunities to resolve policy or legislative challenges or to make improvements to wider policy delivery are missed leading to delays meeting UK net zero targets.
7. Underwater noise guidance	There is a lack of clear guidance on underwater noise management within harbour porpoise SACs (England and Wales specific).
8. Proportionate EIA	The volume of information required for offshore wind EIAs will continue to impact decision makers' resource availability, leading to delays during both consent application and preconstruction discharge of consent conditions.
9. Adoption of new research	There isn't a defined process or transparent way of communicating when and how evidence and research outcomes inform Government, SNCB and regulatory body positions on the impacts of offshore wind farms.
9. Strategic approach to data collection	The different approaches to collecting monitoring data at project sites across the UK is preventing development of a more coordinated, robust evidence base to support the understanding and potential resolution of uncertainty in offshore wind development.

Actions to solve these issues have been identified in roadmaps – high level timelines showing the key actions that are planned that will solve these issues. The roadmaps are also a tool to help identify opportunities to share best practice (for example, Natural England's best practice guidance to facilitate sustainable development of offshore wind[22]), work on common approaches across the UK and discuss and recommend new activities necessary to close any gaps that the road mapping process highlights. Roadmaps are available on the P2G website under each of the barriers[23].

4.1.2 Entry points for research impact

The priority opportunities where ECOWind can create impact include:

- Contributing expertise and evidence to working groups on priority barriers such as:
  - Strategic compensation
  - Cumulative impact assessment
  - Biodiversity
  - Marine Spatial Planning
  - Underwater noise
  - Proportionate EIA
  - Strategic data collection
- Building relationships with developers.

[22] https://www.blog.renewableuk.com/post/natural-england-s-best-practice-advice-to-facilitate-sustainable-development-of-offshore-wind

[23] https://www.owic.org.uk/pathways-to-growth-challenges

5 Ongoing offshore wind research projects of relevance

5.1 Offshore Wind Evidence and Change Programme

As manager of the seabed around England, Wales and Northern Ireland, The Crown Estate (TCE) recognised that the sustainable growth of the offshore wind sector needs to be done in a way which is both sensitive to the importance of biodiversity in our precious marine environment and in balance with the wide range of interests from other seabed users.

To address this challenge, TCE have convened government bodies, the industry and key stakeholders from across the UK to work collectively on a shared mission, founded on the need to better understand and overcome the cumulative environmental impacts of offshore wind, and its effects on users of the sea and onshore communities.

The programme, known as the Offshore Wind Evidence and Change programme (OWEC), will play a pivotal role in achieving the environmental aspirations of the Offshore Wind Sector Deal alongside other strategic delivery programmes, and the sector's full potential to support net zero. Launched in December 2020, The Crown Estate has committed a £50m 'kick-starter' investment to fund and deliver a five year programme. In January 2022 TCE announced a £12 million investment in three projects to explore a wide range of issues and evidence gaps around the expansion of offshore wind:

- POSEIDON (Planning Offshore Wind Strategic Environmental Impact Decisions) – led by Natural England, this four-year project will improve the knowledge of environmental risks across UK waters and provide tools for future offshore wind planning.
- PrePARED (Predators and Prey Around Renewable Energy Developments) – a four-year partnership led by Scottish Government's Marine Scotland directorate and co-funded by Crown Estate Scotland that will help improve understanding of how seabirds, marine mammals and fish respond to offshore wind farms.
- Remote Tracking of Seabirds at Sea – the Royal Society for the Protection of Birds (RSPB) will harness novel tracking techniques over a five-year period to fill critical knowledge gaps in the movements and populations of seabirds, such as puffin and kittiwake.

OWEC is led by TCE, together with its programme partners, the Department for Energy Security and Net Zero, and Defra. It is being delivered in collaboration with devolved government bodies and organisations from across the UK that have an interest in planning for the future of offshore wind.

Each project must support the overall programme mission and fulfil other agreed criteria. Projects are delivered through one or more of four core themes, which emerged from a process of collaboration and have been endorsed by the Programme Steering Group.

