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To:	Mona Offshore Wind Project
Cc:	Innes, Colin; Waddell, Keira
Subject:	EN010137 - Mona Offshore Windfarm - deadline 6 submissions for the Ørsted IPs [SWLLP-LEGALDIV.FID5260048]
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Attachments:	EN010137 - DL6 - Wood Thilsted addendum for the Orsted IPs(1011475881.1).pdf EN010137 Deadline 6 - Post hearing submission for the Orsted IPs (20048546 20048544 20048542 20048547 20048545 20048543)(1011479559.1).pdf EN010137 Deadline 6 - Summary of Post hearing submission for the Orsted IPs (20048546 20048544 20048542 20048547 20048545 20048543)(1011480307.1).pdf

Good evening,

Application by Mona Offshore Wind Limited (the "Applicant") for an Order Granting Development Consent for the Mona Offshore Windfarm (the "Project")

Submission on behalf of (1) Barrow Offshore Wind Limited (ref: 20048546) (2) Burbo Extension Ltd (ref: 20048544) (3) Walney Extension Limited (ref: 20048542) (4) Morecambe Wind Limited (ref: 20048547) (5) Walney (UK) Offshore Windfarms Limited (ref: 20048545) (6) Ørsted Burbo (UK) Limited (ref: 20048543) (the "Ørsted IPs")

We represent the above Interested Parties (who for convenience we refer to as the "Ørsted IPs") who are taking part in the examination for the Project in respect of the issues raised in their relevant representations and written representations. The Ørsted IPs attended Issue Specific Hearing 6 ("**ISH6**") on 10 December.

In accordance with examination deadline 6, please see attached the Ørsted IPs:

- post-hearing submission, which includes responses to the ISH6 action points;
- a summary of the post-hearing submission; and
- an addendum to the Wood Thilsted report, which responds to points raised during ISH6.

If you have any questions, please let me know.

Kind regards
Anna

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POST HEARING SUBMISSIONS ON BEHALF OF:

(1) BARROW OFFSHORE WIND LIMITED (REF: 20048546) (2) BURBO EXTENSION LTD (REF: 20048544) (3) WALNEY EXTENSION LIMITED (REF: 20048542) (4) MORECAMBE WIND LIMITED (REF: 20048547) (5) WALNEY (UK) OFFSHORE WINDFARMS LIMITED (REF: 20048545) (6) ØRSTED BURBO (UK) LIMITED (REF: 20048543) (THE "ØRSTED IPs")

IN CONNECTION WITH THE Application by Mona Offshore Wind Limited for an Order Granting Development Consent for the Mona Offshore Wind Farm

1. Introduction

1.1 This post-hearing submission is provided in accordance with deadline 6 of the examination timetable for the application by Mona Offshore Wind Farm Limited (the "**Applicant**") for an Order under the Planning Act 2008 (the "**Act**") granting Development Consent for the Mona Offshore Wind Farm (the **"Project**").

1.2 We represent six owners of operational offshore windfarms in the East Irish Sea (as set out relevant representations RR-004, RR-007, RR-047, RR-087, RR-088 and RR-090), who we refer to together as the "**Ørsted IPs**" for the purposes of this submission.

1.3 The Ørsted IPs attended Issue Specific Hearing 6 - Onshore and Offshore Environmental Matters and the Draft Development Consent Order ("**ISH6**") on 10 December 2024. At ISH6, the Ørsted IPs addressed agenda item 5 'Other offshore infrastructure users', primarily in respect of 'Potential wake effects for other offshore wind farms'.

1.4 The Ørsted IPs have made substantial submissions[1] outlining their position on the policy and regulatory basis for the Applicant to provide an assessment of the Project's wake effects, and the consequences of leaving this issue unassessed for decision-making. The Ørsted IPs have also provided extensive evidence demonstrating the extent of the wake effects on their operational assets, including an assessment of the Project's wake effects undertaken by consultants Wood Thilsted (the "**Wake Report**").[2]

1.5 In this post-hearing submission, the Ørsted IPs:

1.5.1 set out their further concerns regarding wake loss; and

1.5.2 respond to submissions made at ISH6, in line with Action Point 11 of the ISH6 action points.

1.6 Additionally, in **Appendix 1** The Ørsted IPs have provided some additional submissions on a few points from an industry/company perspective.

1.7 Alongside this submission, an addendum to the Wake Report prepared by Wood Thilsted is submitted, which responds to a number of technical points raised during ISH6. We note also that Wood Thilsted is updating the Wake Report, in response to feedback received from the applicant for the Morgan Offshore Windfarm in respect of boundaries applied. However, these updates will not impact the results for the Project.

2. Requirement for wake effects to be considered

2.1 The National Policy Statement EN3 ("**NPS-EN3**") establishes a policy framework for the consideration of the effects of new offshore wind development on existing operational infrastructure.

2.2 This framework creates approaches relating to initial site selection and design, assessment and mitigation of effects and, finally, decision-making in respect of a development. As outlined below, the framework as it relates to the relationship between a proposed development and other offshore infrastructure is underpinned by the principle that new development should seek to co-exist with existing development. In order for co-existence to be achieved, the effects of new development must be assessed, understood and minimised.

2.3 When the policy framework is read as a whole it is clear the purpose and intent of the policy is to ensure the successful coexistence of the proposed project with existing and consented projects. Coexistence requires meaningful adverse effects to be properly assessed and analysed. It is only when that exercise has been completed that conclusions can be reached regarding the extent to which her the proposed project can successfully coexist with existing and consented development. That is the policy outcome which underlies the various parts of the policy.

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1 In particular, [REP4-129].

2 [REP5-120].

Design and site selection

2.4 At the design and site selection stage, applicants are "*encouraged to work collaboratively with those other developers and sea users on co-existence/co-location opportunities, shared mitigation, compensation and monitoring where appropriate…"*[3]

2.5 The Applicant, from the outset, has denied that the issue of wake loss on neighbouring development is an issue which is relevant under the NPS-EN3. The Ørsted IPs raised concerns regarding wake effects in their section 48 consultation responses. The Applicant has recorded that the Ørsted IPs raised this issue during the PEIR stage in their consultation report [APP-037], and responds in the Environmental Statement that on the basis of generic findings in the Frazer Nash study undertaken for the Crown Estate ("**TCE**") and the distances between the assets, wake effects were "*not considered further*".

2.6 The Applicant has supported its position by cherry picking quotes (for example, that wake losses at distances much larger than 20km become "vanishingly small) from the Frazer Nash study and has refused to revisit the issue or undertake meaningful engagement on it despite considerable evidence indicating that the Project could cause material wake effects. They chose to effectively ignore the issue until the Ørsted IPs submitted the Wake Report demonstrating the materiality of the wake effect. The Applicant now appears to accept that the Project will have an effect on the Ørsted IPs existing developments but the opportunity to engage with the Ørsted IPs and give the matter appropriate consideration at the design and site selection stage has lapsed.

Assessment of effects

2.7 In respect of assessment of effects, the NPS-EN3 directs:

2.7.1 The scale and location of future offshore wind development around England and Wales means that development has occurred, and will continue to occur, in or close to areas where there is other offshore infrastructure.

2.7.2 Where a potential offshore wind farm is proposed "*close to existing operational infrastructure or has the potential to affect activities for which a licence has been issued by government*" the Applicant should assess the potential effects on that *"existing or permitted infrastructure or activities*";[4]

2.7.3 The assessment should be undertaken for all stages of the lifespan of the proposed wind farm in accordance with the appropriate policy and guidance for offshore wind farm EIAs; and

2.7.4 Applicants should "*engage with interested parties in the potentially affected offshore sectors early…with an aim to resolve as many issues as possible prior to the submission of an application*" and "*such engagement should be taken to ensure that solutions are sought that allow offshore wind farms and other uses of the sea to co-exist successfully"*.[5]

Assessment under paragraph 2.8.197-2.8.198

2.8 As the Ørsted IPs have outlined in previous submissions,[6] it is non-contentious that their developments are "*existing operational infrastructure*" for the purposes of paragraph 2.8.197.

2.9 As previously canvassed, the Ørsted IPs consider their developments are "close" to the Project in the context of wake effects given the potential for the Project to have material adverse impacts on the energy yield at those developments (as demonstrated by the Wake Report). Therefore, the potential effects of the Project on the Ørsted IPs must be assessed and potentially mitigated by the Applicant in order to achieve co-existence and therefore compliance with paragraphs 2.9.197-2.8.203 of the NPS-EN3.

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3 At 2.8.28.

4 2.8.197

5 2.8.200 and 2.8.203.

6 In particular [REP4-129].

2.10 Throughout the examination, and at ISH6, the Applicant has argued for an extremely narrow interpretation of the terms of the NPS-EN3 in order to justify their refusal to assess the effects of the Project on the Ørsted IPs developments. In summary, the Applicant argues that:

2.10.1 "*close*" means "*proximate*" or "*not far from*" and therefore it is not possible to interpret the distances between the Project as being "*close*" to Ørsted IPs'; and

2.10.2 *"activities for which a licence has been issued"* means activities which are authorised by a marine licence or generation licence only (rather than a consent). Therefore, the only activities which could possibly be captured are the operation of a windfarm under the Electricity Act 1989 (authorised by a generation licence) or the securing of structures to the seabed (authorised by a marine licence). In the Applicant's view these licences do not authorise economic activity and therefore are not impacted by wake.

2.11 The Ørsted IPs consider the Applicant's interpretation of these terms to be unduly narrow, ignores the wider context, and if adopted would entirely undermine the purpose of the NPS-EN3.

2.12 In respect of the interpretation of "*close*", the Ørsted IPs consider the meaning ascribed by the Applicant of "*proximate*" or "*not far from*" does not provide any clarification as to what distances are intended to be captured by this policy. The Applicant has not stated the distance at which a development can no longer be considered 'close', however it has relied on the separation distance established for the offshore leasing process (7.5km) as justification for not carrying out an assessment of the Project's wake effects.

2.13 The Applicant's interpretation is not workable in a planning context. It is not clear whether the Applicant considers there is a cut-off distance for all types of development, in the context of all effects, or whether a judgment should be made depending on the context. The Applicant's view is that the potential for an effect to occur is irrelevant, however, the Applicant has not provided any alternative basis for making this assessment. Rather, the Applicant's argument appears to be that what qualifies as "*close*" is an intuitive exercise, which all parties should have a shared understanding of. That would be irrational.

2.14 An important principle of legal interpretation is that where the meaning of a word is not defined, it should be established in light of the purpose of the provision and framework in which it is contained. The purpose of this provision is to provide an understanding of the effects of a development on existing sea users, in order to allow the Secretary of State to undertake decision-making in accordance with the coexistence principles of the NPS-EN3. As outlined further below, these principles include satisfaction that site selection and site design has been made with a view to avoiding or minimising disruption or economic loss to other offshore industries. In the Ørsted IPs view, the purpose of the policy framework overall is to ensure that new development understands and minimises adverse impacts on existing infrastructure, to ensure successful coexistence.

2.15 Therefore, if a development has the potential to result in a material impact on existing infrastructure, it should be considered 'close' to that infrastructure for the purposes of the NPS-EN3.

2.16 The Ørsted IPs consider the term 'close' is deliberately not defined, to allow for a flexible and contextual interpretation which can be applied to the varied circumstances which could be relevant under paragraph 2.8.197, in the context of large-scale and complex development, where technical understanding of infrastructure and its impacts on the receiving environment are developing.

2.17 The Applicant's interpretation of the second limb of 2.8.197 – "*the potential to affect activities for which a licence has been issued by government* is unduly narrow.

2.18 We note that marine licenses are required to deposit a substance or object "*in the sea or on or under the sea bed"* (not only to structures secured to the seabed).[7] Additionally, we consider the Applicant's focus on the divorcing of economic activity from the activities authorised by these licences is unhelpful and unnecessary. A generation licence authorises the operation of, and therefore generation of electricity from, a generating station. Therefore, if a proposed development has the potential to impact on the ability of a generating station to generate

[7] Section 66 of the Marine and Coastal Access Act 2009.

electricity, it is captured by paragraph 2.8.197. The generation of income from that activity is a secondary matter.

2.19 The Ørsted IPs consider the intention behind the two limbs in 2.8.197 is to capture both existing development and consented but not yet built development. 'Licence' in this context merely means 'authorised' – it is a broad term intended to capture any activities which the Government has approved. We note that elsewhere in the NPS-EN3 the term 'marine licence' is used where policies specifically only relate to marine licences. This interpretation ensures that unbuilt but authorised developments are protected to the same degree as existing development.

Engagement under paragraph 2.8.200-2.8.203

2.20 From the outset, the Applicant has refused to meaningfully engage with the Ørsted IPs on the issue of wake loss. The potential for wake loss was 'scoped out' of the application, and the Applicant has refused to engage on an approach to assessing wake effects, even in light of considerable evidence provided by the Ørsted IPs for material impacts at their developments at various stages of this examination. As outlined earlier in this submission, the Ørsted IPs raised their concerns regarding wake effects at their developments at the earliest opportunity, in their section 48 consultation responses. The Applicant's consultation report [APP-037] records that the Orsted IPs' feedback on this point was received at PEIR stage, however the Applicant did not consider assessment or analysis was required.

2.21 The Applicant's approach to this issue has been belligerent and fails to accord with the spirit and intent of the NPS-EN3. The Applicant has not engaged with a view to ensuring solutions which enable successful co-existence.

<u>Decision-making</u>

2.22 In respect of the Secretary of State's decision-making, the NPS-EN3 highlights the importance of potential effects of a proposal on existing development. The NPS-EN3 relevantly provides that:

2.22.1 In circumstances where a proposed offshore windfarm potentially affects other offshore infrastructure *"the Secretary of State should expect the applicant to work with the impacted sector to minimise negative impacts..."*;[8]

2.22.2 The Secretary of State should be *"satisfied that the site selection and site design of a proposed offshore wind farm and offshore transmission has been made with a view to avoiding or minimising disruption or economic loss…to other offshore industries…"*;[9] and

2.22.3 Where proposed development is *"likely to affect the future viability…of an existing or approved/licensed offshore infrastructure or activity"* the Secretary of State is directed to give those effects *"substantial weight in its decision-making*."[10]

2.23 The Ørsted IPs have provided significant evidence for a material and relevant effect of the Project, which the Applicant has consistently refused to engage with. As a result, the Applicant cannot be considered to have worked with industry to "*minimise negative impacts"* and to date site selection and design cannot be considered to have been made to avoid or minimise wake-loss related impacts on industry.

2.24 There are now limited options to address this issue. Those options are:

2.24.1 to modify site layout or project design, to minimise the adverse impact;

2.24.2 to modify the operation of the development to minimise the adverse impact (in this case, this could include measures such as wind sector management or wake steering); or

2.24.3 privately negotiate compensation.

2.25 Given the Applicant's refusal to acknowledge the materiality of the effects of the Project in terms of wake loss, despite the Ørsted IPs raising direct concerns in June 2023, during the Project's PEIR-phase (a phase that an applicant typically uses to understand and respond to concerns

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[8] 2.8.344.

[9] 2.8.345.

[10] 2.8.347.

raised by stakeholders, and to share preliminary impact assessments with them), no steps have been taken to assess or to minimise the material effects of the Project on the Ørsted IPs developments. It is noted that the effects raised by the Ørsted IPs are not merely hypothetical – they have been substantiated by a body of evidence including a specific wake report.

2.26 During ISH6, the Applicant made statements that suggested mitigations would only have a minor beneficial effect at the Orsted IPs developments but would have a major adverse impact on the Project. Therefore, the Applicant's implication is that because the Project has a larger generating capacity compared to individual existing developments, it is exempted from complying with obligations of coexistence under the NPS-EN3.

2.27 We note that the Applicant is not in a position to make judgments regarding the effectiveness of potential mitigation measures, or the proportionality of effects between the Ørsted IPs developments and the Project, given it has not shared evidence that supports its position on these issues. As evidenced by the research submitted by the Ørsted IPs [REP4-126], the industry understanding of wake effects has developed considerably in the last 10 years. The Applicant's position on this issue does not reflect contemporary understanding, and they have provided no evidence to support their assertions regarding the materiality of Project's wake effects, or what design mitigations might be possible and the consequences of those for the Project.

3. Responses to issues raised at ISH6

Previous examples of wake analysis

3.1 During ISH6, the Applicant has asserted that the Ørsted IPs' interpretation of NPS-EN3 in this examination is unprecedented. The Applicant argues that if consideration of the wake effects of a project was required by policy, it would have been addressed in the consenting of round three projects. Therefore, the Applicant considers this is not a genuine policy requirement and has implied that Ørsted A/S (the parent company of the Ørsted IPs) has been inconsistent in its approach to this issue.

3.2 The Ørsted IPs' response to this assertion is two-fold:

3.2.1 First, the Ørsted IPs consider their interpretation of the NPS-EN3 and approach to wake loss is not new and there are numerous examples of agreements which reflect that;

3.2.2 Second, the Ørsted IPs consider any increased focus by existing developers on the wake impacts of incumbent development in contemporary consenting processes is due to the outcomes of assessing the interrelationship of built offshore windfarms becoming available. This has disclosed that wake loss is a more material issue than was previously understood.

3.3 There are examples of wake loss between offshore wind development being dealt with in the consenting process. Namely, as the Applicant and Examining Authority are aware, the equivalent policies (under a previous iteration of the NPS-EN3) were considered in the Awel y Mor application. In that case, where there was potential for a 2% reduction in energy yield at the existing windfarm, the Secretary of State considered a wake assessment was required to ensure the effect was mitigated and minimised.[11]

3.4 Additionally, the Ørsted IPs note that wake effects were openly considered during the consenting process for the Burbo Bank Extension offshore wind farm, the Walney Extension offshore wind farm, and the Hornsea 2 offshore windfarm.

3.5 Importantly, the Ørsted IPs wish to respond to the Applicant's insinuation that Ørsted A/S has taken an inconsistent approach to this matter in respect of Ørsted-owned development. Danish Oil and National Gas ("**DONG**") - Ørsted A/S' former name, raised the issue of wake loss in the examination of Hornsea Two offshore windfarm, a round 3 project.

3.6 In that examination, solicitors acting on behalf of DONG, raised concerns regarding the impact of wake effects that Hornsea Two would have on energy yield at Hornsea One. That submission is attached as **Appendix 2** to this document. It also acknowledged that, at that time, there was limited understanding of the relationship between offshore windfarms in terms of wake. This issue is one which has matured over time.

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[11] At 4.178 of the Secretary of State's decision.

3.7 In that examination, a private solution was negotiated, such that the examining authority was not required to determine the issue. It is noted the relevant provisions of the NPS-EN3 relied on by the Ørsted IPs are the same in substance as those which applied in the Hornsea Two examination.

3.8 These submissions demonstrate that the Orsted IPs' interpretation of NPS-EN3 is not new or novel. Further, they demonstrate that Ørsted A/S has taken a consistent approach to wake loss in respect of other developments.

3.9 The Ørsted IPs understand that this is an issue which is regularly dealt with by applicants and incumbent developers - often resolved through negotiation. In other cases, applicants have engaged with impacted sea users on this effect, assessed the effect and either demonstrated the effect is immaterial or provided appropriate mitigation, such that scrutiny of the issue in an examination has not been required.

3.10 The Ørsted IPs acknowledge that the industry's understanding of the impacts of wake effects has developed significantly in recent years, in particular in the years following the Crown Estate's Offshore Wind Leasing Round 4. It is noted that the majority of the research provided by the Ørsted IPs at deadline 4 [REP4-127]-[REP4-131] is post-2020.

3.11 While the potential for wake effects has always been acknowledged, recent reporting on real life examples has been able to provide significantly more detailed information regarding actual effects which occur between windfarms, including at greater distances than previously understood. As a result, the offshore wind industry has developed a more sophisticated and empirical understanding of wake effects.

3.12 As such, the Ørsted IPs consider that asset owners have become increasingly alert to the risk of wake loss at their developments. That being the case, it may be that the issue of wake loss has become a greater focus in contemporary examinations of offshore windfarm projects.

3.13 However, the Ørsted IPs reiterate that the interpretation of the NPS-EN3 to include consideration of wake impacts is not novel. Further, significant precedent exists for the consideration and resolution of disagreement between developers regarding wake effects. The Applicant has now had numerous opportunities to work through this issue with the Ørsted IPs in a manner consistent with other developers and has chosen not to.

<u>The Crown Estate's Round 4 leasing requirements</u>

3.14 As discussed in previous submissions, the Applicant has erroneously relied on compliance with the boundary requirements in the Crown Estate's ("**TCE**") round 4 leasing process, to justify not carrying out an assessment of the Project's wake effects.

3.15 During ISH6, the Applicant stated that TCE's recent submission on the examination of the Outer Dowsing Offshore windfarm (the "**ODOW submission**")[12] indicated that wake was taken into account in the setting of this separation distance.

3.16 Further, the Applicant appears to rely[13] on the following passage from the ODOW submission as support for its argument that development beyond the TCE separation distance is not 'close' under the NPS-EN3 for the purposes of wake effect:[14]

> *This 7.5km was used for the purpose of processing project proposals in the tender only, being higher than the 5km buffers that are specified within the seabed lease agreements (introduced in Round 3); this was for the purpose of de-risking the Round 4 tender by providing additional mitigation and assurance to participants through limiting proximity.*

3.17 The Ørsted IPs reiterate that the ODOW submission demonstrates that wake was one of a number of factors (including navigation and safety) taken into account in setting a <u>minimum</u> separation distance between offshore windfarms. As noted in the submission, that distance was set "*for the purposes of processing project proposals in tender only…* ". Therefore, the buffer was not intended to replace analysis in the consenting process.

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12 Attached to the Orsted IPs' deadline 5 submission [REP5-118].

13 See, for example the Applicant's response to ExQ2 (Q2.19.2) [REP5-080].

14 Appendix 1, 1. bullet point 3 [REP5-118].

3.18 This is made clear further on in the submission, where TCE acknowledges that wake effects can extend beyond the buffer distance and states "*The location of a wind farm within an area of seabed leased from The Crown Estate is for developers to decide and design for, subject to obtaining the necessary consents and The Crown Estate's approval*."

3.19 In the Ørsted IPs' view, the clear thrust of the ODOW submission is that:

3.19.1 TCE did not undertake a detailed or conclusive analysis of wake loss in setting the round 4 separation distances. Rather, it was one factor taken into consideration in setting a minimum distance for the purposes of the leasing tender process.

3.19.2 The 7.5km separation distance was not intended to replace the requirement for project-specific analysis of the effects on any of the factors taken into account in its establishment. This includes navigation, safety and wake.

3.19.3 It is accepted that wake effects can extend beyond the 7.5km separation distance and that factors other than distance are relevant to the level of wake effect experienced at other developments.

3.20 Additionally, as outlined earlier in this submission, the industry's understanding of wake effects has developed significantly in the years following the establishment of TCE's separation distance. Therefore, even if TCE intended for this distance to be relied on for what should be considered 'close' under NPS-EN3 (which the Ørsted IPs consider would be irrational as it would allow TCE to implicitly override a regulatory process over which it does not have jurisdiction), this distance would no longer be based on sound information.

3.21 We note the 2023 Frazer-Nash study relied on by the Applicant and provided at deadline 3 post-dates the establishment of the round 4 separation distances (and the signing of the agreements for lease) and should not be interpreted as forming the basis for that separation distance. This is confirmed by TCE in the ODOW submission: *"…[the Fazer-Nash study] has no direct link to the buffer zones set out in the 2019 Information Memorandum for Offshore Wind Leasing Round 4".*

3.22 We also reiterate that that study, which takes some generic, theoretical offshore wind farm pairs and looks at the balance in total production based on different densities and separation buffers, cannot be relied on as an assessment of the likely effects of the Project on the Ørsted IPs' developments, in these specific circumstances.