In addition to the three projects already mentioned, OWEC has funded and will continue to fund a wide breadth of work across its four themes[24] as set out in the table below. So far, 25

[24] https://www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/offshore-wind-evidence-and-change-programme/offshore-wind-evidence-and-change-programe-themes-and-projects/

projects have been awarded funding, with three completed and 13 underway, gathering data and evidence that will help to find space in a busy seabed, enable better understanding of how offshore wind affects the environment and habitats, and inform decision making and understanding around environmental benefits and provision of compensation. There would be considerable benefit to industry, Government and academia in increasing join up and coordination across these research efforts.

Theme	Project
Finding space for offshore wind	**Future Offshore Wind Scenarios** This UK-wide study is assessing the different areas that could potentially accommodate future offshore wind projects up to 2050, and the different forms that development could take, for example using a fixed or floating wind farm design. Project is led by the BEIS, TCE and CES with consultancy support from Arup, ABPmer and the Offshore Renewable Energy Catapult
	Air Defence Concept Demonstration This project is testing concepts and technologies including new radars which show potential to distinguish between wind turbines and aircraft. The project is part of a wider work package which aims to deliver an initial Air Defence & Offshore Wind Mitigation Strategy & Implementation Plan Project led by The Ministry of Defence and the Offshore Wind Industry Council (OWIC) with The Crown Estate, BEIS and OWIC developer members
	Strategic East Coast Spatial Study This project aimed to improve the understanding of the constraints that offshore wind farms may have when connecting to the electricity network and whether alternative approaches can reduce community and environmental impacts. It looked at options for better coordination, land and sea infrastructure and connections into the national grid[25] Project led by TCE, National Grid Electricity System Operator (ESO), National Grid Electricity Transmission, and the MMO with consultancy support from AECOM
	Virtual offshore wind planning fund This series of workshops will explore issues around co-location, the tides and other matters to improve knowledge and understanding of fisheries within the Offshore Wind and Marine Planning sectors. Project led by TCE, in partnership with the National Federation of Fisheries Organisation (NFFO).
Improving understanding of environmental impacts	**Offshore wind knowledge and evidence hub** The project aimed to bring together all relevant data into a new single, authoritative source of information on which to base future offshore wind assessments and to build consensus around environmental topics and their management. This will support improved decision making through the EIA process by ensuring documents are accurate and proportionate in assessing the environmental impacts of offshore wind farms, and how they can be mitigated. The project is led by TCE and the Institute of Environmental Management and Assessment (IEMA) with support from others
	Improving seabird impact assessments This project was designed to ensure that cumulative assessments of the impact of built and future windfarms on seabirds are as realistic as possible, avoiding overestimates being made which could hamper future development. The outcomes can help to improve planning and decision making by creating greater consensus on how cumulative impacts on seabirds should be assessed. The project was led by TCE with Natural England, CES and RenewableUK, along with support from statutory nature conservation bodies and regulators.
	Fish and fisheries evidence gaps This UK-wide project seeks to identify key gaps in fish and fisheries data across the UK relating to offshore wind farms to show where research may need to take place to inform future offshore wind planning. The project is led by Marine Scotland (through its ScotMER programme) with support from The Crown Estate and consultancy support from Brown and May Marine.
	Offshore Wind Enabling Actions Programme (OWEAP) This programme, led by the Defra will deliver projects which will make key contributions to the OWEC programme (see section 4.3).

[25] https://www.thecrownestate.co.uk/media/3801/east-coast-grid-spatial-study-summary-report.pdf

Theme	Project
	The project is funded by HM Treasury and led by Defra in partnership with TCE, BEIS and others.
	Offshore Wind Environmental Evidence Register (OWEER) The Offshore Wind Environmental Evidence Register has built a publicly accessible UK-wide register of evidence gaps and relevant research projects across four key areas – the seabed, marine mammals, seabirds and fish. It can be viewed on the Marine Data Exchange. JNCC has led the development of the register with the support of Defra and The Crown Estate.
	PrePARED (Predators and Prey Around Renewable Energy Developments) The Predators and Prey Around Renewable Energy Developments (PrePARED) project will investigate how seabirds, marine mammals and fish change their behaviour in response to offshore wind development. This five-year project is being delivered Marine Scotland, NatureScot, Natural England; Aberdeen, Exeter and Aarhus universities, UK CEH, BioSS and SMRU
	Remote Tracking of Seabirds at Sea This project will develop of new tag and receiver systems suitable for use on seabird leg rings and offshore turbines to collect data on currently unmeasurable parameters. The project will focus on kittiwake due to the acknowledged cumulative impacts on this species and associated consenting risk. The project is led by RSPB.
	POSEIDON (Planning Offshore Wind Strategic Environmental Impact Decisions) The POSEIDON project will conduct analysis to strengthen the knowledge base of the potential risks of developing wind farms on different environmental receptors, such as seabirds, marine mammals, marine landscapes and benthic seabed habitats. New and existing data on environmental sensitivities will be combined using existing web-based tools where possible, to provide a comprehensive environmental baseline. These tools will be used by marine managers, scientists, developers and all those with an interest in offshore wind to ensure that decisions on marine planning and project development can factor in environmental risk from the outset. This collaborative UK-wide project is being led by Natural England, with support Cefas, JNCC, MMO, NRW, NatureScot and Bangor University.
	FiSMaDim (Fisheries Sensitivity Mapping and Displacement) Running from September 2022-August 2024, FiSMaDim will identify the recent spatial distribution of fishing activities of UK vessels in the UK EEZ based on individual vessels' positional tracking data, fisheries activity database and relevant ancillary data collected by MMO & Marine Scotland, the project. The project will assess the constraints and opportunities for the fishing industry to adapt (including displacement) to the local development of OWFs, providing evidence to inform British Energy Security Strategy, 25-years Environmental Plan and Fisheries Act. This project is led by Cefas, with support from University of St Andrews and Marine Scotland Science, with stakeholders across fishing cooperatives, offshore wind industry, Defra's Arms-Length Bodies.
	NICE (Nature Inclusive Cable Enhancement and Protection) Running from September 2022-November 2024, NICE will aim to provide evidence on the potential ecological impacts (focused on benthic epifauna), of NID technologies for cable protection, compared to existing 'standard' cable protection technologies. This project is led by Cefas, with support from ARC Marine.
	FLOWERS (Floating Offshore Wind Environmental Response to Stressors) Running from September 2022-March 2025, FLOWERS aims to reduce uncertainty of poorly understood stressors within offshore wind farms EIAs for floating offshore wind farms.

Theme	Project
	This project is led by Cefas, with support from Marine Scotland.
Ensuring sensitivity to marine protected areas	**Cross-government group on compensatory measures** The four UK governments and other key stakeholders have come together in this forum to identify and progress ways to deliver compensation to marine life potentially at risk of harm due to offshore wind farms. The group meets quarterly and comprises government advisors, regulators, policymakers, and representatives from the devolved governments, along with Defra. The project is led by the Defra with support from others.
Investigating environmental benefits	**North Sea Net Gain** This project is an international collaboration to provide further evidence on how benthic biodiversity is distributed across the North Sea and around the UK into one dataset. Through a thorough data mining process, detailed maps were produced of habitats and distributions of key benthic species in the North Sea. These will be publicly accessible via a new app, to be launched early in 2022, for industry, government bodies and anyone with an interest in marine life and space. The Crown Estate is leading the project in partnership with The Rich North Sea Programme, delivered through Cefas and the Flanders Marine Institute (VLIZ), and supported by the Project Advisory Group including Natural England and JNCC.

5.2 Scottish Marine Energy Research (ScotMER) Programme

To develop offshore wind efficiently and in a sustainable manner, and ensure our marine environment is managed to meet the long term needs of nature and people, Marine Scotland have identified the need to improve the evidence base around how developments will affect our socio-economics, our natural environment, and other users of the sea.

Scotland's National Marine Plan commits the Scottish Government to make decisions on the best available scientific evidence. Where knowledge gaps and uncertainties exist that add risk to decision making, the ScotMER programme seeks to address these evidence gaps, where it is most needed, and feed new information back into planning, licencing, consenting and policy. As an example, new evidence produced by the ScotMER programme is now feeding into the Sectoral Marine Plan for Offshore Wind Energy Iterative Plan Review process, and will be used in environmental assessments for new ScotWind developments.