3.23 This is supported by TCE's comments in the ODOW submission that "*The report summarises modelling applied to generic/hypothetical wind farms and does not replace the need for project-specific analysis*."

Shepherd & Wedderburn LLP

20.12.2024

Appendix 1 – Ørsted responses

Appendix 1 – Ørsted responses

Introduction

1.1 Ørsted commissioned the Wake Report for two major reasons. Firstly, to evidence that wake effects have a material impact on other wind farms that cannot be ignored and secondly, to demonstrate that modelling wake is feasible and not an obscure, untrustworthy science, as argued by the Applicant, but an essential tool that underpins all investment decisions in the wind industry, including the estimation of wake effect.

1.2 We ought to acknowledge that the Applicant knows more about their development than third parties and for this reason our preference is for the Applicant to assess impact in line with NPS-EN3. Their continued refusal to comply with the policy forced us into commissioning an independent consultant, Wood Thilsted (**WT**), to assess the wake effect.

1.3 As such, WT used their expertise and professional judgment to create a reasonable set of assumptions and calculate the wake effect. We believe it is still possible for the Applicant, and indeed their responsibility, to apply their insider knowledge of the development to better the understanding of the wake effect on other wind farms.

Impact of wake effect on Irish Sea developments future viability

1.4 The Applicant appears to assume the only relevant effect of the Project is the immediate impact on energy generation at individual developments. UK offshore wind projects have historically been developed with government-sponsored market support. This support typically guarantees developers minimum electricity prices via Contract for Difference (CfD) and Renewable Obligation Certificates (ROCs) but are time limited.

1.5 As a result, late life developments will face greater uncertainties and pressure on profit margins due to volatile revenues coupled with the ageing nature of the assets pushing operating costs up. In such environment, it is entirely possible that a 5% reduction in electricity production could accelerate the decision to decommission early. [comments]

1.6 As part of their 2023 annual report[1], The Crown Estate published a study of the benefits of life extension along with a comparative analysis of different offshore wind project types. They summarise their finding as such: "w*hile new developments contribute highly to security of affordable energy, a life extended project scores much higher in terms of the efficiency of materials and space, and minimising environmental impact*". This conclusion underscores the importance of properly assessing wake to facilitate the future co-existence of the projects.

1.7 The Applicant's approach ignores that the unmitigated effect of the Project is such that it is likely to be a material factor in long-term decision making regarding such generation assets. Therefore, the generation at risk is not merely immediate reductions canvassed in the Wake Report but could (a) shorten the life and result in the loss of the entire output of the generation assets; or (b) stop the generator from pursuing a lifetime extension of the existing generation assets.

[1] Page 24 of the "UK Offshore Wind Report 2023" by the Crown Estate (attached appendix)

Critiques of the Wake Report

1.8 Wood Thilsted have prepared an addendum to the Wake Report, which addresses technical criticisms made at ISH6. That addendum is submitted alongside this submission. We do not seek to repeat the responses made in the addendum here. However, the Ørsted IPs wish to respond to a small number of issues raised.

Reliability of modelling

1.9 During ISH6 the Applicant characterised the Wake Report as *"one of multiple different approaches which could be taken to understanding this issue"* which would all have *"equal validity"* and which would produce an "*almost endless variety of different outcomes".* The Applicant stated it did not understand where the Wake Report sits in the overall realm of possible outcomes. The Applicant also stated that there is *"no such thing as industry standard methodology"*.

1.10 The Ørsted IPs considers this characterisation undersells the industry's understanding and ability to deal with this issue. Developers such as Orsted and the Applicant would not be able to calculate business cases for the purpose of price auctions or take investment decisions if the Applicants assertions were true.

1.11 Offshore wind developers routinely undertake wake assessments of their developments. An accurate understanding of energy yield, which is inextricably linked with wind resource and wake, is fundamental to any business case for such development. While certain assumptions must be made in carrying out such assessments, these can and are made on an educated basis to provide a range of robust likely outcomes.

1.12 The modelling tool utilised for the Wake Report (DNV WindFarmer:Analyst) is the most common tool used by developers and is broadly accepted in the industry to produce reliable results.

1.13 The accuracy of the wake model used in the Wake Report has been extensively validated by DNV as mentioned in the final paragraph of section 1.2 of the Wake Report. These validations show that the wake model produces results which closely predict actual losses experienced on operational wind farms, and not one of endless possible outcomes as suggested by the Applicant.

1.14 As with any model, the wake model used in the Wake Report will have an uncertainty which has been established through the extensive validations on operational projects. The inputs to the wake model will also contain uncertainties. The industry is very able to understand and characterise these uncertainties hence the Applicants assertion that each different approaches have equal validity shows a fundamental misunderstanding of the effect. Wake impacts can be evaluated taking consideration of the uncertainty of the analysis

1.15 As the Wake Study looks at the comparative difference between two scenarios where the only thing changing is the addition of neighbouring wind farms, many of the modelling and input uncertainties will be identical and cancel each other out reducing the inherent uncertainty in the wake analysis.

Mooir Vannin

1.16 During ISH6, the Applicant criticised that the Wake Report did not include an assessment of the proposed Mooir Vannin offshore wind project ("**MV**"). The Applicant suggested that this indicates the Ørsted IPs do not consider its own developments should be subject to the same requirements as other developments.

1.17 The Ørsted IPs wish to record that this is not their position. The Ørsted IPs view is that the effects of wake should be shared between developers. As outlined earlier in this submission, Ørsted A/S has historically taken a consistent approach to this issue in respect of its own developments and will continue to do so.

1.18 MV was not included in the Wake Report for a number of reasons, including that it is at a much earlier stage of development, with consent applications not expected to be lodged until Spring 2025. Therefore, the level of information available regarding MV is considerably less certain at this point of its development.

1.19 In contrast, the Project, along with the proposed Morgan and Morecambe offshore windfarms are considerably progressed in the DCO examination process, with the applicants for each development refusing to engage with the Ørsted IPs on the issue of wake loss. Therefore, the Ørsted IPs only option has been to assess the effects of those developments as accurately as possible, and given that the predicted effects are material, pursue the issue in the examination process.

1.20 However, we note that MV falls within a neighbouring nation and separate legal jurisdiction and therefore will be subject to a different decision-making process. Additionally, the MV site was awarded to Ørsted in 2015, well before the round 4 bidding process relevant to the Project concluded. As a result, prospective developers were on notice of potential wake effects from MV at the time of bidding and would have had the opportunity to build the consequences of those effects into their business cases. In contrast, the Ørsted IPs could not have been aware of the Project (or the proposed Morgan or Morecambe offshore windfarms) at the time of investment decisions were being made regarding their developments.

<u>Response to ISH6 Action Point 9</u>

1.21 Typically, the wind resource available to an offshore wind farm will vary from year-to-year in the range of ±5% of the average production. Outlier years can result in fluctuations that extend outside this range

1.22 However, the size of the fluctuations from year to year is not directly related to the wake impacts as described in the Wake Report. It is very important to note that the wake losses predicted as a result of the Project would occur in both low and high wind years. It is not a variable effect which would be eliminated if the natural variability of the wind resource was to cause an annual effect greater than the estimated wake loss. It would impact the Orsted IP developments in every year post commissioning of the Project resulting in a long-term average effect as estimated in the Wake Report, and the wake effect is not in any way mitigated by wind resource variability.

Ørsted

20.12.2024

Appendix

UK Offshore Wind Report 2023” by the Crown Estate

Offshore Wind

THE CROWN ESTATE

UK Offshore Wind Report 2023

Introduction

Gus Jaspert
Managing Director, Marine

I'm delighted to share the 2023 UK Offshore Wind Report. Delivering this holistic view of the UK offshore wind industry is of great importance to us. The Crown Estate's purpose is to deliver lasting and shared prosperity for the nation, using the land and seabed we manage to help catalyse Net Zero, restore nature, create thriving communities and deliver national value. When it comes to our work managing the seabed, this means taking a strategic and long-term view of this vital resource.

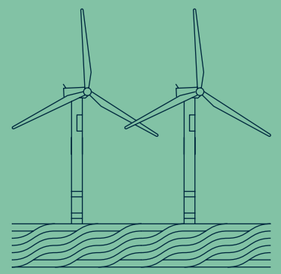
The UK's ability to rise to these challenges is directly linked to the growth and success of our offshore wind industry. Reading this report, it's extraordinary to see how far we've come in the almost 25 years since the first turbines were installed, collectively building a world-leading offshore wind market capable of powering 14.2m homes, drastically reducing our reliance on fossil fuels.

But as we look ahead we face new challenges which require new approaches. We need to achieve more in the next decade than we have in the last 25 years, accelerating the growth of the sector to maximise its contribution to Net Zero ambitions and unlock the jobs and prosperity it can bring. Yet at the same time our seas are under mounting pressure, supporting a growing number of livelihoods, industries and natural habitats. Growth must be achieved in a responsible way which allows all these other interests to thrive.

Achieving that means taking a more strategic, holistic and data-led approach than ever before to ensure we make the most of this vital resource so that it can contribute to the needs of our country and nature.

2023 saw many examples of new ways of thinking and new approaches being realised. Through our Whole of Seabed Programme we are digitally mapping the seabed space needed to meet future demand for a wide range of industries, infrastructure, and habitats out to 2050. This work will support the development of a pioneering Marine Delivery Routemap enabling partners and us to forward plan how we use the seabed in the future, which recognises the hat-trick of priorities we must consider – nature recovery, jobs and regeneration, and achieving Net Zero.

We are increasing collaboration with systems operators, governments and the sector to take a more strategic approach to resolve system issues, de-risk and accelerate the leasing process and put social value at the heart of decision-making. This includes working with the Electricity System Operator (ESO) and others to develop a Strategic Spatial Energy Plan; planning ahead for grid connections; the development of an Industrial Growth Plan (IGP) that could support long-term growth of the UK offshore wind sector and boost the UK's economy by up to £25bn and support over 10,000 jobs; and preparing to launch a pilot £10million Supply Chain Accelerator fund



2,766
operational offshore wind turbines in the UK

to support supply chain opportunities created through the Celtic Sea Leasing Round 5, with a further £40 million earmarked for offshore wind. For Offshore Wind Leasing Round 5 we set clear expectations on the commitments developers will need to make when it comes to delivering broader social, environmental and economic benefits arising from their projects.

We have been able to move faster than ever before between leasing rounds, bringing the 4.5GW Offshore Wind Leasing Round 5 opportunity to market within a year of signing Round 4 Agreements for Lease, whilst welcoming the Government's intention to work towards a further pipeline of up to 12GW. This acceleration is not just about faster leasing, but also about faster deployment of offshore wind – in part, thanks to up-front Habitats Regulations Assessments, planning together for grid connections and investing millions in surveys to inform site selection. We also announced a process to consider requests for increases in capacity on several projects already in agreement to ensure that we are maximising the potential from existing wind farm areas.

Deeper collaboration, enhancing evidence and data, forward planning together, resolving system issues, all increasing our pace: this is the shift in mentality we will need to take into the future if we are to meet the UK's critical Net Zero ambitions and ensure the social and economic benefits of the offshore wind sector are felt across the country.

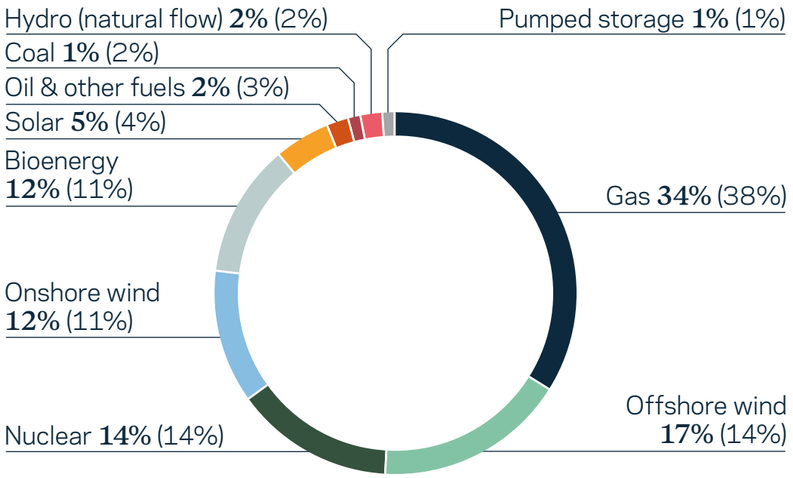
We've come a long way, and built a solid base from which, together, we can accelerate the energy transition, support nature recovery and grow the supply chain. But we want, and need, to do even more. That's why we welcomed the UK Government's commitment to bring forward legislation that will modernise our investment powers, in particular our ability to borrow. This would allow us to invest significantly more, to have a greater impact and accelerate the sustainable deployment of offshore wind for the benefit of the country and the environment.

The one constant we can rely on is increasing volatility, whether that's geopolitical, economic or environmental. However, this report paints a picture of a robust industry which is able to overcome challenges and continue to grow. That's in no small part thanks to a commitment to work together, which will be a powerful force as we take on the challenge to do more, and do things differently, to ensure the continued success of the UK offshore wind industry.

I would like to thank all those who have contributed to this report and shared data, particularly Crown Estate Scotland, allowing us to present a holistic view of the UK offshore wind industry. I hope you enjoy reading this report and reflecting on yet another extraordinary year for the UK offshore wind industry.

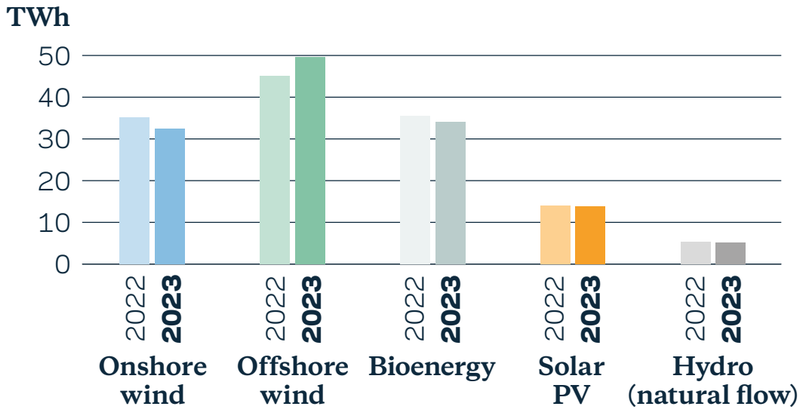
Gus Jaspert
Managing Director, Marine

Figure 1: UK electricity generation mix 2023 (2022 comparison)[1]



1 Source: Department for Energy Security and Net Zero (DESNZ).

Figure 2: Renewable energy generated by fuel type[2]



2 Source: Department for Energy Security and Net Zero (DESNZ).

49TWh

Amount of electricity produced by UK offshore wind in 2023

50%

UK offshore wind generated enough electricity in 2023 to supply the needs of 50% (14.2m) of UK homes

17%

Proportion of total UK electricity generated by offshore wind in 2023[3]

18.5m tonnes[4]

CO_2 displaced through use of renewable energy[5]

3 Source: DESNZ Energy Trends publication March 2024

4 Rounded up from 18.49m

5 How this is calculated can be found at the end of the report.

Offshore Wind 2023 highlights

49TWh
UK offshore wind electricity produced in 2023

26
Offshore Transmission Owners

15GW
Operational offshore wind capacity

52
Offshore wind farms in the UK

43%
Of European offshore wind capacity hosted within UK waters

Marine Data Exchange

10 years
Since The Crown Estate established The Marine Data Exchange

50%
UK offshore wind supplied the equivalent electricity needs of 50% of UK households in 2023[1]

18.5m
Tonnes CO_2 displaced by use of offshore wind energy

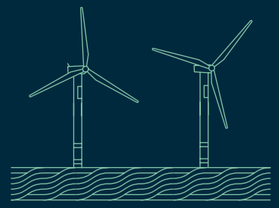
30k+
Total offshore wind workforce, growing to c.100,000 by 2030[2]

96.5%
Performance Index, technical availability of the wind farm fleet in England and Wales

41%
Reduction in Lost Time Injury Frequency (LTIF) in the UK[3]

Looking forward:
A strong pipeline of offshore wind capacity

50GW
UK Government offshore wind capacity target for 2030



93GW
Pipeline of offshore wind capacity in the UK including operational, committed, under development / preplanning and current potential[4]

4GW
Of additional capacity through potential capacity increases[5]

4.5GW
Capacity of floating offshore wind to come from Leasing Round 5[6]

c.268,000km²
Of seabed under management, equating to approximately twice the land area of England, Wales & Northern Ireland and included in the 2050 Marine Delivery Routemap

1 49TWh of power generated is the equivalent of the annual electricity needs of 50% of UK homes.
2 OWIC – Offshore Wind Skills Intelligence Report June 2023.
3 LTIF tracks fatalities and lost work day injuries per million hours worked. Reduction is based on latest data available, 2022 v 2021.
4 See page 36 of this report for more detailed explanation on the offshore wind development pipeline.
5 Up to 4GW, subject to assessments and approvals. Part of the overall 93GW pipeline.
6 Part of the overall 93GW pipeline.

Table of contents

This report is produced annually by The Crown Estate to provide a picture of the UK offshore wind industry, using our own and publicly available data.

THE CROWN ESTATE

We work across communities, cities, countryside, coast and the seabed with a responsibility – and opportunity – to play our part for the benefit of the nation, its finances and its future.

At the heart of our business lies a set of core duties to grow both the value of the portfolio into perpetuity and the income we return to the Treasury. Established through an Act of Parliament, we operate independently and commercially, occupying a space between the public and private sectors. Today, we express this through our purpose: to create lasting and shared prosperity for the nation.

Across our £16 billion portfolio, we are acting in the national interest for today and for future generations. Our strategy focuses on the nation's long-term challenges where we are best placed to make a difference. We aim to:

- be a leader in supporting the UK towards a net zero and energy-secure future;
- take a leading role in stewarding the UK's natural environment and biodiversity;
- support thriving inclusive communities and economic growth; and
- responsibly generate value and financial returns for the country.

A company for the country, all our net revenue profit goes to the Treasury for the benefit of the nation's finances. This has totalled more than £3.2 billion over the last ten years.

Crown Estate Scotland
Oighreachd a' Chrùin Alba

Crown Estate Scotland is a public corporation which manages a range of property, including the seabed, to deliver lasting, valuable benefits to Scotland and its people. Our revenue profits are paid to the Scottish Government for use in public spending. Part of our role is awarding the rights to build and operate renewable energy projects in Scottish waters, and we are committed both to supporting the development of Scotland's blue economy and the Scottish Government's target of reaching net zero emissions by 2045. To learn more about the work we do and the causes we support, visit **crownestatescotland.com**

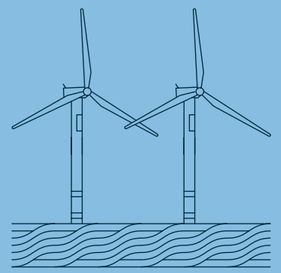
Acknowledgements
In order to provide a UK-wide picture of offshore wind, Crown Estate Scotland has provided statistics for this report and there are features on the performance and development of the Scottish offshore wind portfolio.

Our thanks to all those who have provided content, in particular: Balfour Beatty; Ben Barden Photography; Dan Bolt; Diamond Transmission Partners; Dogger Bank Wind Farm; Equitix; Frontier Power; Global Energy Group; Jason Hawkes; Kate Harvey (G+); Lewis Jeffries; Monty Rakusen; Offshore Wind Industry Council (OWIC); Ofgem; Ørsted; Scott Young (Renewable UK / OWIC); Valery Joncheray; World Forum Offshore Wind.

Offshore wind farm overview

It has been 20 years since The Crown Estate awarded its first commercial offshore wind lease and since then the UK market has grown rapidly. It now hosts 43% of all European offshore wind capacity, and generates enough electricity to supply the needs of 50% of UK homes.

In this section we take a look at some of the key statistics in the UK and global offshore wind markets, some of the milestones achieved by UK offshore wind farms in 2023, and developments in the wider market to support the industry to continue to thrive.



52

The number of wind farms in UK waters (operating and under construction)

Siemens Gamesa offshore wind turbine blade factory, Hull

2023 was a year in which the industry set more records. Offshore, a record 49TWh of green electricity was produced during 2023, and on the morning of 21 December, wind power, including onshore, produced a record 56% of Britain's electricity.[1]

Total offshore wind operational capacity in the UK now stands at 14.7GW, generated by 45 offshore wind farms comprising 2,766 turbines.

In 2023 the under-construction pipeline continued to grow despite challenging economic conditions, from 6.7GW in 2022 to 7.8GW in 2023, equivalent to a 50% increase on the operational fleet.

Other milestones in the year included the UK Secretary of State for Energy Security and Net Zero granting development consent to Ørsted's Hornsea 4 project, Scotland's largest wind farm, Seagreen Phase 1 becoming fully operational, and construction beginning for RWE's 1.4GW Sofia offshore wind farm. The world's largest offshore wind farm under construction, Dogger Bank, started producing electricity for the first time. It was the first commercial deployment globally of the GE Vernova's ground-breaking Haliade-X 13MW turbines. At over 130km from shore, the site showcases the shallow waters and windy conditions afforded by the UK market.

Meanwhile, London Array celebrated ten years in operation. When the 630MW wind farm became operational in 2013, it was the largest offshore wind farm in the world and remained so until 2018. The size and scale of more recent projects is a reminder of how rapidly the UK industry has grown in recent years, in part as a consequence of The Crown Estate's approach to Offshore Wind Leasing Round 3.

1 Source: ESO - Britain's Electricity Explained: 2023 Review (excludes N Ireland whose system operator is SONI).

Gwynt y Môr offshore wind farm array.

Figure 3: Increase in global offshore wind operating capacity

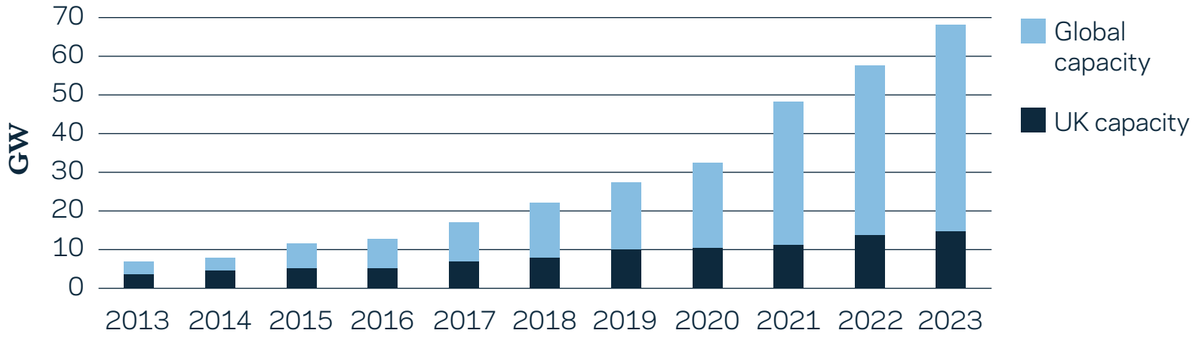
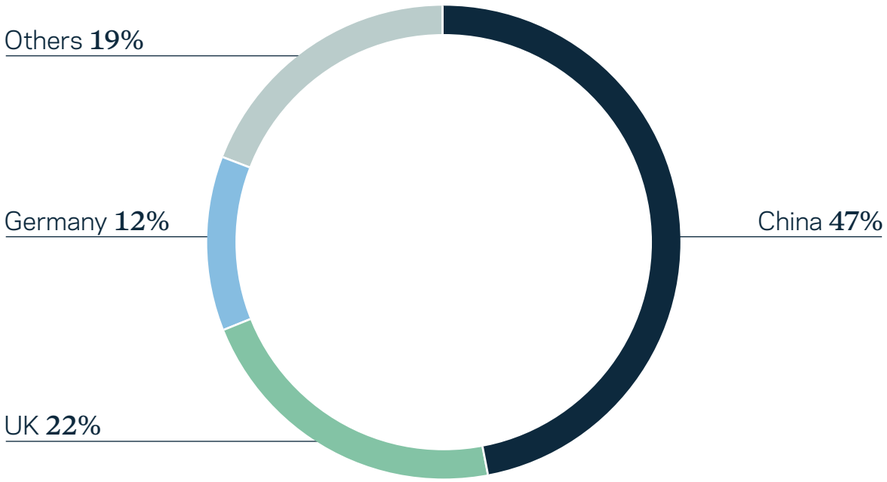
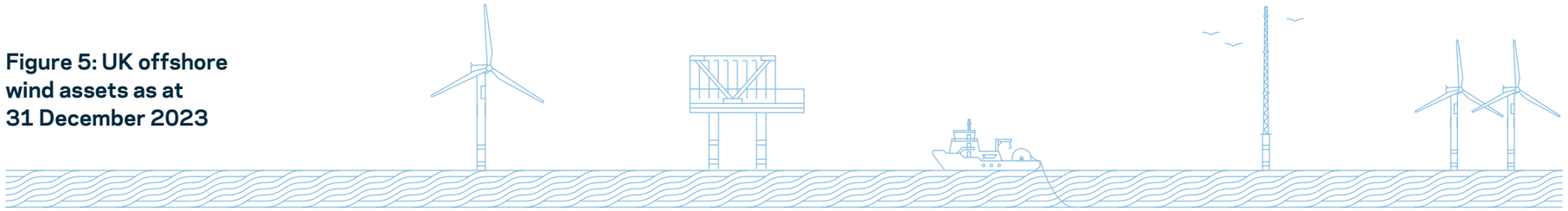


Figure 4: Global offshore wind operating capacity in 2023



Offshore wind assets, activity and ten year grid connected trends

Figure 5: UK offshore wind assets as at 31 December 2023

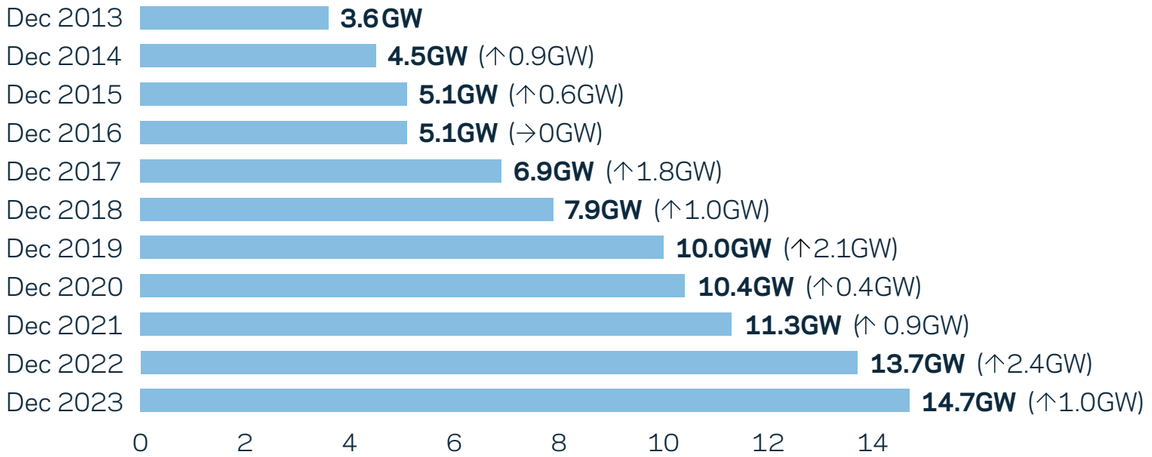


	GW	Offshore turbines	Offshore substations	Export cables	Offshore met masts	Wind farms
Operational:	14.7	2,766	40	90	10	45
Under construction[1]:	7.8	586	10	14	0	7
Total:	**22.5**	**3,352**	**50**	**104**	**10**	**52**

1 Sites under construction, including where first power is achieved, but not yet fully operational.

Wind turbine array

Figure 6: UK offshore wind grid connected[2] (change from previous year)



2 Grid connected capacity stated refers to the capacity connected to the grid from fully operational and partially operating sites (those under construction but already exporting power at December 2023).

Figure 7: Asset activity in 2023

Wind farms achieving Final Investment Decision

- East Anglia THREE
- Hornsea 3
- Moray West

Wind farms starting offshore construction

- Dogger Bank B
- Dogger Bank C
- Moray West
- Sofia

Wind farms under construction

- Dogger Bank A
- Dogger Bank B
- Dogger Bank C
- East Anglia THREE
- Moray West
- Neart na Gaoithe
- Sofia

Wind farms achieving first power

- Dogger Bank A

Wind farms becoming fully operational

- Seagreen Phase 1

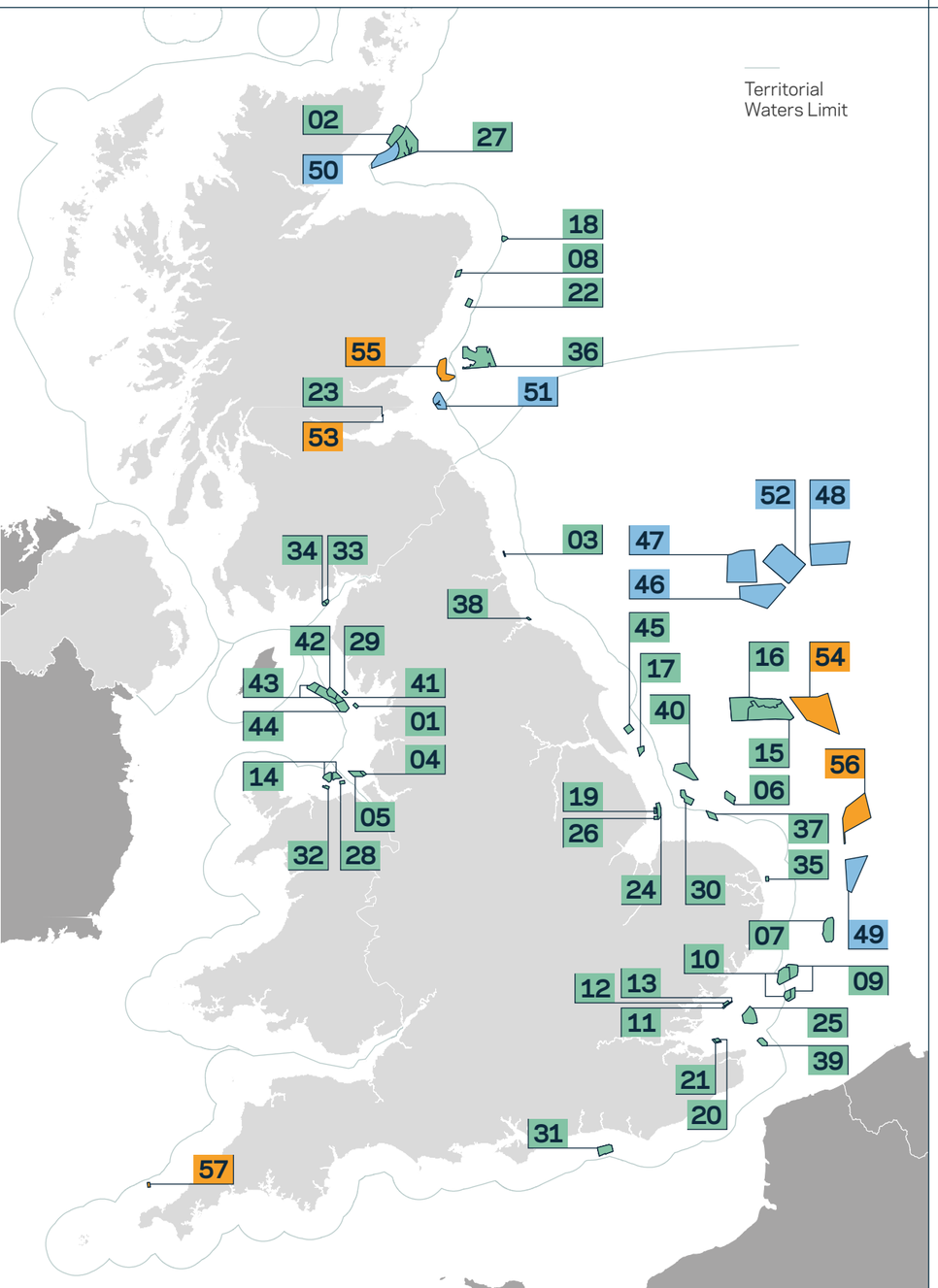


Figure 8: UK offshore wind project pipeline as at 31 December 2023

Operational: Total capacity of wind farms that have been fully commissioned.

		Capacity MW[1]
01	Barrow	90
02	Beatrice [2]	588
03	Blyth Demonstration Phase 1	42
04	Burbo Bank	90
05	Burbo Bank Extension	259
06	Dudgeon	402
07	East Anglia ONE	714
08	European Offshore Wind Deployment Centre [2]	97
09	Galloper	353
10	Greater Gabbard	504
11	Gunfleet Sands Demonstration	12
12	Gunfleet Sands I	108
13	Gunfleet Sands II	65
14	Gwynt y Môr	576
15	Hornsea 1	1,218
16	Hornsea 2	1,386
17	Humber Gateway	219
18	Hywind Scotland [2]	30
19	Inner Dowsing	97
20	Kentish Flats	90
21	Kentish Flats Extension	50
22	Kincardine [2]	50

		Capacity MW[1]
23	Levenmouth Demonstration [2]	7
24	Lincs	270
25	London Array	630
26	Lynn	97
27	Moray East [2]	953
28	North Hoyle	60
29	Ormonde	150
30	Race Bank	573
31	Rampion	400
32	Rhyl Flats	90
33	Robin Rigg East [2]	84
34	Robin Rigg West [2]	90
35	Scroby Sands	60
36	Seagreen Phase 1 [2]	1,075
37	Sheringham Shoal	317
38	Teesside	62
39	Thanet	300
40	Triton Knoll	857
41	Walney 1	184
42	Walney 2	184
43	Walney Extension	659
44	West of Duddon Sands	389
45	Westermost Rough	210
Total		**14,741**

Under construction: Total capacity of wind farms that have commenced construction but are not yet fully operational.

		Up to capacity MW[1]
46	Dogger Bank A	1,235
47	Dogger Bank B	1,235
48	Dogger Bank C	1,200
49	East Anglia THREE	1,397
50	Moray West [2]	882
51	Neart na Gaoithe [2]	448
52	Sofia	1,400
Total		**7,797**

Government support on offer: Total capacity of wind farms that have secured a Contract for Difference.

		Up to capacity MW[1]
53	Forthwind [2]	12
54	Hornsea 3	3,000
55	Inch Cape [2]	1,080
56	Norfolk Boreas	1,400
57	Wave Hub	30
Total		**5,522**

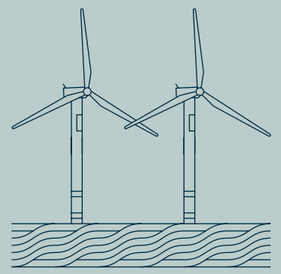
To find out where future development sites are – please see figure 38 on page 39.

1 Capacities noted are rounded to the nearest whole MW. 2 Asset managed by Crown Estate Scotland.

Offshore wind farm performance

The performance of UK offshore wind farms, and how fully plant capacity is used, is a vital indicator of the health and efficiency of the fleet. In this section we look at the performance of offshore wind farms, including capacity factor, power output and the impact of wind speed variation.

We cover performance across England and Wales which is under the remit of The Crown Estate, and Scotland, managed by Crown Estate Scotland.



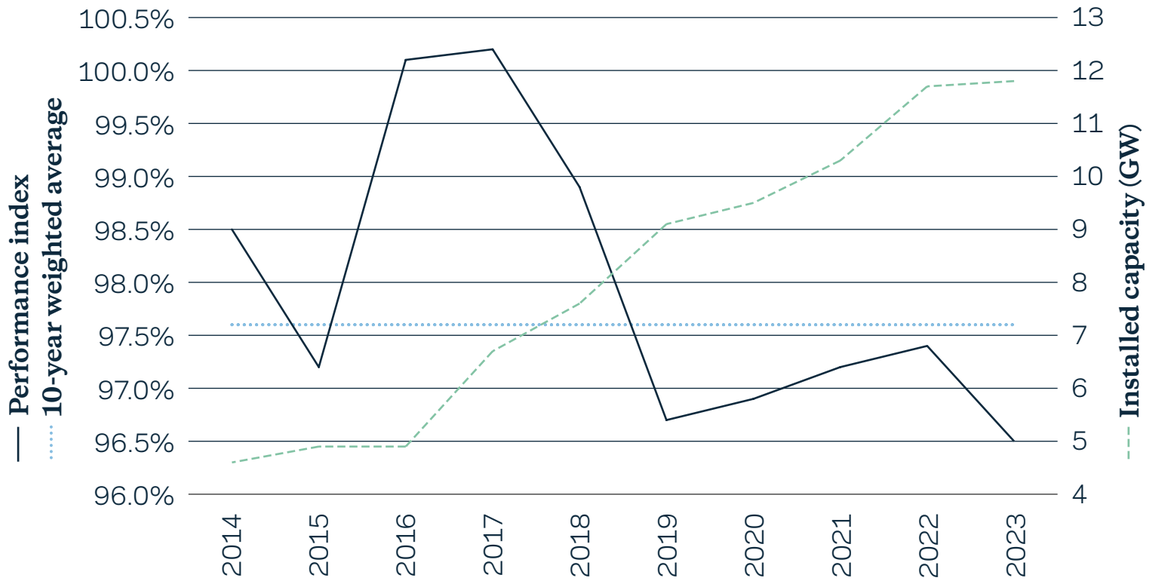
96.5%

Performance Index – indicating the technical availability of the wind farm fleet in England and Wales

Walney Offshore Wind farm array

England and Wales Fleet Performance Index

Figure 9: Fleet Performance Index – England and Wales



The Crown Estate's Fleet Performance Index compares metered electricity output against the expected output adjusted for actual wind speed during that period. It gives a direct measure of the performance of the offshore wind farm fleet in England and Wales, without any adjustment for outages and operational events.

The analysis only includes fully operational wind farms excluding the construction period. The analysis includes the whole system of the wind farm and its associated transmission/ export of electricity back to shore.

The expected power output is derived from satellite measurements and theoretical power curves. This indirect calculation carries a notable uncertainty, but gives an indication of the technical availability of offshore wind farms.

In 2023 the Fleet Performance Index was 96.5%, down from 97.4% in 2022, with a 10 year weighted average of 97.6%. Events that have had a noticeable impact include Distribution Network Operator (DNO) outages, substation maintenance and turbine main component exchanges.

England and Wales capacity factor

The capacity factor indicates how fully a plant's capacity is used, and varies year on year depending on the wind conditions.

Figure 10 shows the average capacity factor and the power output across all offshore wind farms in England and Wales between 2005 and 2023.

The fleet continues to improve its performance and in 2023 power output across the fleet in England and Wales reached an all-time high of 42.8TWh, giving a fleet capacity factor of 41%.

This upward trend reflects the continued improvement in turbine technology and the ability of newer wind farms to take advantage of more favourable wind conditions further out to sea.

Details on capacity factors and wind variability in Scotland can be found on page 14.

Figure 10: Capacity factor – England and Wales

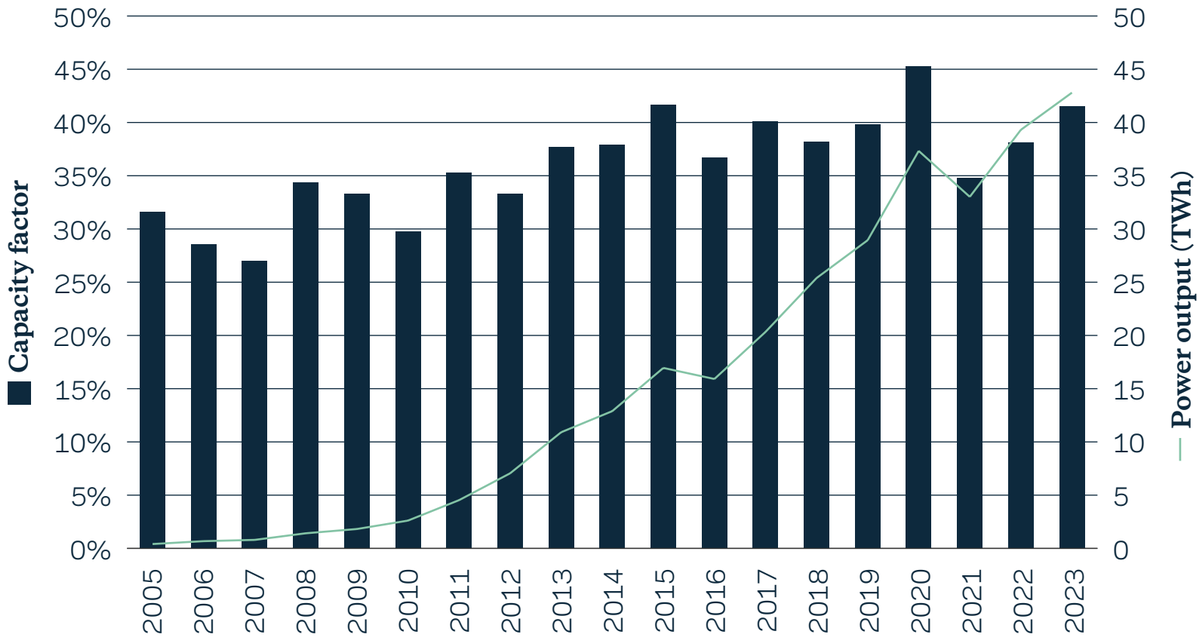
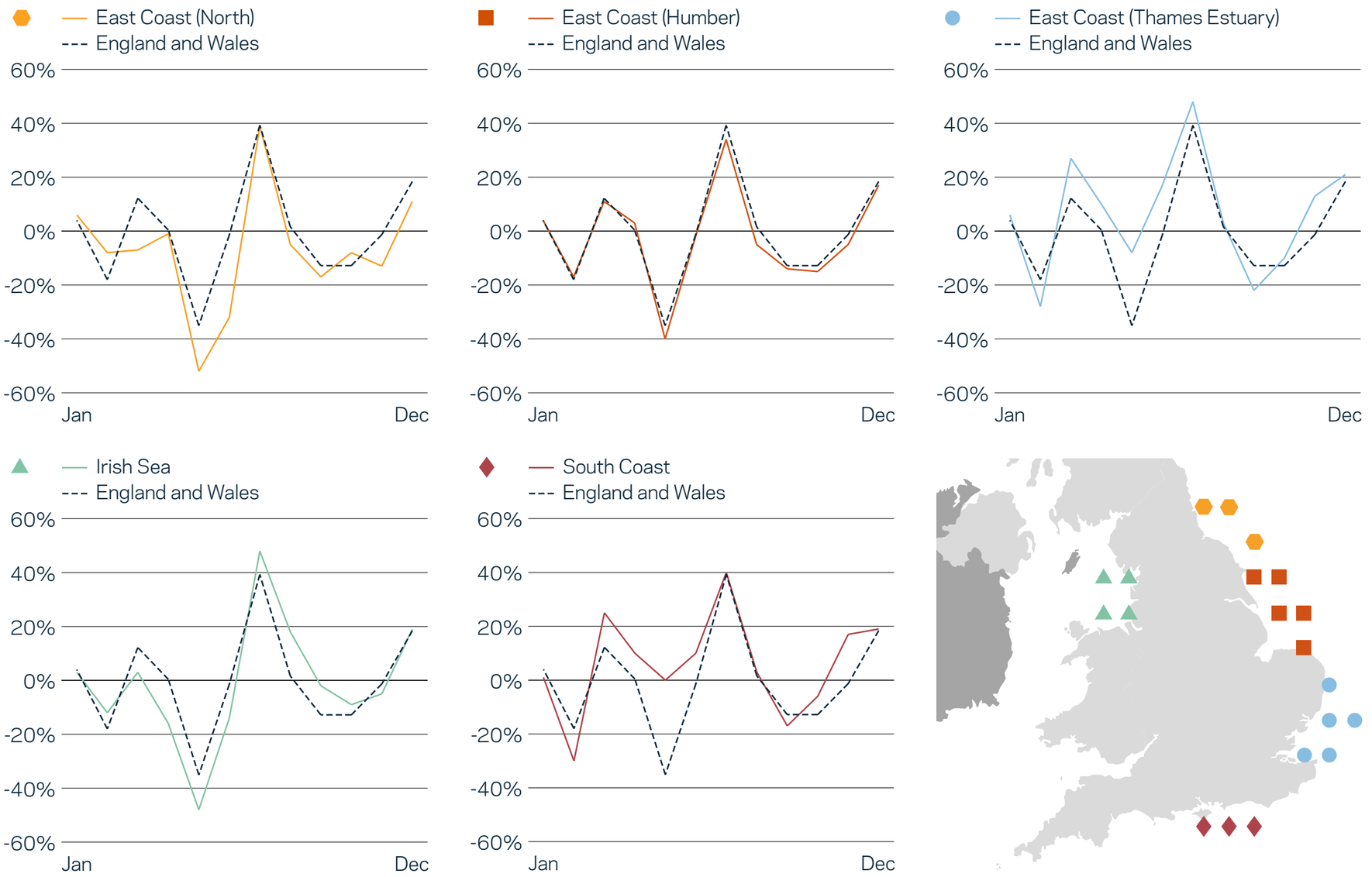


Figure 11: Monthly energy deviation due to wind speed in 2023 (zero on each graph represents the long-term average for each month)



England and Wales wind variability

Figure 11 shows the impact on energy production due to monthly wind speed variation in England and Wales.

The overall energy deviation at the end of 2023 was in line with the long-term average (LTA). February and May were significantly below the LTA with offshore wind production down by 18% and 35% respectively. Conversely, July proved to be an exceptionally strong month, with production 39% above average. This will have presented challenges to planning and carrying out summer construction and maintenance campaigns, aiming to take advantage of ordinarily less energetic months of the year.

The charts demonstrate the benefits of having an offshore wind fleet spread around the coastline, able to take advantage of different wind speed conditions in different locations. For example, the South Coast performed in line with the LTA in May, compared to every other area which saw production drop significantly.

Adding capacity in the Celtic Sea, starting with Offshore Wind Leasing Round 5, is expected to slightly increase resilience of the UK's renewable electricity production. For more information, see Offshore Wind Leasing Round 5 – floating wind in the Celtic Sea on page 38.

Offshore wind generated electricity

Figure 12 compares the output of the biggest producing wind farms in the UK in 2023 compared to production in 2022.

The UK fleet generated 49TWh in 2023, a 9% increase on output in 2022. That is enough to supply the electricity needs of 14.2million homes (see figure 13) and marks another record high for the sector.