Marine Scotland has worked with industry, environmental NGOs, Statutory Nature Conservation Bodies, and other interested stakeholders, to map out the gaps in knowledge when assessing the environmental and socio-economic impacts of offshore renewable developments. To do this, seven specialist groups were created, each focussing on particular impact receptors. These groups are:

- Ornithology
- Marine mammals
- Fish and fisheries
- Diadromous fish
- Benthic
- Physical processes
- Socio-economics

Each group, made up of experts and stakeholders, have worked together to produce 'evidence maps' which provide a framework to guide ScotMER research projects. The evidence maps guide the ScotMER research projects, with the highest priority projects taken forward by the programme. A streamlined version of the evidence maps for all groups can be accessed online[26].

Projects carried out under ScotMER include those in the table below, several of which are of direct relevance and interest to the ECOWind projects:

[26] https://www.gov.scot/policies/marine-renewable-energy/science-and-research/

Project
Sectoral Marine Plan: roadmap of actions This project produced a roadmap of actions required to improve our understanding of the potential implications of ScotWind sites on seabirds as identified by the sectoral marine plan. https://www.gov.scot/publications/sectoral-marine-plan-roadmap-actions/
Offshore wind developments – collision and displacement in petrels and shearwaters: literature review This project undertook a literature review of the risk of collision and displacement from OSW developments in Scotland for these key species of marine birds. https://www.gov.scot/publications/review-inform-assessment-risk-collision-displacement-petrels-shearwaters-offshore-wind-developments-scotland/
Development of a novel physiology tag to measure oxygen consumption in free-ranging seabirds This project took initial steps to develop a new type of tag that can measure energy expenditure of seabirds. To do this, the project adapted a Near-infrared spectroscopy system for humans, that can measure muscle oxygen saturation, and deployed the new tags on European shags. https://www.gov.scot/publications/development-novel-physiology-tag-measure-oxygen-consumption-free-ranging-seabirds/
Fish and fisheries research to inform ScotMER evidence gaps and future strategic research in the UK: review This study undertook a literature review and consultation with key stakeholders to establish current knowledge for evidence gaps identified in the ScotMER Fish and Fisheries evidence map. This report includes research recommendations to help fill remaining strategic priority gaps. https://www.gov.scot/publications/review-fish-fisheries-research-inform-scotmer-evidence-gaps-future-strategic-research-uk/
Assessing fisheries displacement by other licensed marine activities: good practice guidance - literature review This project developed 'Good Practice Guidance for Assessing Fisheries Displacement' through a detailed literature review and consultation with the ScotMER Fish and Fisheries Receptor Group (FFSRG), commercial fisheries industry, offshore energy and regulatory sectors https://www.gov.scot/publications/good-practice-guidance-assessing-fisheries-displacement-licensed-marine-activities-literature-review/
Develop best practice recommendations for combining seabird study data collected from different platforms This study developed best practice guidance to combine seabird survey data collected from different platforms based on a literature review, expert knowledge and a bespoke model development including sensitivity analysis. This can be used in environmental assessments for planning and licensing. https://www.gov.scot/publications/study-develop-best-practice-recommendations-combining-seabird-study-data-collected-different-platforms/
Impact of climate change on seabird species off the east coast of Scotland and potential implications for environmental assessments This study investigated the potential impacts of climate change on seabird distribution, abundance and demography off the east coast of Scotland, and examined integration of these climate models into standard population forecast models used in assessments for offshore wind developments https://www.gov.scot/publications/study-examine-impact-climate-change-seabird-species-east-coast-scotland-potential-implications-environmental-assessments/
Offshore wind developments assessment - seabird collision risk, displacement and barrier effects This project developed a new framework to enable the assessment of collision, displacement and barrier effects on seabirds from offshore renewable developments to be integrated into a single overall assessment of combined impacts. https://www.gov.scot/publications/study-examine-seabird-collision-risk-displacement-barrier-effects-integrated-assessment-offshore-wind-developments/
Improving Our Understanding of Seabird Behaviour at Sea This project collated tracking data from five seabird species thought to be vulnerable to offshore wind farms. These data were analysed to understand whether seabird distribution data, usually undertaken in daytime, good weather conditions, were representative of behaviour in other conditions https://www.gov.scot/publications/improving-understanding-seabird-behaviour-sea/
Feasibility of extending SeabORD to the entire breeding season