The UK is home to seven of the world's largest operational wind farms. In 2023 Hornsea 2 overtook Hornsea 1 as the world's largest operational offshore wind farm. Collectively the two sites generated over a fifth of the UK's offshore wind generation (22.4%), reflecting the increasing size and capabilities of new offshore wind farms.

Figure 12: Percentage of total 2023 offshore wind electricity, generated by asset (position change from 2022)

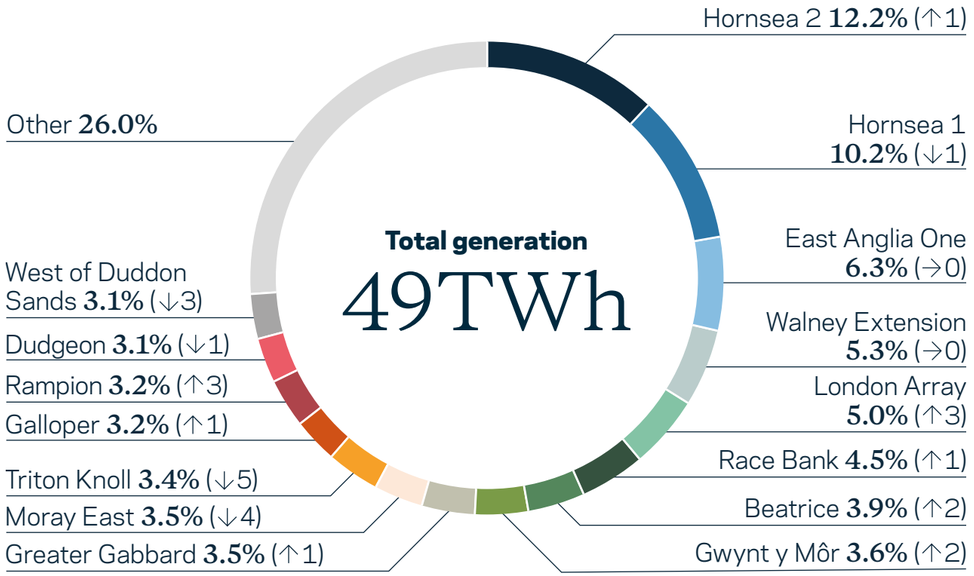


Figure 13: Percentage of UK homes' annual electricity needs that can be supplied by offshore wind

10%
2013
2.7m homes
(5.1TWh)

26%
2018
6.9m homes
(26.6TWh)

50%
2023
14.2m homes
(49.0TWh)

56% *estimated*
2024
15.7m homes
(54.5TWh) *estimated*

UK offshore wind generated **49.0TWh** last year. That's enough to supply the electricity needs of **half of all UK homes**.

Performance in Scotland

Portfolio managed by Crown Estate Scotland

The Seagreen Phase 1 project completed commissioning works in October 2023, with all 114 turbines successfully installed and generating. This wind farm is the largest in Scotland, with an installed capacity of 1,075MW, and is currently the world's deepest fixed bottom offshore wind farm with the deepest foundation installed at 58.6m below sea level. The port of Montrose hosts the operations and maintenance base for the wind farm and in 2023 it began use of the state-of-the-art Edda Brint service operation vessel which has been prepared for future zero-emission usage due to its hybrid hydrogen power capability.

Construction of Neart na Gaoithe offshore wind farm continued throughout 2023, with over 30 turbines now installed. First power is currently expected during 2024, with the project ramping up throughout the next year.

Construction on Moray West offshore wind farm commenced during 2023, with first power generation estimated to arrive in summer 2024. Once all 60 turbines have been installed, Moray West will have a generating capacity of 882MW. Full operation of the wind farm is anticipated to begin in early 2025.

At the end of 2023, 2,973MW of capacity was fully operational with a further 1,330MW in construction. 2023 saw the Scottish fleet generate in excess of 6.2TWh of electricity.

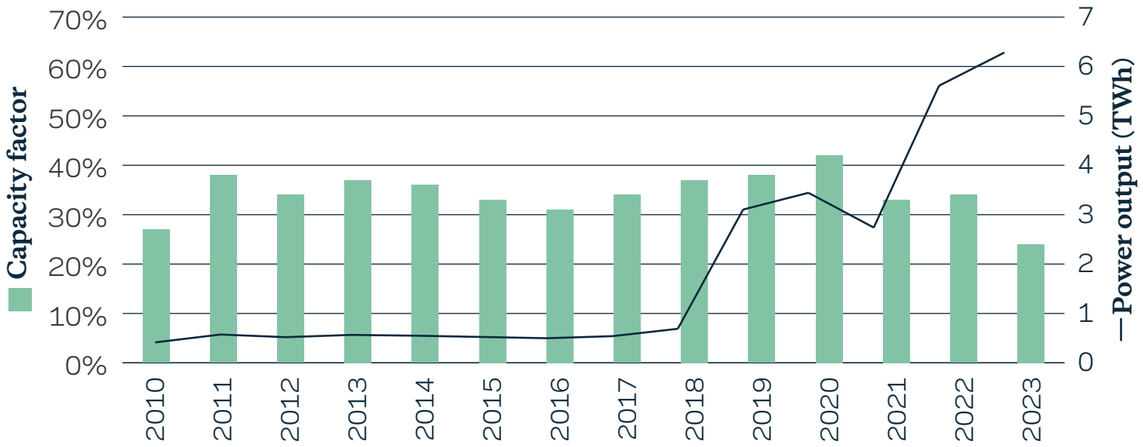
Grid capacity continues to be a significant challenge for the Scottish portfolio with further curtailment constraining the wind energy produced as more wind farms move into operation. In 2023 the offshore wind portfolio was also challenged with lower wind yield and unplanned maintenance on some of the assets.

Capacity factor – Scotland

Figure 14 provides a picture of the capacity factor and power output of Scottish offshore wind farms between 2010 and 2023, as the operational fleet has grown. When Beatrice wind farm became fully operational in 2019, Scotland's offshore wind capacity increased markedly. There were further increases due to the performance of Hywind Scotland in 2020, setting a record for the highest annual average capacity factor for a UK offshore wind farm at 57.1%. Through 2021, wind speed decreased impacting the capacity factor, to then increase in 2022, in addition to Moray East wind farm becoming operational.

During 2023, wind speed dropped back from the average last three years and this was compounded by grid challenges as Seagreen become operational and cable outages at Moray East impacted the potential for generation. Capacity factor was disproportionately impacted by generation potential being lost at the two largest wind farms in the fleet leading to an historically low capacity factor of 24%. The average capacity factor over the last five years in Scotland was 34%.

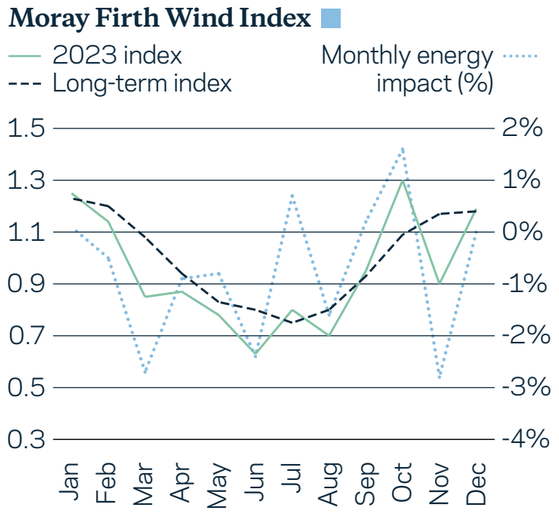
Figure 14: Capacity factor – Scotland

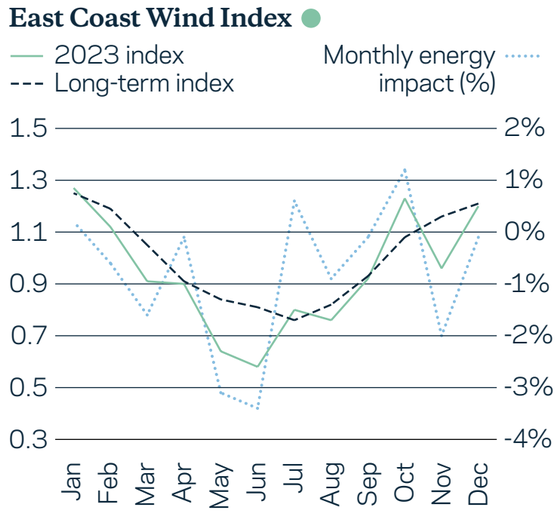


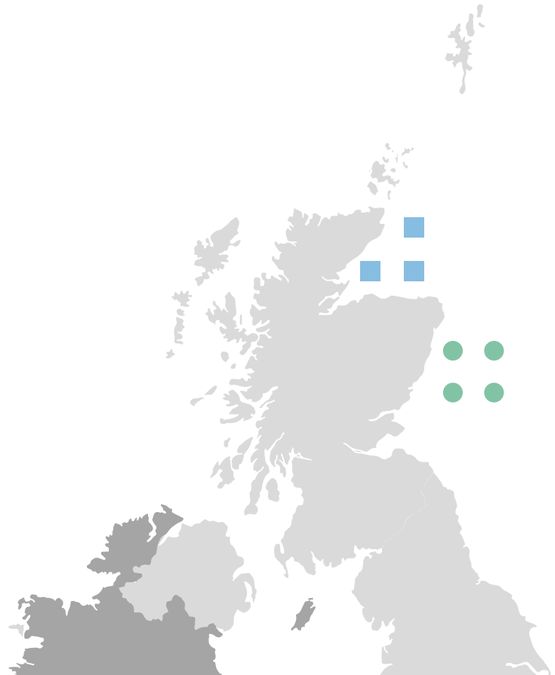
Wind variability – Scotland

Figure 15 illustrates Scotland's monthly wind speed indices based on the average of two regions, East Coast and Moray Firth. Wind speed trends for 2023 were similar for both regions, with the overall 2023 wind index in Scotland 5.4% below the long-term average. The cumulative total annual energy deviation associated with this decreased wind speed is 9.9% below the long-term average. This is a very different outcome compared to 2022 where wind speeds exceeded the long-term average for most of the year. The graphs illustrate consistency of wind resource being down on average across the UK. Similar to the rest of UK waters, wind speed was down against the long-term average for most of 2023.

Figure 15: Monthly wind speed index in 2023

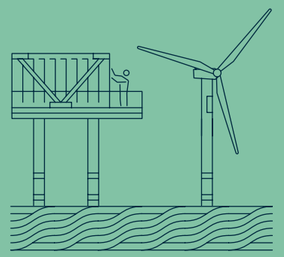






Offshore Transmission Owner (OFTO) performance

The strength of the UK market doesn't rest on offshore wind farms alone. The performance of Offshore Transmission Owners (OFTO), which provide the transmission connection to the onshore electricity network, is a key indicator of a healthy, efficient industry. In this section we take a look at how these assets have performed.



99.4%

The average OFTO availability for 2022/23

Gwynt y Môr offshore wind farm array and substation. Vessel in the background.

By the end of 2023, the OFTO network comprised 26 licensed OFTOs[1], up from 24 in 2022, supporting over 11.8GW of generating capacity. The number of export cable circuits which make up the network also increased from 47 in 2022 to 52.

OFTOs interface with either National Grid's National Electricity Transmission System (NETS), or the lower voltage distribution networks owned and operated by Distribution Network Operators (DNO), ensuring that electricity generated can get to consumers. Transmission system availability figures, summarised in this section, are taken from the annual NETS performance report produced by National Grid covering April 2022 – March 2023. The full report can be found here.

Over the year, the average availability was 99.42%, the highest level since 2018-19 (99.5%) and significantly above the 98% minimum level of availability target set through the regulatory framework. This increased the five year average for availability, which now stands at 99.18%.

Figure 17 shows the breakdown of OFTO unavailability, with planned and unplanned outages making up 73% of system unavailability, a 2% increase on 2021-22.

1 Hornsea 2 OFTO licence granted July 2023 and Triton Knoll OFTO licence granted December 2023. However, these are not included in the performance statistics in this section of the report.

Figure 17: 2022-23 OFTO system unavailability

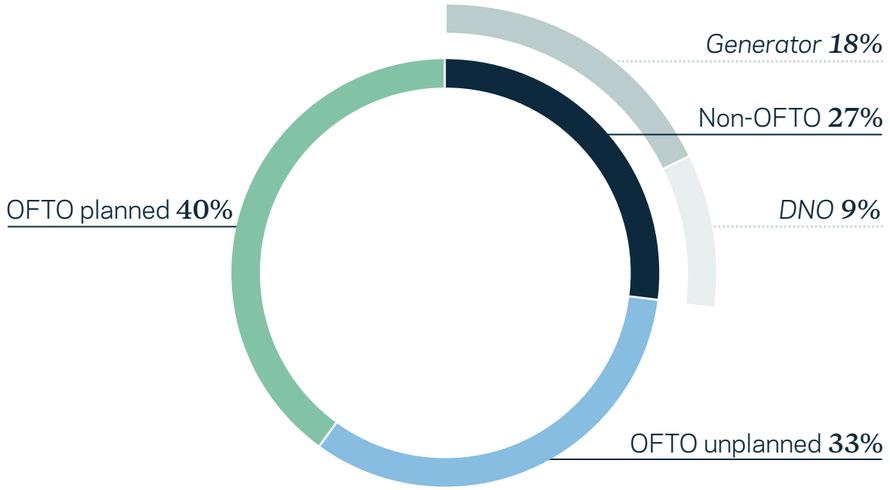
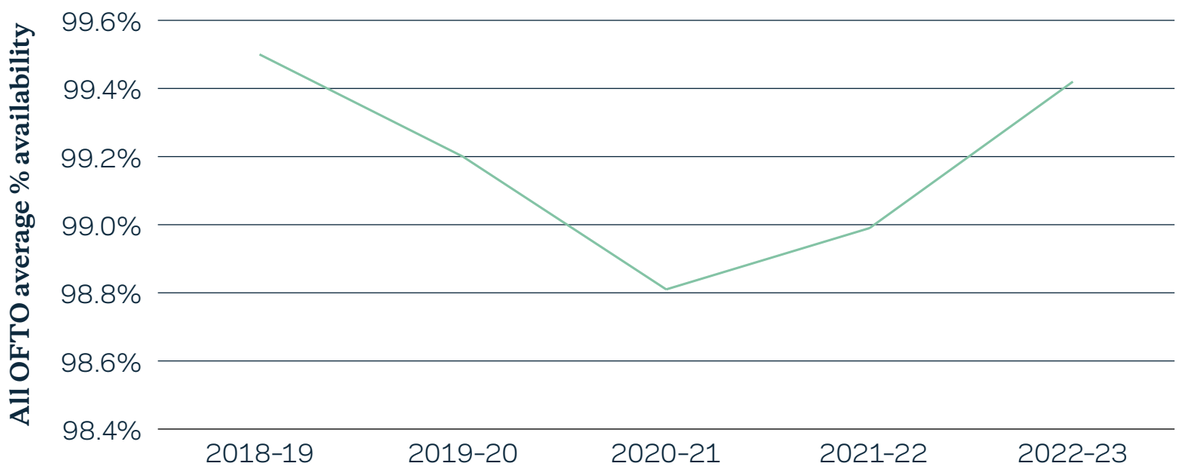


Figure 16: OFTO availability trend



Planned outages were the main cause of system unavailability with most taking place over the summer months. The number of these events decreased 38% over the year. However, unplanned outages increased, a situation usually caused by plant or equipment failure, such as circuit trips/faults, or outages requested by the DNO. In January 2024 Ofgem updated its 2014 guidance on 'Exceptional Events', providing greater clarity on circumstances under which OFTOs are not deemed responsible for system unavailability.

Reducing unexpected failures, particularly in the current market with long lead-times for replacement parts and vessels, is a key consideration as we accelerate towards net zero. On pages 21-24 we look at the work in place to maintain system availability, particularly when assets in this maturing market are reaching the end of their original design life.

Figure 18 on page 17 shows annual availability data for each OFTO, including all outages that originate on an OFTO's system but excluding outages that originate elsewhere, for example on a wind farm generator or DNO system. The OFTO availability incentive then adjusts the reported outage data to calculate incentivised performance for each OFTO.

OFTO ownership details can be found on The Crown Estate's website.

Aerial view of substation at Rampion wind farm

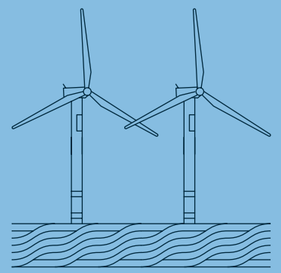
Figure 18: Offshore Transmission Networks % annual system availability

OFTO	2018-19	2019-20	2020-21	2021-22	2022-23
Barrow	100	100	100	100	100
Beatrice	N/A	N/A	N/A	99.16	99.32
Burbo Bank Extension	98.15	99.67	99.99	100	100
Dudgeon	100	99.31	99.83	99.92	99.95
East Anglia One	N/A	N/A	N/A	N/A	100
Galloper	N/A	100	99.95	100	99.97
Greater Gabbard	99.82	99.78	99.78	99.98	94.74
Gunfleet Sands	99.97	100	99.66	100	100
Gwynt y Môr	99.93[1]	96.10	86.31	99.21[1]	99.9
Hornsea One	N/A	N/A	100	99.93	99.57
Humber Gateway	100	99.83	99.76	98.73	99.72
Lincs	100	99.56	99.44	99.98	96.63
London Array	99.94	99.95[1]	99.77	99.82	99.92
Ormonde	100	100	100	99.93	99.38
Race Bank	N/A	100	99.26	100	99.93
Rampion	N/A	N/A	N/A	100	99.56
Robin Rigg	100	99.87	99.95	100	100
Sheringham Shoal	99.40	100	100	99.69	99.61
Thanet	100	100	99.84	100	99.72
Walney 1	100	99.95	100	98.9	100
Walney 2	91.42	100	100	100	100
Walney Extension	N/A	N/A	99.97	100	100
West of Duddon Sands	100	100[1]	99.50	99.19	99.09
Westermost Rough	99.73	100	100	99.93	100

1 Figure has been updated as an exceptional event with agreement from OFGEM.

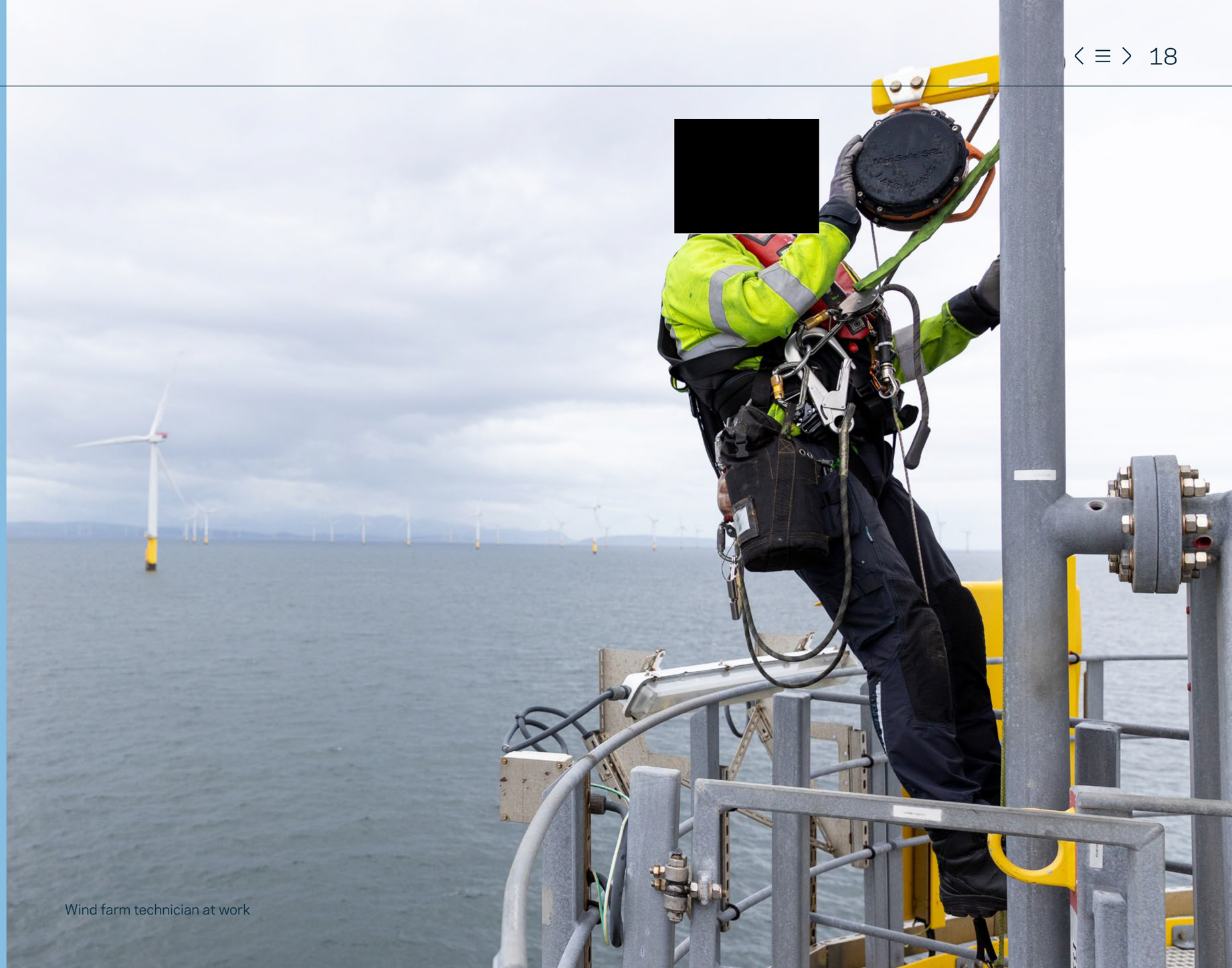
Health, safety & wellbeing

With new technologies being introduced, new waters being explored, new jobs being created, some assets nearing end of life, and the scale of development ever-increasing, the industry's commitment to health, safety and wellbeing is paramount.



41%

Reduction in Lost Time Injury Frequency (LTIF) in the UK (2022 data)



Wind farm technician at work

The Crown Estate's Safety First strategy puts health, safety and wellbeing at the centre of our decision-making and we are committed to thinking ambitiously about how we support health and safety resiliency in offshore wind.

We appreciate the need for a step change in our culture and capability. Moving forward, as the industry accelerates and continues to evolve and develop new technology in higher risk environments we are transforming our approach and strategy to surpass our previous achievements and build pace.

In 2023 we continued to strengthen and leverage our wide-ranging relationships with governments, international bodies and organisations including Trinity House, G+, and the Maritime and Coastguard Agency; and were pleased to become an Associate Member of the International Marine Contractors Association (IMCA).

We continue to work closely with the Health and Safety Executive HSE and support its strategic objectives of protecting people and places, especially fostering better health and mental health, and in 2023 welcomed the opportunity to take part in its Chairs Forum, to discuss the safe transition towards Net Zero. We built our incident handling capabilities by holding a crisis simulation exercise based on an offshore incident scenario, allowing the team to understand how to support customers and suppliers in the event of an incident. We also spent a day on board survey vessels with the teams conducting surveys for The Crown Estate in the Celtic Sea, sharing best practice and health and safety expectations with one another before work commenced. This is a practice we intend to replicate in the future as we continually look for ways to improve how we care for our people, our customers and our suppliers.

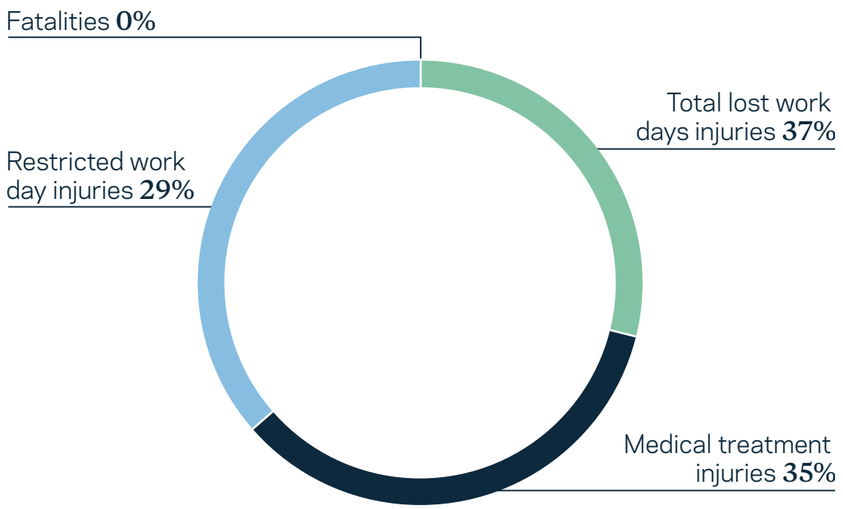
The importance of actively promoting industry sharing is highlighted in the figures in this section. Whilst we are seeing a downward trend in reducing the number of incidents, it is vital that this momentum is maintained and we work together to build a safer and healthier future.

G+ update and data

The Crown Estate remains committed to working closely with G+, the global health and safety organisation for the offshore wind industry, to share information on an international level and seek best practice from across the globe. We welcome the commitments made by David Griffiths, the new chairperson of G+, to expand the reputation and reach of the organisation in North America and Asia Pacific regions. These commitments include initiating new workstreams into welfare in the offshore wind industry, severe weather preparedness, health and safety considerations around the use of surveying buoys, and the safe transit of vessels around offshore wind farms.

Technicians ascending a wind turbine to conduct inspections

Figure 19: Global offshore wind industry recordable injuries 2022[1]



1 Source: G+ 2022 Incident data report (2023 data expected June 2024) – see G+ website

G+ update and data (continued)

Here we highlight data as published in the G+ 2022 incident data report, accessible by visiting the G+ website. The data for 2023 is due to be published in summer 2024.

Lost Time Injury Frequency (LTIF)[1] and Total Recordable Injury Rate (TRIR)[2] are key indicators of the effectiveness of health and safety procedures and figure 20 shows progress in 2022 across both categories. Globally, LTIF reduced 34% in 2022 compared to 2021, and TRIR reduced 16%. This trend was mirrored in the UK with both scores reducing, bringing the UK figures lower than the global average. This is despite the number of hours worked increasing by 38% globally and by 6% in the UK. There were no fatalities in 2022, an indication that there is a strong adherence to process and procedure across the sector.

In the UK, 'Near Miss' and 'First Aid Injury' continued to make up the majority of incidents (figure 22) with 75% (260) of all incident types occurring on operation sites (figure 23). Promisingly, the number of incidents fell significantly across all site locations, by 64% on construction sites, by 36% on development sites. UK incidents on operation sites are at 18%, higher than the rest of the world so require continued focus.

Figure 21 shows the UK top three work processes causing most incidents in 2022. 'Lifting Operations' remains the process causing most incidents (13%), followed by 'Access/ Egress' (10%) and 'Routine maintenance' (8%). However, Lifting Operations and Routine Maintenance have reduced from 15% and 11% respectively in 2021. Good progress was also made in the year on reducing the number of incidents caused by 'Dropped objects', falling by 71%, from 94 incidents to 27.

1 The number of fatalities and lost work day injuries per million hours worked.
2 The number of fatalities, lost work day injuries, restricted work day injuries and medical treatment injuries per million hours worked.

Figure 20: 2022 and 2021 LTIF & TRIR values for UK and rest of world

	LTIF		TRIR	
	2022	2021	**2022**	2021
UK	**1**	1.7	**2.7**	3.79
Global	**1.03**	1.55	**2.82**	3.28

Figure 21: UK top three work processes causing most incidents in 2022

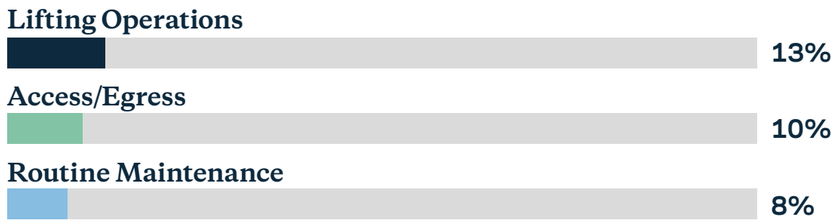


Figure 22: UK incident consequence profile 2022

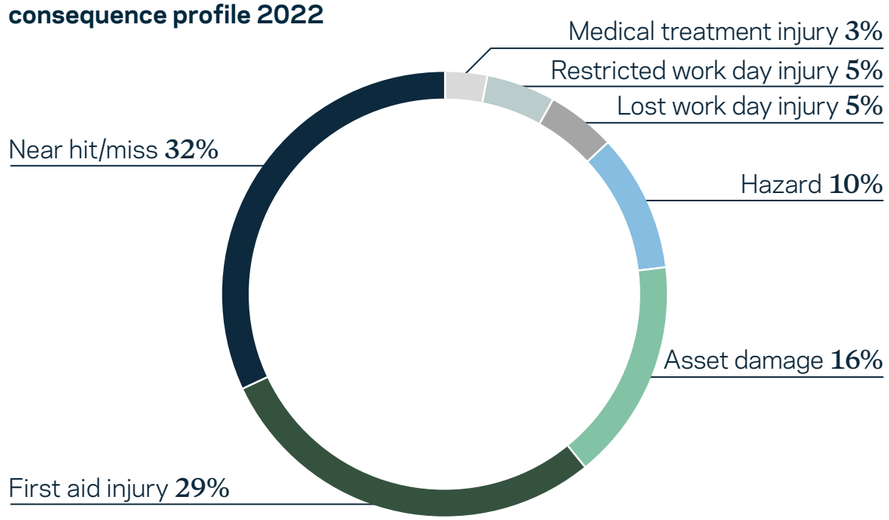
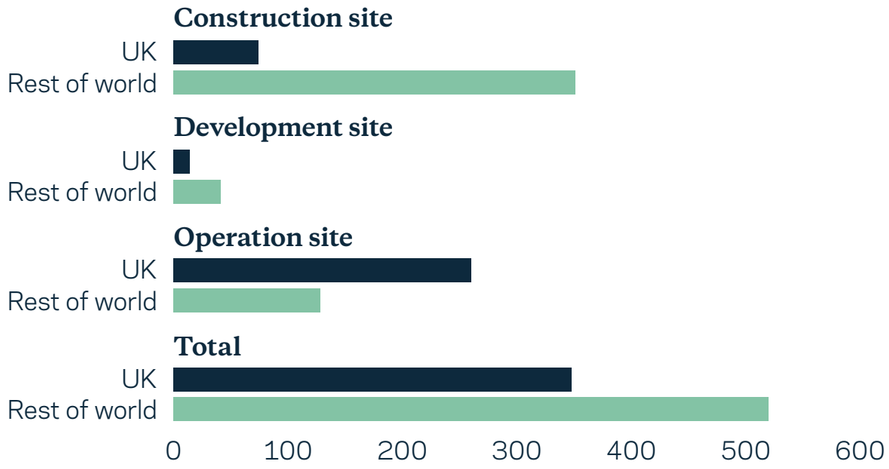


Figure 23: Incidents by site type in 2022 – UK v rest of world



Keeping the turbines spinning – the life extension opportunity

2023 marked a significant milestone for the UK offshore wind industry. The first commercial offshore wind farms, which were commissioned in 2003, reached their original expected 20 year design life. Following closely behind, in 2027 the first Renewables Obligation Certificates (ROCs) – a form of government subsidy for offshore wind farm operators – are due to expire, and in 2030 the first OFTO tender revenue stream will come to an end.

These milestone moments illustrate a challenge which must be factored in to considering how 50GW by 2030, and c.95GW by 2050, can be achieved.

Crew transfer vessel arriving at a wind turbine

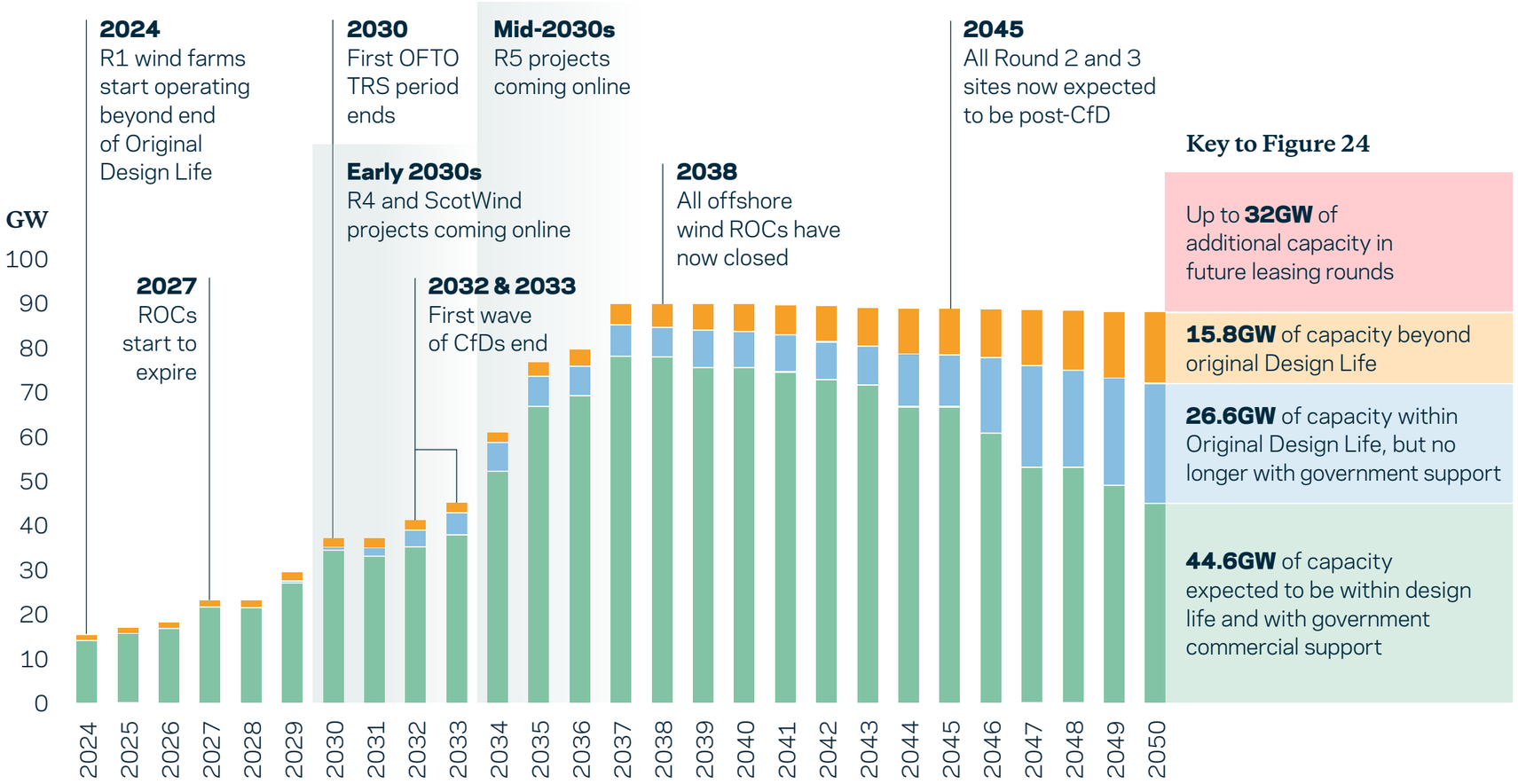
Figure 24: Capacity with increasing risk exposure

Figure 24 illustrates the offshore wind capacity that becomes more exposed to major events and economic changes, either due to potential expiry of government support in the form of subsidies, or through reaching end of expected lifetime.

Capacity is categorised in terms of:

- Original Design Life – usually 20-25 years
- Subsidy / Support Scheme – 15 years (CfD) or 20 years Renewable Obligation Certificates (ROC)

This profile considers the capacity in the operational and under construction UK fleet (figure 5 on page 8) and the capacity identified in the future development pipeline (figure 38 on page 39). Future timings are based on typical expected lead times for completion of project stages.



Key to Figure 24

Up to **32GW** of additional capacity in future leasing rounds

15.8GW of capacity beyond original Design Life

26.6GW of capacity within Original Design Life, but no longer with government support

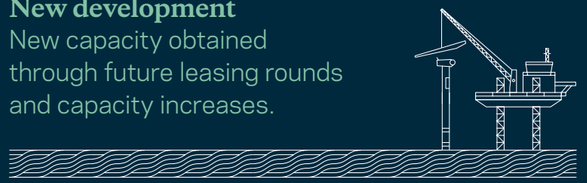
44.6GW of capacity expected to be within design life and with government commercial support

It is expected that a combination of new offshore wind developments, and repowering and extending the life of existing offshore wind farms (see figure 25 below) will be needed to maintain and grow a healthy offshore wind pipeline that supports 2050 targets.

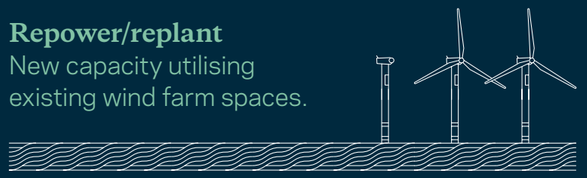
New projects and technologies can generate more electricity from the same space. But in an increasingly busy seabed, repowering and extending the life of existing offshore wind makes efficient use of space, supports the network of jobs and supply chain benefits built up over time, and makes use of existing infrastructure which has long-since offset the carbon impact of the development phase.

Figure 25: Options for growing and sustaining offshore wind capacity

New development
New capacity obtained through future leasing rounds and capacity increases.



Repower/replant
New capacity utilising existing wind farm spaces.



Life extension
Prolonging and maintaining the existing fleet.

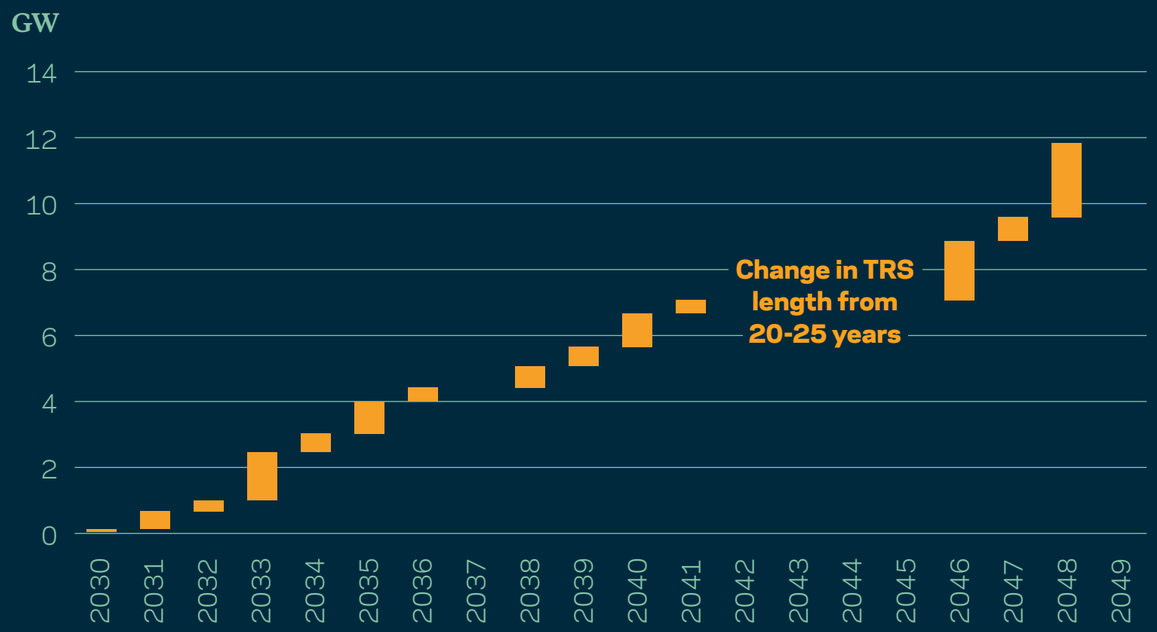
Offshore transmission asset lifespan

The maintenance and performance of offshore transmission assets is fundamental to the strength of the offshore wind system. A key driver for maintenance of these assets is the financial certainty which comes with the OFTO tender revenue streams (TRS), which supports a strong business case for investment.

Figure 26 reveals that by 2040, under current arrangements, the TRS would have ended for around 7GW of generating capacity. Consideration must be given to if and how the scheme continues to support and incentivise these assets to operate beyond their original design life, at the most efficient cost to the consumer.

Since 2020, The Crown Estate has been working with both generators and OFTO operators through dedicated engagement sessions and surveys to gain combined insights into risks and issues around the extension of the transmission assets.

Figure 26: Capacity connected by OFTO post end of tender revenue stream



Rampion offshore wind substation

The benefits of life extension

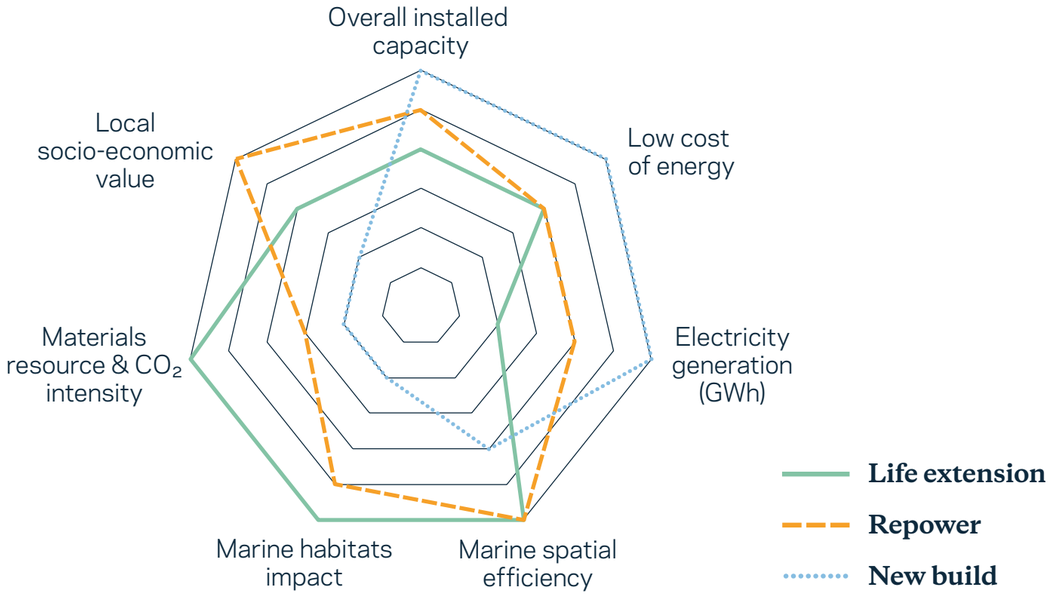
In 2023 The Crown Estate commissioned a report to examine the comparative social and environmental value of life extension of offshore wind farms. Figure 27 shows the relative scoring of typical new build, repowered and life extended projects against a range of value factors.

While new developments contribute highly to security of affordable energy, a life extended project scores much higher in terms of the efficiency of materials and space, and minimising environmental impact.

A typical life extended project could...

- Avoid an additional 136 tonnes steel, 8 tonnes glass and 4 tonnes polymer per MW
- Continue 150 operational jobs with c.95% based directly in the project region
- Avoid an additional 470 tonnes CO_2 per MW
- Have negligible marine environment impact to benthic habitats, fish and shellfish, and marine mammals

Figure 27: Comparative value scoring of offshore wind project types



Addressing the challenge

Work is well underway to address the 15.8GW of post-design life capacity identified in figure 24 and to mobilise the life extension opportunity.

The Crown Estate is working closely with customers, industry, Ofgem and government bodies about future approaches, with the aim of creating an environment that encourages a holistic approach to offshore wind life extension.

We're collectively building more evidence too. Our own research is contributing to our understanding of the environmental and social value of wind farm life extension. Elsewhere Crown Estate Scotland, Ofgem, the UK Government, developers and many others are building evidence to support our understanding, covering areas such as the financial value of wind farm life extension, innovations to repower maturing wind farms, and how subsidy schemes can incentivise and support extending the life of wind farms and transmission assets.

As the challenge moves ever closer, the key now is to share the emerging body of evidence and work together to establish a joined-up approach to maintaining maturing assets. Over the coming months we will be working closely with industry, governments and wider stakeholders, with an ambition to build a life extension roadmap – a coordinated approach to address this challenge in a way which continues to support net zero and deliver social and environmental benefits for the country.

Diversity & skills

As the offshore wind industry grows, so too does the number of job opportunities, bringing economic and social benefits across the UK. In June 2023, a report by the Offshore Wind Industry Council (OWIC) estimated that the number of jobs in the UK's offshore wind sector by 2030 will exceed 100,000 for the first time.

A diverse and skilled workforce will be critical to meeting this growth and ensuring the long-term resilience of the sector; delivering a wider talent pool to draw from in the places they are most needed, and the diversity of thinking required to meet the challenges of tomorrow.

Several announcements in 2023 signalled new supply chain opportunity in the UK. SeAH Wind secured a deal to supply Norfolk Vanguard's Monopile Foundations, which will be built in Teesside; ORE Catapult opened 'Launch Academy East of England', an extension of its existing technology accelerator to support the commercialisation of UK-based small and medium-sized enterprises to develop innovative new products and services; Siemens Gamesa commenced blade production in Hull; and Ørsted launched its UK and Ireland Innovation Hub to engage with start-ups and smaller businesses in the area of renewable energy.

Technician replacing sensor in the nacelle hub

Focus on: East Coast opportunity

Progress was made towards ensuring future jobs can be filled by a skilled, diverse workforce. Here we highlight three landmark initiatives The Crown Estate supported during the year to unlock the jobs and skills opportunity offered by the thriving offshore wind industry off the east coast.

Upskilling work coaches

Working with the Department of Work and Pensions (DWP), The Crown Estate built a pilot programme designed to help work coaches in East Anglia and Lincolnshire better understand the career opportunities offered by offshore wind development in the region. The ambition is to give them the knowledge to signpost job seekers to the diverse range of careers offered by the sector, helping tackle regional inequalities, highlight career prospects and help address labour shortages facing the industry. Workshops for DWP work coaches and a careers fair will be rolled out in 2024.

Projekt Renewable Grimsby

This educational and cultural hub opened its doors in Grimsby in 2023. Its aim is to inspire the next generation of renewable energy experts through a 'destination' of immersive experiences which showcase the benefits of renewable energy and educate and influence future talent and the local community. In support of this initiative, The Crown Estate has invested an initial £50,000 and opened a bespoke space within the hub as part of our drive to build social, as well as economic and environmental value, from this rapidly growing sector.