Project
SeabORD is a method that can assess displacement and barrier effects from offshore renewables on seabirds, but is currently limited to four species during the chick-rearing season. This review examined ways to improve the SeabORD model including extending to the entire breeding season https://www.gov.scot/publications/study-examine-feasibility-extending-seabord-entire-breeding-season/
Public perceptions of offshore wind farm developments in Scotland Aims were to gain an overview of the perceptions and experiences of those living near offshore wind developments in Scotland, to understand the factors which affect perceptions and experiences of living near offshore wind farms, to understand if perceptions and experiences change at different stages of a development, and to understand whether, and in what way, offshore wind farms influence people's decisions regarding tourism and recreation in coastal areas. https://shorturl.at/LMPV0
The Status of Sabellaria spinulosa Reef off the Moray Firth and Aberdeenshire Coasts and Guidance for Conservation of the Species off the Scottish East Coast Research to confirm the existence of Sabellaria spinulosa (Sabellaria) in reef form off the Scottish east coast. https://data.marine.gov.scot/dataset/status-sabellaria-spinulosa-reef-moray-firth-and-aberdeenshire-coasts-and-guidance
Scoping Study - Regional Population Viability Analysis for Key Bird Species This project provides a comparative investigation of PVA methods for seabirds, describing model performance, providing a set of recommendations for practitioners and highlighting research gaps. https://data.marine.gov.scot/dataset/scoping-study-regional-population-viability-analysis-key-bird-species-cr201616
Improving estimates of seabird body mass survival relationships This project used data on mass, body size, timing of breeding and recapture/resighting histories to estimate the relationship between mass at the end of breeding season and over-wintering survival probability for four key species in the Forth and Tay region: kittiwake, puffin, common guillemot and razorbill https://data.marine.gov.scot/dataset/improving-estimates-seabird-body-mass-survival-relationships
Review Of Demographic Parameters And Sensitivity Analysis To Inform Inputs And Outputs Of Population Consequences Of Disturbance Assessments For Marine Mammals The interim Population Consequence of Disturbance (iPCoD) is a framework that allows individual-level effects from disturbance to be scaled to population-level impacts. This approach is parameterised by published figures for specific UK populations or derived from the literature for a given species. This report establishes the most up-to-date information on five key species of UK marine mammal (harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal) for use in the iPCoD model. https://data.marine.gov.scot/dataset/review-demographic-parameters-and-sensitivity-analysis-inform-inputs-and-outputs-population
Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters This project consolidates marine mammal abundance and distribution estimates derived from data collected by local, regional, national and international partners. https://data.marine.gov.scot/dataset/regional-baselines-marine-mammal-knowledge-across-north-sea-and-atlantic-areas-scottish
Developing marine mammal Dynamic Energy Budget models This report has developed dynamic energy budget (DEB) models for harbour porpoise, bottlenose dolphins, minke whales, harbour seals and grey seals in the UK based on values from current literature. It illustrates how a DEB model can be used to investigate the potential effects of disturbance that cause a reduction in energy intake, subsequently effecting vital rates (individual survival and birth rate), using harbour porpoise as an example. and their potential for integration into the iPCoD framework https://data.marine.gov.scot/dataset/developing-marine-mammal-dynamic-energy-budget-models-and-their-potential-integration-ipcod
Seabird Survey Designs for the East Coast of Scotland This project estimates the power of different simulated survey designs to detect accurate flight heights and/or changes in population density of seven seabird species and harbour porpoise. This will allow informed decisions about the minimum effort required to collect accurate information for specific species and regions at different times of year. https://data.marine.gov.scot/dataset/seabird-survey-designs-east-coast-scotland

Project
Automated Identification of Fish and Other Aquatic Life in Underwater Video This project provides an overview of the current state of computer vision technologies for automated detection of aquatic life in underwater video and provides a development route for a tool to analyse the large amount of video footage without the need for human supervision. https://data.marine.gov.scot/dataset/automated-identification-fish-and-other-aquatic-life-underwater-video

5.3 Offshore Wind Enabling Actions Programme

Defra's Offshore Wind Enabling Actions Programme (OWEAP) was a two-year programme (2020-2022) that aimed to encourage and ensure the responsible and sustainable growth of offshore wind, whilst recognising its essential contribution to meet the UK Government's climate change targets and ensuring the marine environment is sufficiently protected. OWEAP was designed to:

- Increase understanding of the environmental impacts of offshore wind and
- Find strategic solutions to manage and mitigate impacts to reduce barriers to the expansion of offshore wind in English waters.

OWEAP has been delivered through four projects:

1. Reducing the impact of underwater noise (Underwater Noise)
2. Delivering marine net gain through offshore wind (Marine Net Gain)
3. Using 'Better Data' to improve consenting and monitoring (Better Data)
4. Enabling the offshore wind industry to avoid, reduce and effectively compensate impacts (Compensation and Impacts).

Following the publication of the BESS in March 2022, the Programme was required to pivot to deliver the Offshore Wind Environmental Improvement Package (OWEIP), building on the foundations of the OWEAP.

To date the following projects have been published from the OWEAP:

Project
Mitigating the Impacts of Offshore Wind Farms on Protected Sites and Species in the UK This report presents an analysis of approaches to mitigation of environmental impacts of offshore wind on protected sites and species in the UK. http://sciencesearch.defra.gov.uk/Document.aspx?Document=15217_HMC_MitigationofOW-Final.pdf
A review of the use of compensatory measures and applicability to UK offshore developments This work took the form of a literature review and brought together expertise and knowledge from Cefas, Natural England and Joint Nature Conservation Committee to define, highlight and review key areas for consideration on the use of compensatory measures offshore. http://sciencesearch.defra.gov.uk/Document.aspx?Document=14993_ME6032OWEACompensationReviewReport.pdf
Identification of Key Species in the UK, with a Focus on English Waters, Sensitive to Underwater Noise Work investigated the impacts of impulsive and continuous anthropogenic noise on protected and/or commercially important marine species that spend all or part of their time in UK waters. This review has identified key species that are impacted by anthropogenic noise, which frequencies cause these impacts and highlighted evidence gaps and priorities for future research. http://sciencesearch.defra.gov.uk/Document.aspx?Document=15309_Williamsetal2021keyspeciesnoise.pdf
UK Marine Policy & Legislation Review for Implementing Marine Net Gain Analysis of the UK government policy and delivery landscape to support the development and implementation of the concept of Marine Net Gain (MNG). http://sciencesearch.defra.gov.uk/Document.aspx?Document=15221_HMCDefraMNGReport-Final.pdf

A full list of Ocean Energy research projects can be found online on the Offshore Renewables Joint Industry Programme (ORJIP) website: http://www.orjip.org.uk/projects. ORJIP is a UK-wide collaborative programme of environmental research that aims to reduce consenting risks for offshore wind and marine energy projects. The offshore wind workstream aims to:

- fund research to improve our understanding of the effects of offshore wind on the marine environment.
- reduce the risk of not getting or delaying consent for offshore wind developments.
- reduce the risk of getting consent with conditions that reduce viability of the project.

The programme pools resources from the private sector and public sector bodies to fund projects that provide empirical data to support consenting authorities in evaluating the environmental risk of offshore wind. Projects are prioritised and informed by the ORJIP Advisory Network that includes key stakeholders such as statutory nature conservation bodies, academics, non-governmental organisations and others.

5.4 SuperGen

The Supergen programme was set up in 2001 by the Engineering and Physical Sciences Research Council (EPSRC) to deliver sustained and coordinated research on Sustainable PowER GENeration and supply. The programme focused on several key research areas, including bioenergy; energy networks; energy storage; fuel cells; hydrogen and other vectors; marine, wave and tidal; solar technology; and wind power.

For phase four of the programme, the Supergen Wind and Supergen Marine Hubs were combined into one Offshore Renewable Energy Hub, following consultation with the wider research community and EPSRC. The Supergen Offshore Renewable Energy (ORE) Hub[27] builds on the work of the former Hubs, and looks at synergies between offshore wind, wave and tidal technologies as well as building on current research in each area.