East Coast internships

The Crown Estate works in collaboration with organisations in the marine sector to offer full-time, paid internships to young people interested in a career in the marine environment, helping to nurture the diverse, skilled workforce needed by the marine industry to achieve a sustainable future. In 2023 we funded a new 'Marine Futures North East Internship Programme', as part of a joint collaboration with Lincolnshire Wildlife Trust, Ørsted and Natural England. The six month internship offers two graduates the chance to gain work experience and build relationships in renewable energy, marine ecology and community engagement, and conduct marine research projects in and around the east coast area, further supporting the development of skills and research in this region. This programme complements our existing programmes in the North West and Kent.

Photo: Monty Rakusen

Technician on a vessel next to an offshore wind turbine.

Building the future workforce

Three other announcements during the year demonstrate the commitment to inspire and upskill a diverse and resilient future workforce across the country. In collaboration with **Microsoft UK,** The Crown Estate launched a new **Minecraft Education world** called **'Offshore Wind Power Challenge'**[1] to inspire 7–14 year olds to learn more about the challenges of planning offshore wind farms and protecting the marine environment, through immersive and interactive game-based learning.

Dogger Bank Wind Farm's Scholarship Fund opened its third round of scholarship applications for local students, with a total of 62 scholarships being awarded during the wind farm's construction phase to help young people prepare for working life in a net zero world.

Finally, operations and maintenance (O&M) consultants, **Generating Better,** launched **The Offshore Wind O&M Management Programme,** a training programme to help address the skills gap, upskill in the face of a challenging commercial environment and build a support network of people with an interest in O&M management. With a number of free and subsidised places available for under-represented groups, the programme also aims to make a practical contribution to improving diversity in offshore wind and O&M.

Screenshot of Minecraft game in progress

The Crown Estate is committed to building a truly diverse, collaborative and inclusive culture and we closely monitor our progress in this area. Growth in the Marine Team in 2023 led to changes in colleague representation across several demographics. The percentage of people with a disability or long-term condition rose from 11.8% to 17.6%; we maintained a broadly equal balance between male/ female colleagues (52% vs 48% respectively); and the percentage of colleagues representing 'Black/ Black British', 'Asian/ Asian British' and 'Other' ethnicity groups all rose. The percentage of those identifying as 'White' and 'Mixed/ Multiple' ethnic group decreased slightly. The data shows some promising improvements but we remain focussed on using our reach and alliances to increase diversity, equity and inclusion across our business and the industry as a whole.

1 Minecraft Education | The Crown Estate

OWIC People and Skills Plan

To maximise the social and economic benefits of the anticipated growth in labour demand up to 2030, which is expected to more than treble from the current 30,000, the Offshore Wind Industry Council (OWIC) has published a People and Skills Plan. It sets out a vision for the sector to be "among the most attractive, equitable, diverse and inclusive sectors…in the UK economy." The plan, developed with industry, identifies four cross-cutting themes and priorities for focus, as shown in Figure 28 below.

Working across the sector, including supply chain and developers, apprenticeships will represent 5% of the workforce by 2030 (a doubling of the 2019 Sector Deal target) and industry will work collaboratively to tackle barriers to employment and progression faced by women and under-represented groups. Occupational pathways and job profiles, and a shared industry value proposition, will support attraction and retention, including from support workers coming into the sector from other industries. Partnerships will enable increased capacity to create training and qualification standards and solutions.

As interest in skills rises up the agenda, OWIC will also enhance its approach to labour forecasting to provide industry with the data it needs. This means the OWIC Skills Intelligence Report, which monitors progress against Sector Deal targets and provides workforce estimates, will be published every two years rather than annually, with the next instalment expected in 2025.

Whilst this means there are no updated workforce statistics to report on this year, we have included the 2022 data in Figure 29, to maintain focus on the Sector Deal workforce gender and ethnicity targets, and progress against them.

Figure 28: Offshore Wind Industry Council People and Skills Plan

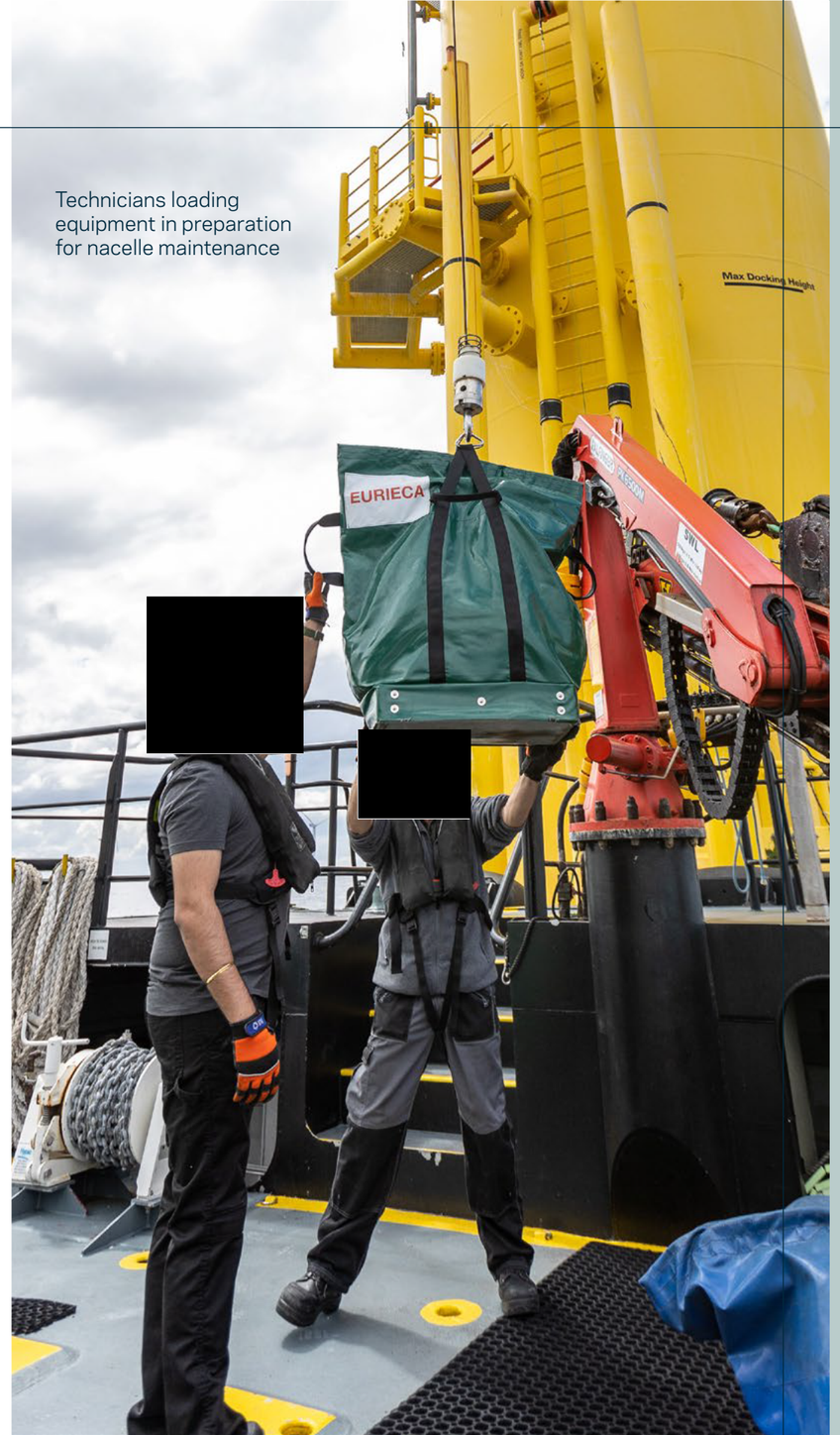
Theme 1: Supporting priority occupations

Theme 2: Cluster-based partnerships

Theme 3: A just transition

Theme 4: A diverse and inclusive sector

Priority 1: Attraction and recruitment	**Priority 2:** Retention and upskilling	**Priority 3:** Training provision	**Priority 4:** Educational outreach



Technicians loading equipment in preparation for nacelle maintenance

Figure 29: Offshore Wind Sector Deal workforce targets and progress against them up to 2022[1]

Female employees

16%
Baseline (2019)

33%
Target (2030)
(40% if feasible)

20.6%
Progress (2022)

Black, Asian and minority ethnic employees

3.7%
Baseline (2019)[2]

9%
Target (2030)
(12% if feasible)

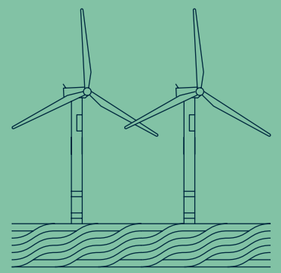
7%
Progress (2022)

1 Updated figures expected in 2025.

2 2019 figure re-baselined in 2021 because of increased accuracy in data collection.

Offshore wind farm ownership

We track UK offshore wind farm ownership to identify key companies, industries and trends in offshore wind investment.



62%

UK offshore wind capacity owned by utility companies

Gwynt y Môr offshore wind farm array and crew transfer vessel

Figure 30 shows companies with the greatest share of operating and under-construction offshore wind farms in 2023, and figure 31 summarises ownership by investor category. Utility companies increased overall share of ownership from 59% to 62%. Whilst the chart indicates a decrease in the percentage share of ownership by financial investors and oil and gas companies, this is a function of all three types of investor increasing capacity ownership in actual terms, leading to minor adjustments in overall percentage ownership. This reflects the progression of two wind farms owned by utilities to the under-construction category, East Anglia THREE owned by Iberdrola (Scottish Power), and Moray West owned by Ocean Winds, a joint venture between EDP Renewables and ENGIE, and minority shareholder Ignitis.

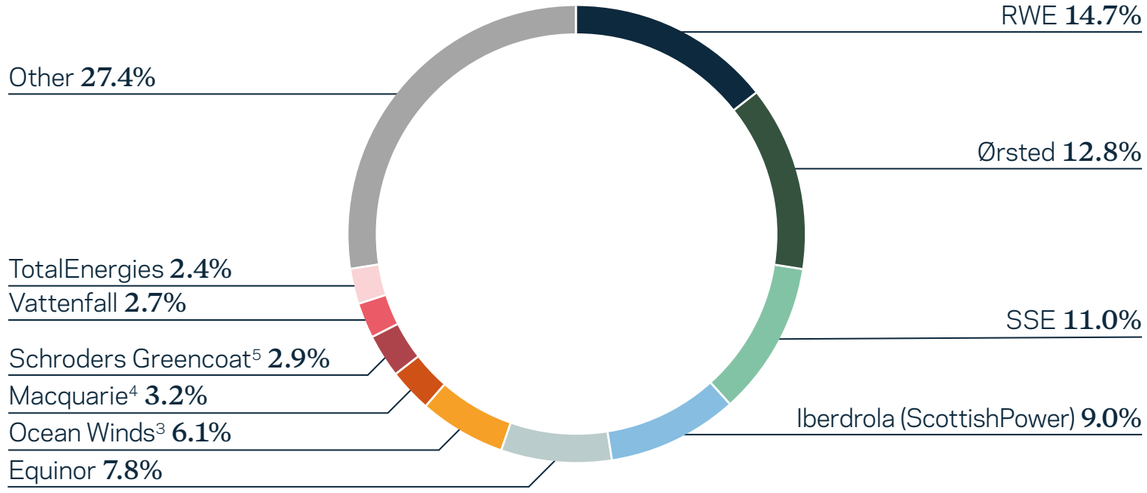
In 2023, relatively little operational and under-construction capacity changed hands – 0.5GW in 2023, compared with 2.3GW in 2022 – in line with a broader M&A trend underpinned by gaps in valuations, high interest rates, mixed macroeconomic signals and geopolitical risks[1]. Significant transactions included the sale of Ørsted's 25% share in London Array to Schroders Greencoat, and 16.7% of Moray East sold by Mitubishi Corporation to Japanese oil and gas major INPEX, through European subsidiaries.

There was notably more capacity changing hands at the development stage, which we cover on page 30.

A full breakdown of offshore wind farm ownership for operating and under-construction sites can be found on The Crown Estate's website.

1 Source Bain: Looking Back at M&A in 2023: Who Wins in a Down Year?

Figure 30: Operational and under-construction wind farm ownership as a % of total capacity in 2023 by company



3 Joint venture between EDP Renewables and ENGIE.
4 Green Investment Group (GIG), GIG Renewable Energy Fund, Macquarie European Infrastructure Fund, Macquarie Infrastructure and Real Assets.
5 Greencoat UK Wind, Greencoat Renewable Income LP, other Schroders Greencoat Funds.

Figure 31: Operational and under construction wind farm ownership as a % of total capacity in 2023 (and 2023 vs 2022) by category[2]

2 Percentages rounded.

Figure 32 shows ownership of projects at both the operational and development stage by investor category. This has remained relatively static since 2022 and indicates financial investors are coming in at the later stages of development, with the supply chain investing at the earlier stages. In 2023 ownership by utility companies was bolstered by the sale of nearly 25% of Leasing Round 4 project Outer Dowsing, to Gulf Energy Development by Macquarie's Green Investment Group.

Shares in several ScotWind projects changed hands in 2023, including 24.5% of Havbredey and Spiorad na Mara in the Outer Hebrides, purchased by Irish energy company ESB from Northland Power. 50% of shares in Arven South transferred to Mainstream Renewable Power from Ocean Winds, as Mainstream, EDP Renewables and ENGIE teamed up to develop both Arven wind farm sites to the east of Shetland.

Figure 33 breaks down the financial investor category by type and digs deeper into the 22% of operating and under construction capacity held by financial investors. Whilst renewable energy and infrastructure funds still hold half of the operating and under-construction wind farm capacity, the proportion of investment funds with more diversified interests has increased slightly from 16% in 2022 to 17% in 2023.

Figure 33: Financial investor capacity ownership (operational and under construction wind farms)

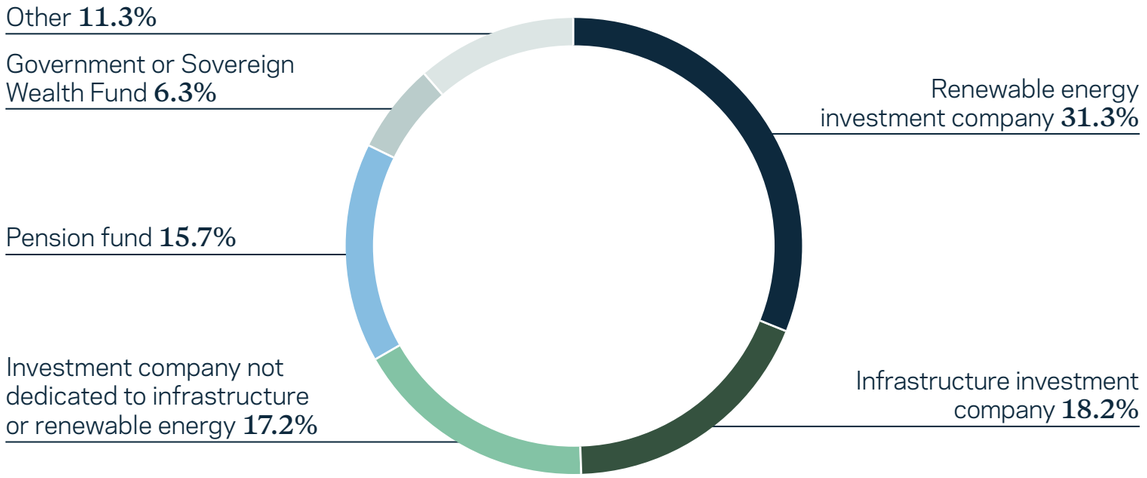
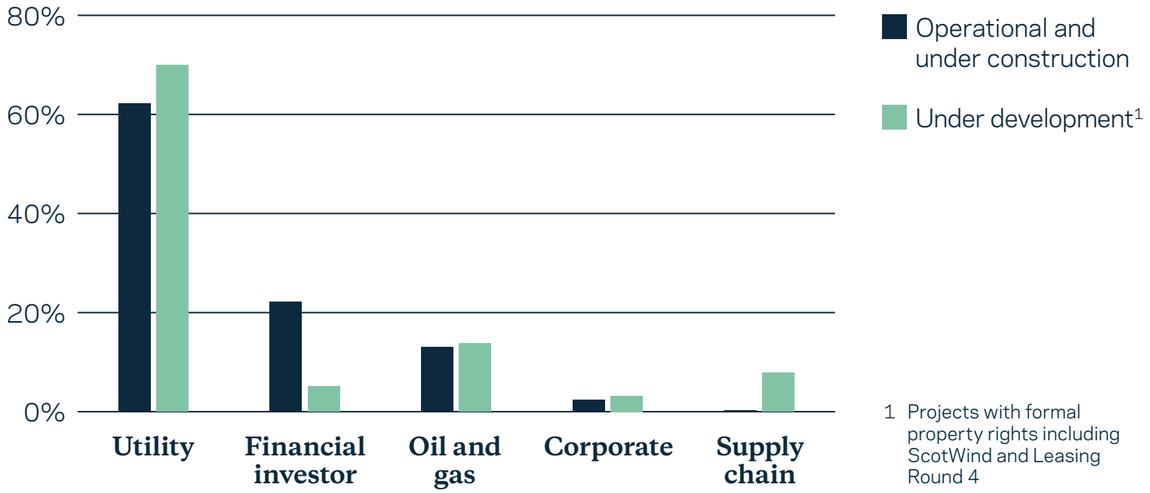


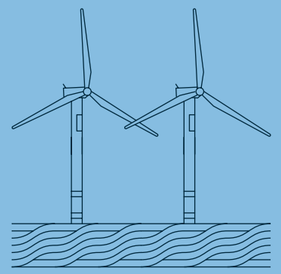
Figure 32: Capacity ownership by category and lifecycle stage in 2023



1 Projects with formal property rights including ScotWind and Leasing Round 4

Wind turbine with open nacelle, technicians and crew transfer vessel

Investment & market



£50m

Total investment earmarked by The Crown Estate to accelerate offshore wind supply chain projects

Floating offshore wind – a new frontier of opportunity and investment

Photo: Courtesy of BW Ideol and Valery Joncheray

13MW GE Vernova Haliade-X turbine

Photo: Courtesy of Dogger Bank Wind Farm

Key transactions in 2023 are listed in figure 34. Approximately 2GW of UK offshore wind capacity changed hands (vs c.20GW globally), with the majority (approximately 1.5GW) relating to projects at the development stage.

Notable transactions are described in the offshore wind farm ownership section on page 29-30.

Significant transactions announced in 2023, but not completed by year end, included the sale of Norfolk Boreas, Vanguard West and Vanguard East by Vattenfall to RWE, and Masdar's proposed purchase of 49% stakes in Dogger Bank South (East and West) Round 4 projects from RWE.

Although few assets changed hands over the course of the year, debt markets were more active. Numerous assets secured financing packages including Moray West (£1.9bn development finance), Kincardine (£408m refinancing) and East Anglia Three (€500m development and construction finance).

2023 saw developers continue to explore alternative routes to market through Corporate Power Purchase Agreements (CPPAs), a long-term contract under which a business agrees to buy some or all of its electricity directly from a renewable energy generator. At least 223MW of capacity was signed to a CPPA in 2023, bringing the total offtake covered under a CPPA to 1GW – representing c.7% of all operational capacity.

Figure 34: Transaction activities completed in 2023 in date order

Asset	Lifecycle stage	Seller (share in the project before transaction)	Buyer (share in the project after transaction)	Approximate value (£m)	Indicative timing
Moray East	Operational	Mitsubishi Corporation (16.7%)	INPEX Renewable Energy Europe (16.7%)	Unknown	Mar-23
Outer Dowsing	Under development	Green Investment Group (50%)	Gulf Energy Development (24.99%)	Unknown	Mar-23
Westermost Rough	Operational	Macquarie European Infrastructure Fund (12.5%)	Equitix (12.5%)	Unknown	Apr-23
Rampion	Operational	Macquarie European Infrastructure Fund (12.5%)	Equitix (12.5%)	Unknown	Apr-23
Galloper	Operational	Macquarie European Infrastructure Fund (12.5%)	Equitix (12.5%)	Unknown	Apr-23
Havbredey	Under development	Northland Power (100%)	ESB (24.5%)	Unknown	May-23
Spiorad na Mara	Under development	Northland Power (100%)	ESB (24.5%)	Unknown	May-23
Hornsea 2 OFTO	Operational	Ørsted (50%), AXA IM Alts (25%), Crédit Agricole Assurances (25%)	HICL Infrastructure (75%), Diamond Transmission UK (25%)	£1,141m	Jul-23
Arven South	Under development	Ocean Winds (100%)	Mainstream Renewable Power (50%)	Unknown	Aug-23
London Array	Operational	Ørsted (25%)	Funds managed by Schroders Greencoat (25%)	£717m	Aug-23
Triton Knoll OFTO	Operational	RWE (59%), J-POWER (25%), Kansai Electric Power (16%)	Equitix (80%), TEPCO Power Grid (20%)	£573m	Dec-23

2023 marked a year of rising interest rates and supply chain cost inflation which hit the offshore wind industry around the world. In the US over 12GW of offshore wind projects sought to change or cancel their subsidy contracts. In the UK, Vattenfall announced it had decided to stop the development of Norfolk Boreas in its current form, highlighting the vulnerability of the supply chain and cost increases up to 40%.[1] However, its subsequent sale to RWE[2] has led to an anticipated revival of the project.

These cost issues were highlighted in September's fifth Contracts for Difference allocation round (AR5) where, for the first time, there were no bids from fixed or floating offshore wind projects. This contributed to the UK falling three places to seventh place in the EY Renewables Attractiveness Index. However, for offshore wind specifically, the UK increased its Index score in the second half of the year, from 52.5 in June to 57.6 in November.

Despite the challenges, the offshore wind sector remains set for considerable growth globally and domestically, with governments continuing to see the technology as key for meeting long-term climate goals. In the UK, the Government's 2030 target of 50GW of offshore wind capacity continues to underpin confidence in the market. Its decision to increase the price cap – by 66% for fixed and 52% for floating – for the sixth Contracts for Difference allocation round (AR6) in 2024, came alongside a total funding commitment of £800million, the largest budget so far.

A series of initiatives were announced in 2023, designed to help mitigate rising costs, maintain confidence in the UK market and support the accelerated growth of the industry. They included:

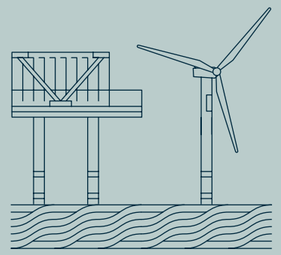
- The UK Government's £960million Green Industries Growth Accelerator (GIGA) to support capacity developments across multiple green industries, and its £1billion Net Zero Innovation Portfolio fund to support the development of low carbon technologies and systems. Both of which include a focus on offshore wind
- The £160million Floating Offshore Wind Manufacturing Investment Scheme (FLOWMIS) launched by the UK Government to support the delivery of port infrastructure to facilitate floating offshore wind
- The Crown Estate's intention to launch a pilot £10million Supply Chain Accelerator fund (see page 40) in 2024 to accelerate and derisk supply chain development projects, with a further £40million earmarked which could be deployed over time
- Up to £500million announced by the Scottish Government to support supply chain development
- The impact of Ofgem's Accelerated Strategic Transmission Investment (ASTI) regulatory approval and funding framework, which aims to unlock c.£20billion of investment in transmission projects required to deliver the Government's 2030 ambitions for offshore wind
- Various funding opportunities through Innovate UK with £25million of loans for innovation, £25million in Smart Grants and other funding opportunities for research.

The UK Government is also consulting on changes to future CfD rounds post AR6, in addition to proposing the introduction of a new CfD Sustainable Industry Reward. The aim is to accelerate the deployment of low carbon electricity generation, specifically offshore wind and floating offshore wind.