The Hub has eight research themes[28] across the current offshore renewable energy landscape, many of which are directly relevant to the work of the ECOWind projects:

- Resource and environment characterisation
- Fluid-structure seabed interaction
- Materials and manufacturing
- Sensing, control and electromechanics
- Survivability, reliability and design
- Operations, management, maintenance and safety
- Environmental and ecosystem aspects
- Marine planning and governance

5.5 Offshore Renewable Energy (ORE) Catapult

The ORE catapult was established in 2013 by the UK government and is the UK's leading innovation centre for offshore renewable energy. The ORE Catapult research elements cover three key research areas[29]:

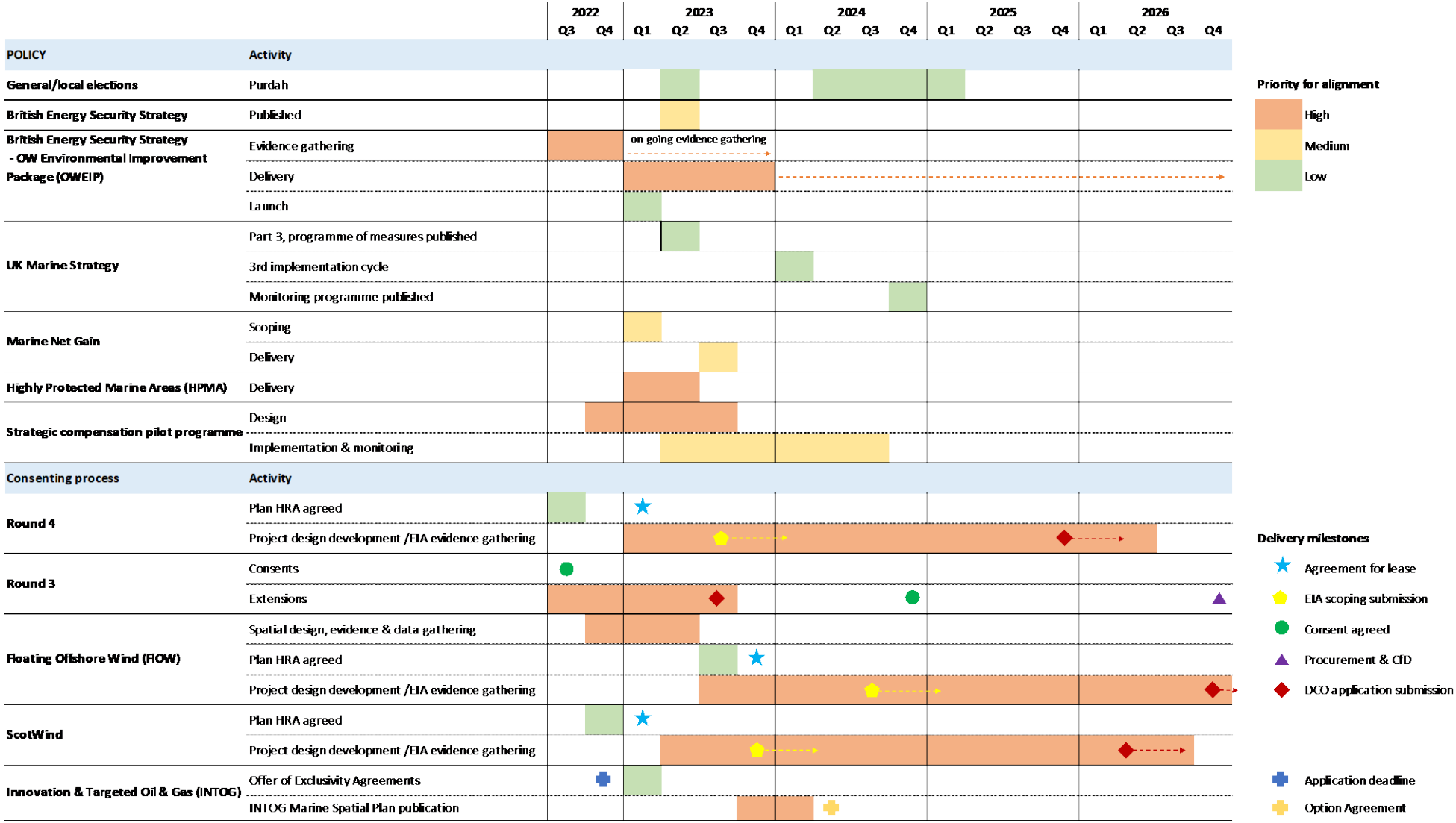
1. Testing and validation of new technologies
2. Operational performance
3. Disruptive innovation