Lifting operations at Rampion wind farm

1 Vattenfall 20 July 2023: First six months 2023: A positive development for the customer business and challenges in offshore wind power – Vattenfall
2 Vattenfall 27 March 2024: Vattenfall and RWE conclude sale of Norfolk Offshore Wind Zone – Vattenfall

Offshore Transmission Owner (OFTO) ownership



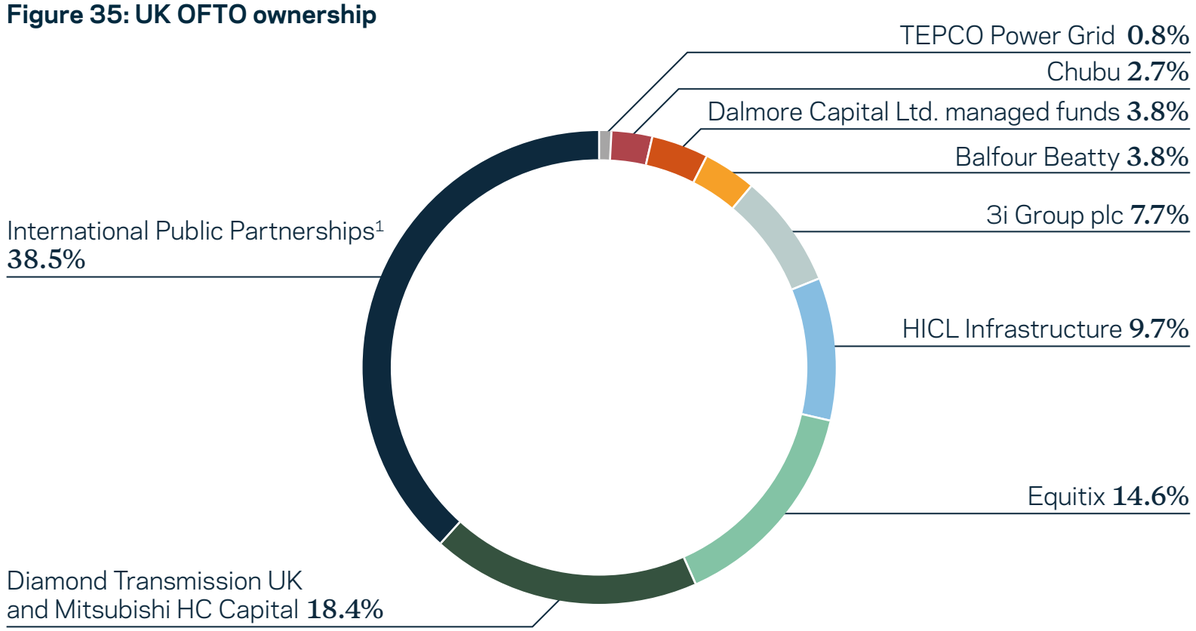
Offshore wind transmission substation at Gwynt y Môr wind farm

In 2023 Ofgem awarded two OFTO licences. The licence for Hornsea 2 was awarded to established OFTO owners Diamond Transmission Partners Hornsea Two Limited, a partnership between Diamond Transmission Corporation and HICL Infrastructure PLC. The licence for Triton Knoll was awarded in December to Triton Knoll OFTO Ltd, an Equitix Limited and TEPCO Power Grid incorporated consortium, bringing TEPCO Power Grid into the OFTO ownership table for the first time (see figure 35).

During the year Ofgem shortlisted four potential operators for the next OFTO tender round (TR10), including a new entrant to the market, a consortium led by Gravis Capital Partners. New entrants to the market could indicate the growing opportunity in this field for investors as the market expands to meet the UK Government target of 50GW by 2030.

OFTO ownership details can be found can be found on The Crown Estate's website.

Figure 35: UK OFTO ownership



1 OFTOs operated by Transmission Capital Partners.

Figure 36: Offshore transmission tenders

Ofgem is responsible for managing the competitive tender process through which offshore transmission licences are granted. The tenders listed below are currently in progress.

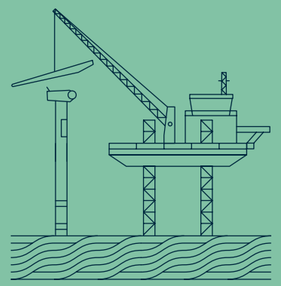
Tender Round 7 *Launched November 2020*	**Licences granted 2023** **Triton Knoll** December 2023 **Licences granted 2024** **Moray East** February 2024
Tender Round 8 *Launched July 2021*	**Licences granted 2023** **Hornsea 2** July 2023
Tender Round 9 *Launched January 2022*	**Preferred Bidder to be appointed 2023** **Seagreen Phase 1** ITT stage commenced January 2023
Tender Round 10 *Launched January 2023*	**EPQ stage commenced 2023** **Dogger Bank A** ITT stage commenced 2023 **Neart na Gaoithe** ITT stage to commence Q4 2023 **Moray West** ITT stage to commence Q2 2024
Tender Round 11	**EPQ stage commenced 2024** **Dogger Bank B**

For more details on the tender rounds, projects and publications relating to the tender processes, please visit Ofgem's website.

Offshore wind development

2023 was another busy year with projects progressing in England, Wales, and Scotland, and momentum maintained for converting pipeline potential into operational reality.

Here we look at some of The Crown Estate's highlights from the year. We also reference the latest updates from Crown Estate Scotland's development pipeline, and look ahead to consider some of the activity expected in 2024.



93GW

pipeline of UK offshore wind capacity

Artificial nesting structures for Kittiwake, related to Hornsea 3 wind farm

Photo: Courtesy of Ørsted

Development portfolio

The portfolio of offshore wind farms in development comprises projects under Agreement for Lease (AfL), where an option over an area of seabed has been granted for offshore wind development.

Figure 37 shows the UK offshore wind development pipeline. Operational capacity increased from 14GW to 15GW as Seagreen Phase 1, Scotland's largest offshore wind farm, became fully operational. At the other end of the pipeline, potential capacity (opportunity announced but not yet under AfL) increased significantly from 4GW to 14GW. This is due to the potential from current leasing rounds and requests for increases in capacity being considered on several projects already in agreement.

Projects update

At the beginning of the year, The Crown Estate awarded landmark Agreements for Lease with developers of the six Offshore Wind Leasing Round 4 projects totalling c.8GW. The projects have the potential to generate enough green electricity to power seven million homes, targeting operation by 2030.

In England and Wales, projects obtain planning consent through a Development Consent Order (DCO) from the Secretary of State. In 2023 all Round 4 projects undertook pre-application statutory consultation on their proposed projects. Hornsea 4 and Awel y Môr were granted consent and Rampion 2 submitted its consent application. Offshore construction started in September 2023 at the 1.4GW Sofia project. The joint DCO application for Sheringham Shoal and Dudgeon Extensions finished examination in July. Consent for this was granted on 17 April 2024.

During the year momentum gathered for floating offshore wind development in the UK. Consent was granted for Wales' first floating wind farm, Erebus, and the White Cross floating wind test and demonstration project submitted applications for consent. On page 38 we look in more detail at The Crown Estate's 4.5GW Offshore Wind Leasing Round 5, which launched in early 2024.

In November, following engagement with offshore wind farm developers, The Crown Estate announced the potential for additional capacity to be generated from array areas for which developers hold existing rights. The process for considering these is underway.[1] If approved, the requests will enable generation of up to an additional 4GW across seven projects.

Ørsted reached a significant milestone this year as construction of three nearshore artificial nesting structures completed. These structures are to compensate for potential impacts of the Hornsea 3 wind farm to Kittiwake, a vulnerable species of seabird, and are the first of their kind. Ongoing monitoring will demonstrate the effectiveness of these structures and provide valuable insights, helping to inform future compensation projects.

You can read about progress in Scotland on page 41.

1 The Crown Estate sets out plan to unlock enough new offshore wind capacity to power up to four million homes.

Figure 37: UK offshore wind development pipeline waterfall (GW rounded)

2 Projects under construction or projects that have government support on offer.
3 Potential from current leasing rounds and additional capacity requests, including Innovation and Targeted Oil & Gas (INTOG) and Leasing Round 5.
4 UK Government Offshore wind net zero investment roadmap.

Offshore Wind Leasing Round 5 – floating wind in the Celtic Sea

2023 was a significant year for the future deployment of floating offshore wind in the UK, with The Crown Estate taking a number of key steps towards a leasing round for this new technology in the Celtic Sea, off the coast of Wales and South West England. The new leasing round is known as Leasing Round 5 and began in February 2024. It is expected to be the first phase of commercial development in the Celtic Sea.

Floating offshore wind is set to be a critical new frontier in the global move away from fossil fuels, with some estimates suggesting it will ultimately account for 80% of global offshore wind potential. To date, operational capacity is modest, with a number of test and demonstration (T&D) projects around the world, including the 50MW Kincardine wind farm off Aberdeen and the 30MW Hywind Scotland project off the coast of Peterhead.

In the Celtic Sea, The Crown Estate is supporting up to five T&D scale floating wind projects, with a combined potential capacity of up to 450MW. Notably, in March 2023, the 100MW Erebus project off the coast of Pembrokeshire attained its full consents – a first for any floating wind project in Wales. These T&D projects can be key enablers of the successful commercialisation of floating offshore wind in the region.

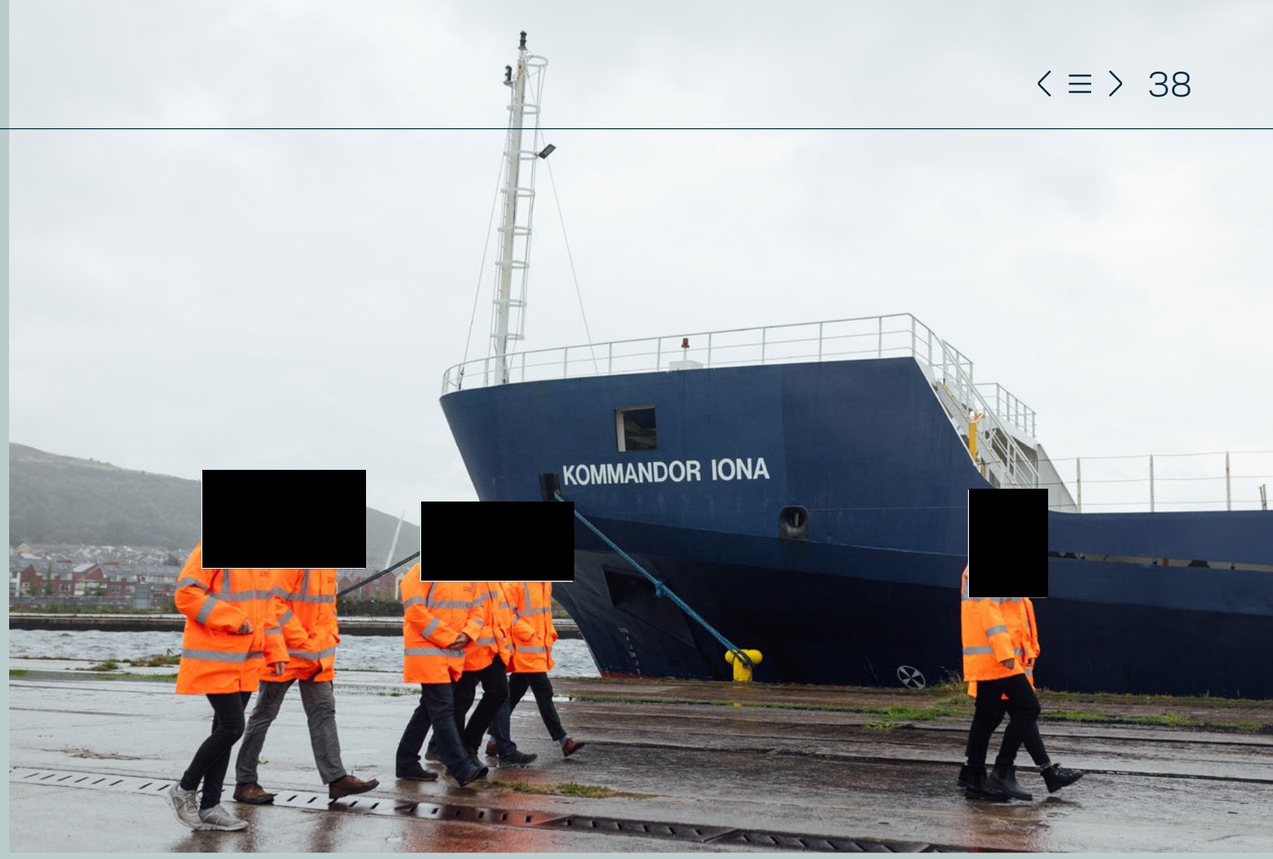
However, both the technology and industry ambition for commercial scale projects have continued to develop, and in 2023 we further refined our proposition for the Celtic Sea. A key focus was work on the spatial design of Leasing Round 5, including supporting the UK Government as it sought to resolve a number of competing demands and policy drivers in the Celtic Sea.

After seeking market feedback in July 2023 on an initial, 'minded-to' detailed spatial design, we confirmed in October 2023 a final design of three Project Development Areas (PDAs) of equal size, each with a potential capacity of up to 1.5GW. In its Autumn Statement in November 2023, the UK Government subsequently confirmed its intention to work towards unlocking space for a further 12GW of capacity in the Celtic Sea.

Alongside work on the spatial design for Leasing Round 5, we continued to progress a number of workstreams to help de-risk projects for developers and accelerate the deployment of floating offshore wind. In July 2023 the first survey vessel set sail from Swansea as part of a multi-million-pound programme of surveys to better understand the physical and environmental properties of the PDAs. We also continued work with the Electricity System Operator (ESO) to support a coordinated grid design for Leasing Round 5, while also carrying out a plan-level Habitats Regulations Assessment ahead of the award of Agreements for Lease (AfLs).

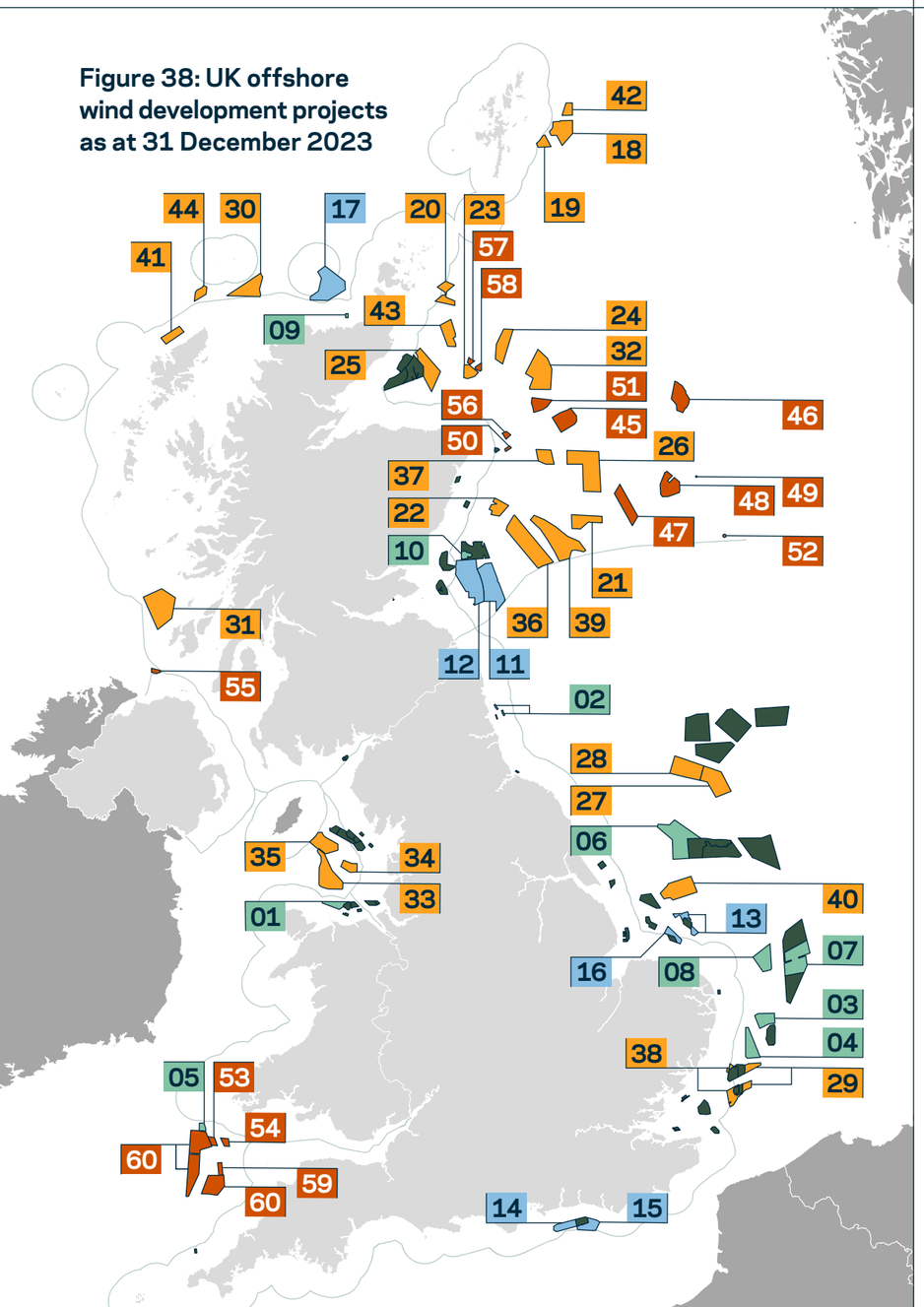
This culminated in the publication of an Information Memorandum (IM) in December 2023 which set out the Leasing Round 5 offer in more detail. This included more information on how we intend to maximise the broader social, environmental and economic opportunities arising from Leasing Round 5 projects. In recognition of the nascent nature of floating wind technology and the lack of a mature supply chain, the IM also included plans for a 50% reduction in option fees if project consenting leads to undue delays in development.

At an event for potential bidders held in Swansea in January 2024, we set out an updated schedule for Leasing Round 5, saving up to six months off the overall process, with AfLs now expected by July 2025. The tender process for Leasing Round 5 formally began with the publication of a Concession Notice and Pre-Qualification Questionnaire in February 2024.



Colleagues from The Crown Estate alongside the vessel used by Fugro for the 2023 geophysical survey

Figure 38: UK offshore wind development projects as at 31 December 2023



Territorial Waters Limit

Ext	2017 Extensions Round project.
IN	Innovation project, INTOG Leasing Round.
R3	Leasing Round 3 project.
R4	Leasing Round 4 project.
SW	ScotWind project (and plan area).
T&D	Test & Demonstration scale floating wind project.
TOG	Targeted Oil & Gas project, INTOG Leasing Round.

1 Capacities noted are rounded to the nearest whole MW.

2 Managed by Crown Estate Scotland.

3 Under construction or government support on offer.

Consented: Wind farms that have received consent but not yet secured a Contract for Difference.

		Up to capacity MW[1]
01	Awel y Môr [Ext]	576
02	Blyth Demonstration Phases 2&3 [T&D]	58
03	East Anglia ONE NORTH [R3]	950
04	East Anglia TWO [R3]	980
05	Erebus [T&D]	100
06	Hornsea 4 [R3]	2,700
07	Norfolk Vanguard East [R3]	1,400
08	Norfolk Vanguard West [R3]	1,400
09	Pentland [T&D, 2]	100
10	Seagreen Phase 1a [R3, 2]	500
Total		**8,764**

In planning: Wind farms for which a consent application has been submitted.

		Up to capacity MW[1]
11	Berwick Bank [R3, 2]	4,100
12	Marr Bank [R3, 2]	
13	Dudgeon Extension [Ext]	402
14	Rampion 2 (Rampion Extension) [Ext]	400
15	Rampion 2 (Zone 6) [R3]	800
16	Sheringham Shoal Extension [Ext]	317
17	West of Orkney (N1) [SW, 2]	2,000
Total		**8,019**

Pre-planning: Wind farms for which a consent application has not yet been submitted.

		Up to capacity MW[1]
18	Arven (NE1) [SW, 2]	1,800
19	Arven South (NE1) [SW, 2]	500
20	Ayre (NE2) [SW, 2]	1,008
21	Bellrock (E1-3) [SW, 2]	1,200
22	Bowdun (E3) [SW, 2]	1,008
23	Broadshore (NE6) [SW, 2]	500
24	Buchan (NE8) [SW, 2]	960
25	Caledonia (NE4) [SW, 2]	1,000
26	CampionWind (E2-2) [SW, 2]	2,000
27	Dogger Bank South (East) [R4]	1,500
28	Dogger Bank South (West) [R4]	1,500
29	Five Estuaries [Ext]	353
30	Havbredey (N2) [SW, 2]	1,500
31	MachairWind (W1) [SW, 2]	2,000
32	MarramWind (NE7) [SW, 2]	3,000
33	Mona [R4]	1,500
34	Morecambe [R4]	480
35	Morgan [R4]	1,500
36	Morven (E1-2) [SW, 2]	2,907
37	Muir Mhòr (E2-1) [SW, 2]	798
38	North Falls [Ext]	504
39	Ossian (E1-1) [SW, 2]	2,610
40	Outer Dowsing [R4]	1,500
41	Spiorad na Mara (N4) [SW, 2]	840
42	Stoura (NE1) [SW, 2]	500
43	Stromar (NE3) [SW, 2]	1,000
44	Talisk (N3) [SW, 2]	495
Total		**34,463**

Future potential: Projects, leasing rounds and additional capacity subject to AfL and plan-level Habitats Regulations Assessment (HRA) or INTOG Sectoral Marine Plan.

		Up to capacity MW[1]
45	Aspen [TOG, 2]	1,008
46	Beech [TOG, 2]	1,008
47	Cedar [TOG, 2]	1,008
48	Cenos [TOG, 2]	1,350
49	Culzean [TOG, 2]	3
50	Flora [IN, 2]	50
51	Green Volt [TOG, 2]	560
52	Judy [TOG, 2]	15
53	Llŷr 1 [T&D]	100
54	Llŷr 2 [T&D]	100
55	Malin Sea Wind [IN, 2]	100
56	Salamander [IN, 2]	100
57	Scaraben [IN, 2, 3]	99
58	Sinclair [IN, 2]	99
59	White Cross [T&D]	100
60	Leasing Round 5	4,500
	Additional capacity requests [Ext/R3]	4,000
Total		**14,200**

Projects in operation or committed[3] (see page 9)

Looking to the future

Figure 38 shows that the UK offshore wind development pipeline remains healthy and continues to grow. However, the pipeline also signals the need to continue to accelerate offshore wind development in order to meet 2050 net zero targets.

In Spring 2024, The Crown Estate intends to outline our initial thinking in relation to future offshore wind leasing as part of our ongoing engagement, seeking the views of our stakeholders and calling for feedback on our proposed approach.

With a sector set to grow radically in the coming years, a vastly more coordinated approach to seabed leasing and the delivery of transmission infrastructure is needed to realise the UK's clean energy potential, navigate emerging challenges while considering other seabed users and the natural environment.

2023 was a strong year for action to address this need. Three seminal reports were published which galvanized governments, industry and wider stakeholders to co-ordinate activity and collaborate on solutions: the UK Government's Offshore Transmission Network Review, a report by the UK's Offshore Wind Champion, Tim Pick, on how to accelerate the deployment of offshore wind farms in the UK, and a report by the UK's Electricity Networks Commissioner, Nick Winser, on how to accelerate the deployment of electricity transmission infrastructure.