[27] https://supergen-ore.net/
[28] https://landscape.supergen-ore.net/
[29] https://ore.catapult.org.uk/what-we-do/offshore-renewable-energy-research/

In an effort to boost the UK's floating offshore wind industry, the ORE Catapult has recently established the Floating Offshore Wind Centre of Excellence (FOW CoE) to develop an internationally recognised initiative to reduce the cost of energy from floating wind. The Centre will accelerate the build-out of floating farms, create opportunities for the UK supply chain, and drive innovations in manufacturing, installation and O&M. The CoE is a collaborative programme with industry, academic and stakeholder partners. The FOW CoE launched a FOW – Environmental Interactions Roadmap in 2022[30] which describes priority interactions between FOW and the marine environment and its users, highlighting evidence gaps and recommending actions for policy, science and technology.

[30] https://ore.catapult.org.uk/?orecatapultreports=fow-coe-floating-offshore-wind-environmental-interactions-roadmap

Appendix 1: Policy & Delivery Landscape Timeline



Timelines are based on TCE's 'planning and development process' displayed on their Round 4 webpage[31]

Appendix 2: Stakeholder map

	Stakeholders																							
Activity	Defra	BEIS	Scottish Gov	Welsh Gov	The Crown Estate	Crown Estate Scotland	OWAT	PINs	MMO	Natural England	Cefas	JNCC	Environment Agency	NatureScot	NRW	Marine Science Coordination Committee	Seabed Users and Developers Group	IFCAs	OWIC	SOWEC	Developers	Wildlife Trusts	RSPB	WWF
POLICY																								
British Energy Security Strategy	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y			Y				Y		Y			
Offshore Wind Environmental Improvement Package	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y			Y				Y		Y			
UK Marine Strategy	Y		Y	Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y	Y	Y
HPMAs	Y		Y						Y	Y	Y	Y		Y	Y		Y	Y				Y	Y	Y
Strategic Compensation	Y	Y		Y	Y		Y		Y	Y		Y			Y		Y		Y		Y	Y	Y	Y
Marine Net Gain	Y	Y			Y		Y		Y	Y		Y	Y		Y		Y	Y	Y		Y	Y	Y	Y
DELIVERY																								
Round 4	Y	Y		Y	Y			Y	Y	Y		Y		Y	Y			Y	Y		Y	Y	Y	
Round 3	Y	Y	Y	Y	Y			Y	Y	Y		Y		Y	Y			Y	Y		Y	Y	Y	
Round 3 Extensions	Y	Y		Y	Y			Y	Y	Y		Y		Y	Y			Y	Y		Y	Y	Y	
FLOW	Y	Y		Y	Y			Y	Y	Y		Y		Y	Y			Y	Y		Y	Y	Y	
ScotWIND			Y		Y	Y		Y	Y			Y		Y						Y	Y	Y	Y	
INTOG			Y		Y	Y		Y	Y			Y		Y						Y	Y	Y	Y	
OFFSHORE WIND RESEARCH PROJECTS																								
OWEC	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y	Y		Y		Y		Y	Y	Y	
Scottish Marine Energy Research Programme			Y		Y	Y				Y	Y	Y		Y						Y	Y	Y	Y	
OWEAP	Y	Y		Y	Y		Y		Y	Y	Y	Y			Y				Y		Y			
SuperGen			Y		Y																Y			
INDUSTRY-LED ENABLING WORK																								
Pathways to Growth	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y				Y		Y	Y	Y	
Scottish Offshore Wind Energy Council			Y		Y	Y		Y	Y			Y		Y						Y	Y	Y	Y	

[31] https://www.thecrownestate.co.uk/round-4/