This led to a commitment from The Crown Estate and the Electricity System Operator (ESO) to work together with others to develop a Strategic Spatial Energy Plan (SSEP) and a Marine Delivery Routemap to ensure that there is a holistic plan for future offshore wind and transmission network needs which takes into account the many other demands on the marine environment, including nature and biodiversity.

It is widely acknowledged that action is needed now to develop the supply chain capability and skills needed to establish and support a rapidly growing sector. The panel on the right summarises recent research by The Crown Estate into the supply chain capacity needed to deliver Leasing Round 5 projects.

In progressing the activity to identify the supply chain capacity required to deliver the portfolio, and secure the economic benefits for the UK, the Offshore Wind Industry Council (OWIC) and OWGP released the Supply Chain Capability Analysis, evidencing the Offshore Wind supply chain has £92billion potential for the UK economy by 2040.

It also led to RenewableUK, OWIC, The Crown Estate and Crown Estate Scotland developing a new Industrial Growth Plan to boost long-term growth of the UK offshore wind sector, published on 17 April[1].

The Crown Estate continues to support the draft Offshore Renewable Energy Action Plan, which is expected to put in place the policy and legislative frameworks to support future offshore wind leasing in Northern Ireland. As part of that, in January 2023, The Crown Estate and the Northern Ireland Executive's Department for the Economy developed a Statement of Intent, outlining the ways in which they will work together to enable leasing for offshore wind in the Northern Ireland marine area.

Internationally, The Ostend Declaration in 2023 saw energy ministers from nine European countries, including the UK, committing to more than doubling the planned 120GW capacity of North Sea offshore wind to at least 300GW by 2050. Additional announcements from the UK Government demonstrated a commitment to collaborating with European neighbours including Ireland, Germany, Denmark and the North Seas Energy Cooperation (NSEC) to support offshore renewable energy and increase interconnectivity, including the development of the world's largest-of-its-kind subsea power line between UK and Netherlands.

Capturing future opportunity

As part of a suite of measures to de-risk and accelerate deployment, we commissioned an independent study, 'The Celtic Sea Blueprint'. This study looked at the minimum supply chain capacity needed to deliver the three projects expected to emerge from Leasing Round 5 and examined the gaps, such as ports deep enough for handling the giant turbines, vessels to service the sites, and export cables to transport electricity to land.

It estimates that 5,300 new jobs and up to £1.4billion could be generated for the UK economy by galvanising the supply chain and infrastructure opportunities arising from the development of new floating wind farms. It also highlights the opportunity for Wales and the South West to be at the forefront of driving this development, building on existing expertise in the region.

In responding to the challenge laid out by the Celtic Sea Blueprint, The Crown Estate is exploring investment options to enable and accelerate the establishment of the supply chain. This includes the launch of a pilot £10m Supply Chain Accelerator fund in 2024 to support early stage supply chain development projects. A further £40million has been earmarked to extend this in the context of the Industrial Growth Plan.

Supply Chain Accelerator

1 Offshore wind industry unveils Industrial Growth Plan to create jobs, tripling supply chain manufacturing and boosting UK economy by £25 billion | The Crown Estate

Crown Estate Scotland development

Crown Estate Scotland has 26 option agreements for offshore wind farms in Scottish waters.

Of these projects, the largest is Berwick Bank, at an expected 4.1GW of generation capacity; Berwick Bank applied for consent in 2023 and will be expecting a determination in 2024.

At the other end of the development scale, in 2023 the Pentland Floating Offshore Wind demonstrator project – which will provide up to 100MW of generation capacity – successfully secured consent for its innovative project off the coast of Dounreay in Caithness.

A further 12 projects have secured exclusivity agreements from the INTOG leasing round.

ScotWind leasing round
Progress on the 20 projects which emerged from ScotWind has continued at pace, with most having undertaken site investigation surveys in 2023.

All of them have submitted the first updates to their Supply Chain Development Statements and we were pleased to see no softening in the strong commitments and ambitions for investment in Scotland; many have now established their own head offices and are building delivery teams. Projects are beginning to develop strong identities in their communities.

There has been notable collaboration between projects on matters including supply chain, surveys, ornithology, and cable landing.

The 2GW West of Orkney project was the first of the ScotWind cohort to submit its consent application to the Marine Directorate of the Scottish Government. More are expected to follow in 2024.

Innovation and Targeted Oil & Gas (INTOG)
The INTOG leasing round offered an opportunity for offshore wind farms to help maximise value from commercial scale deployment via small innovation projects, and to reduce the carbon emissions from North Sea Oil and Gas production via electrification.

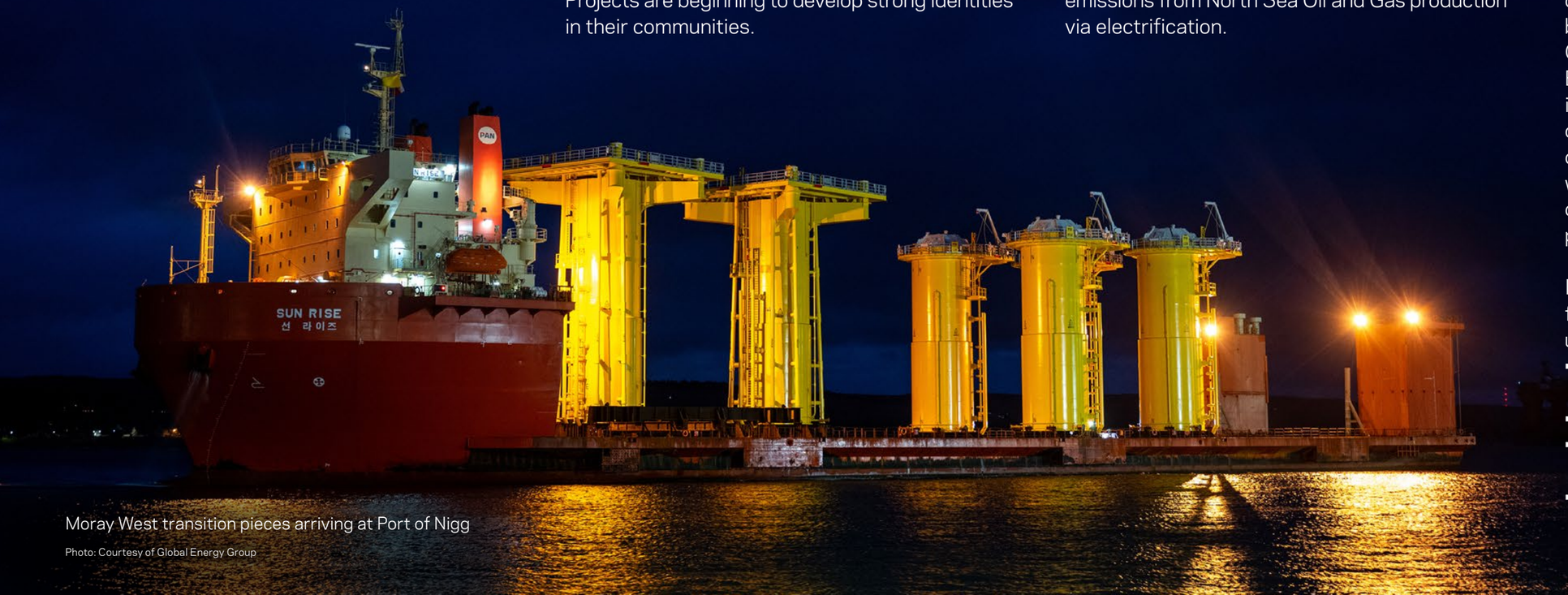
After initial offers were made in March 2023, 12 projects – five innovation and seven targeted oil-and-gas projects – entered exclusivity agreements with Crown Estate Scotland.

Development outlook
Crown Estate Scotland continues to support the strategic infrastructure planning, and socioeconomic development necessary to help Scotland maximise the benefits of offshore wind development.

Notably the Strategic Investment Model (SIM) process is helping deliver transformational supply chain growth in Scotland through collaboration between offshore wind developers, the Scottish Government, enterprise agencies, and Crown Estate Scotland to unlock infrastructure investment. A total of 38 projects with a combined potential capital value of £6.5bn completed SIM stage 1. A number of these will move into stage 2 in 2024 where a full commercial business proposition and investment proposal will be developed.

Investments in energy ports are a key focus for Crown Estate Scotland, as they will help to unlock solutions for our other central priorities:

- Grid and hydrogen development for power export
- Delivering floating wind at gigawatt scale
- Pioneering models for supply chain collaboration
- Supporting Scotland's projects to be world-leading examples.



Moray West transition pieces arriving at Port of Nigg

Photo: Courtesy of Global Energy Group

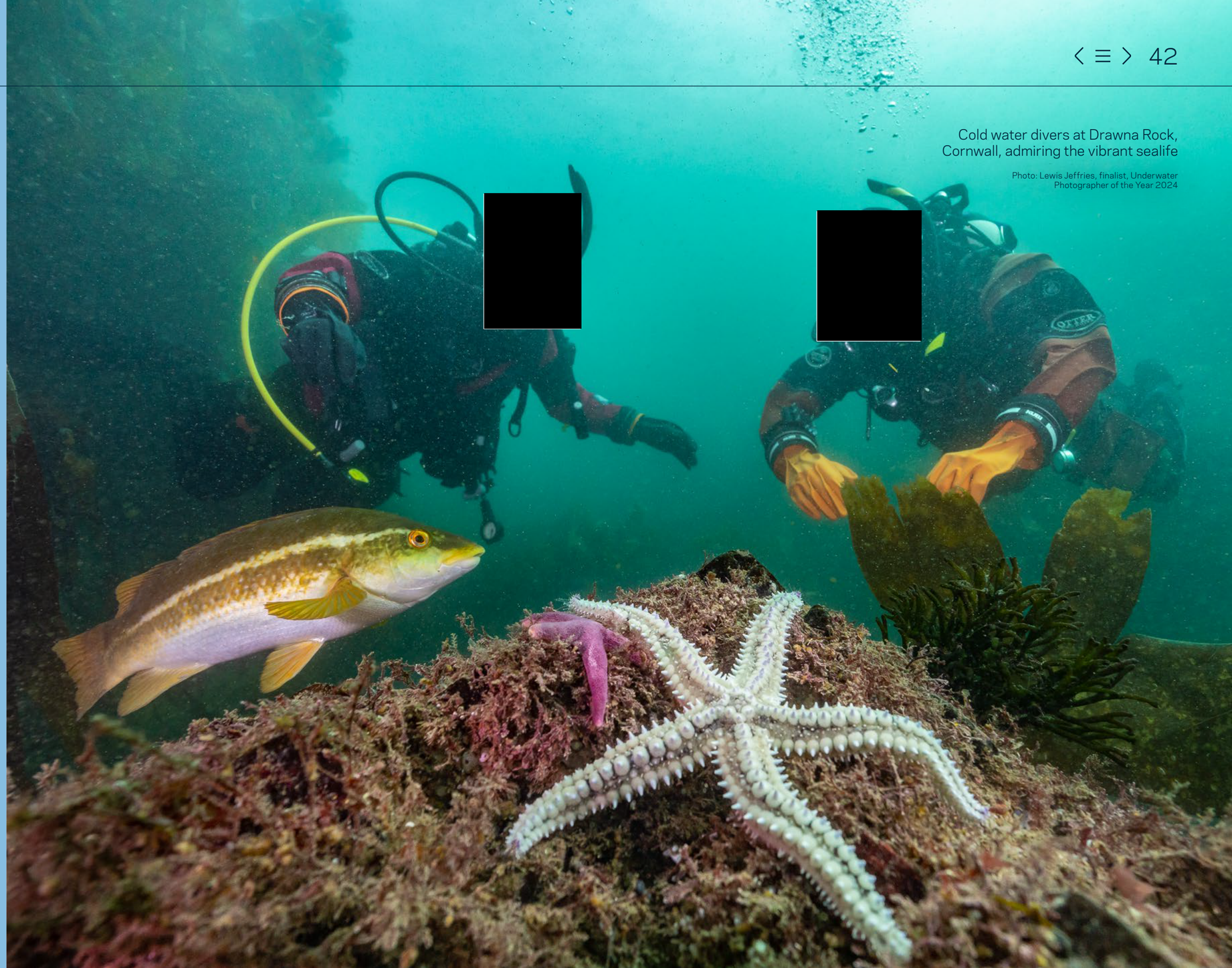
Data & evidence

Demands on the seabed continue to intensify. Alongside offshore wind, space is needed for a diverse range of industries and uses.

To enable these multiple priorities to prosper in a sustainable way, The Crown Estate invests tens of millions of pounds to build world-class data, evidence and cutting-edge digital tools to inform how the seabed can sustain a wide variety of industries, livelihoods and natural habitats for the long-term benefit of the nation.

We work closely with the brightest and best minds to collect data and evidence and fill critical knowledge gaps to help speed up the consenting process. We do this by reducing uncertainties, encouraging innovative design measures to enhance biodiversity, and providing a better understanding of the spatial needs of user groups.

The level of commitment from industry, governments, the environmental sector, organisations representing other users of the seabed and academia to work collaboratively to find a sustainable way forward puts the UK at the forefront of this world-leading work and helps to de-risk and accelerate nature-positive offshore development.



Cold water divers at Drawna Rock, Cornwall, admiring the vibrant sealife

Photo: Lewis Jeffries, finalist, Underwater Photographer of the Year 2024

Delivering with the power of data and evidence: a pioneering approach

In 2023 we launched our pioneering 'Whole of Seabed Programme', using innovative technology to digitally map the seabed space needed to meet future demand for a wide range of industries, infrastructure, and habitats out to 2050. This will allow us to identify optimal sites for future offshore wind leasing, designing out spatial challenges from the start, where we can, and building a holistic view of how other industries and natural habitats can co-exist offshore. This modelling capability represents the most comprehensive and sophisticated approach to spatial mapping in our history, and it will play a vital role in de-risking future site selection.

Figure 39 illustrates the Whole of Seabed mapping process which starts with a wide range of datasets and demand profiles for the spatial needs of different sectors and, stage by stage, refines the optimal seabed area for each sector's requirements. By using a unique set of digital tools, we process and weigh up hundreds of spatial datasets which are structured and prioritised to ensure all environmental, social and cultural interests are fairly represented in line with stakeholder views. This allows us to identify prime areas of opportunity that are technically viable and optimise the cost, location and impact of development in more detail than ever before.

These areas are then added to a digital grid of the seabed which is made up of c.250,000 cells. Using this grid, we can run multi-sector spatial scenarios out to 2050, which demonstrate the different ways in which the seabed could develop and what that might mean for the activities and livelihoods that depend upon the space.

This work will play a key role in a '2050 Marine Delivery Routemap', developed in collaboration with government bodies, delivery agencies and in coordination with international neighbours. The Routemap will support the co-ordination of multi-agency, cross-sector action needed to deliver net zero, nature recovery and support communities and a thriving marine economy.

Evidence gathered through the Whole of Seabed Programme will also contribute to existing work in this space. This includes the cross-government Marine Spatial Prioritisation work led by the Department for Environment, Food and Rural Affairs (DEFRA) in collaboration with the Marine Management Organisation (MMO) and relevant marine planning work within the devolved nations, such as the Welsh National Marine Plan and Northern Ireland's Strategic Environmental Assessment.

Figure 39: Whole of Seabed Programme

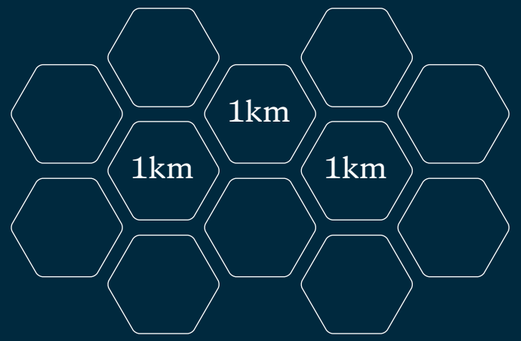
A holistic and cross-sectoral spatial evidence base required to meet a range of future sectoral demands out to 2050

Modelling utilises a wide range of data feeds and demand profiles, across sectors to show spatial needs:

- **6** Key sectors covered in Phase 1
- **12** Sectors by Q1 2024, and >20 in long term
- **250+** Datasets used ranging from birds to sediments
- **>15** Years of spatial modelling capability and evidence development

Analysing this data, we are able to refine Key Resource Areas into Prime Areas of Opportunity (PAO) for each sector.

We understand the seabed by attributing sector PAOs and all other datasets (e.g. water depth) to each of our c.250,000 hex grid cells.



From this, we run multi-sector spatial scenarios to 2050 in 5-year intervals, based on:

1. Different objectives on spatial prioritisation between and within sectors (e.g. minimise costs, minimise impact on other users, maximise co-location).
2. Different sector demand profiles to capture the uncertainty (e.g. GWs of offshore wind needed by 2050 for net zero).

World-class data resources

In 2023 The Crown Estate's Marine Data Exchange (MDE) – the world-leading collection of free-to-access offshore marine industry data and evidence – reached its 10th anniversary. This marked a decade of invaluable data gathering and sharing, helping the UK offshore wind market learn from over twenty years of research, and grow in an informed and evidence-based way. The MDE also became the single portal for sharing offshore data relating to the whole of the UK's seabed, thanks to a new agreement with Crown Estate Scotland to include data covering Scottish waters. The MDE supports a thriving UK market, through collaboration and open and accessible data sharing. Find out more about the MDE by reading the MDE Impact Report and MDE Data Valuation Report. Figure 41 illustrates the scale and value of this data, whilst figure 40 splits data by type.

2023 was also the launch year for the Offshore Wind Evidence and Knowledge Hub (OWEKH). Funded through The Crown Estate's £50million Offshore Wind Evidence and Change programme, OWEKH is an online knowledge centre to enable developers, regulators, marine specialists and other offshore wind professionals to access information that accelerates high-quality consenting around offshore wind development. The best practice guidance delivered by the Hub holds the potential to drive efficiencies for all stakeholders involved in the consenting process.

Figure 40: Data holding by theme

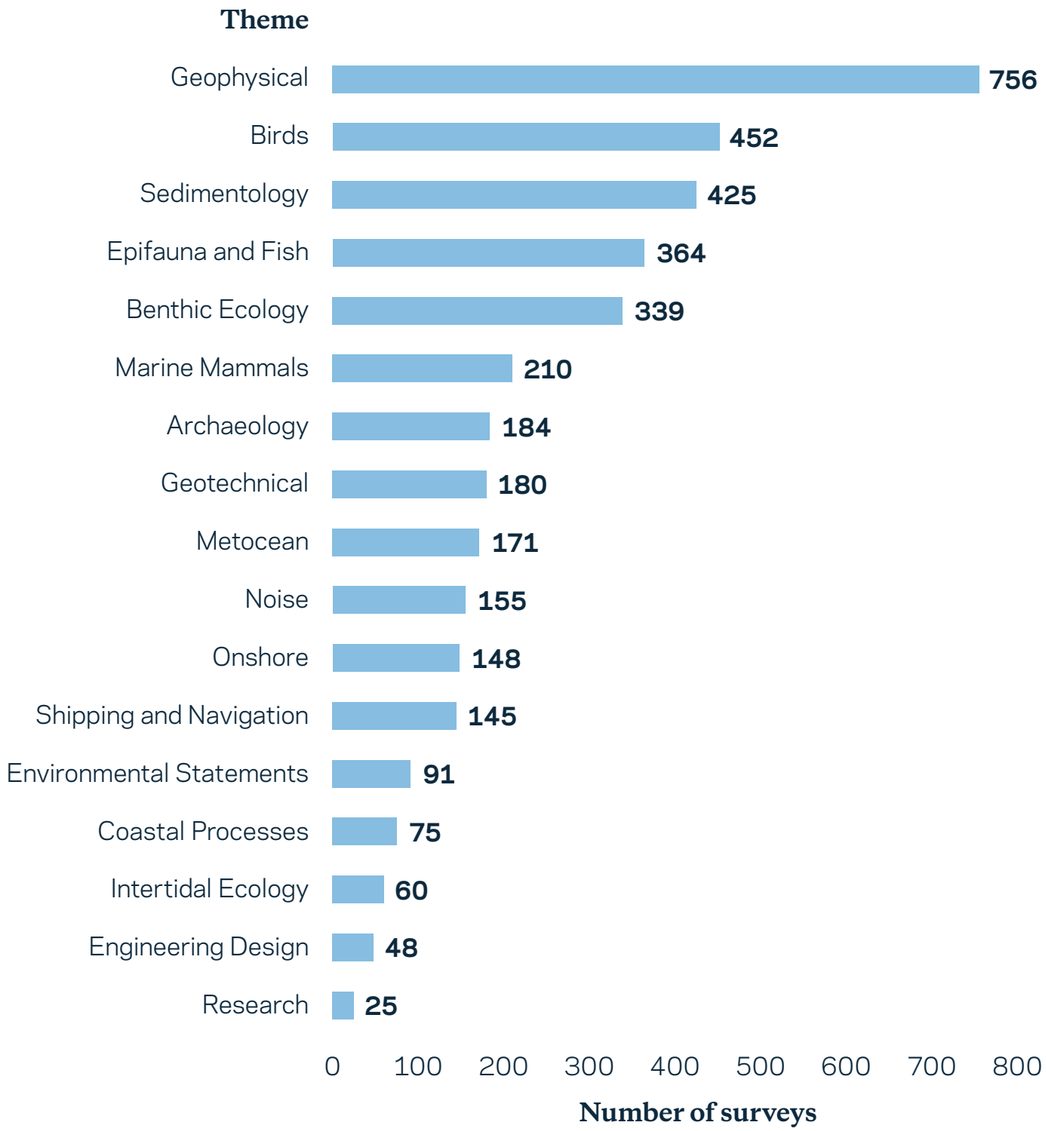


Figure 41: MDE in numbers

268TB
of data

20
years of data

3,000
surveys

£1.54bn
value of data

5,000
users accessed marine data in 2023

Marine Data Exchange

Long-clawed squat lobster using an old pot for shelter

Photo: Dan Bolt, finalist, Underwater Photographer of the Year 2024

Figure 42: MDE history

Marine Data Exchange

2003

Data clause introduced
To support the growth of the offshore wind sector, The Crown Estate pioneered the inclusion of a data clause that would require offshore wind projects to deliver their survey data to The Crown Estate throughout the lifetime of the projects. This data clause has since been rolled out to all seabed leasing agreements which means it is a contractual requirement for our customers to share their survey data with us.

2013

MDE established
In response to the large volumes of survey data being collected and delivered by our customers, we built a bespoke data management system, the Marine Data Exchange. The MDE not only provides a portal for data submission and an audit of the data management process, it also provides a public platform from where data is made publicly and freely available.

2015

MDE moved to the cloud
The MDE data holding surpassed 100TB.

Rather than developing internal infrastructure to accommodate a rapidly growing database, we decided to move the MDE into the cloud. This paved the way for other systems at The Crown Estate to utilise the cloud platform.

2021

New-look MDE launched
In 2021, following feedback from our customers, users and stakeholders, we re-designed the MDE and launched a new version of the site.

The new site is design-led and user-driven. We take an agile approach in rolling out improvements, responding and testing user requirements every step of the way.

2023

10 year anniversary
The MDE celebrated its 10 year anniversary in 2023.

Take a look at the facts, case studies and events that celebrated this milestone.

Gwynt y Môr offshore wind farm array with Snowdonia in the background

Offshore Wind Evidence and Change programme

Despite the game-changing contribution that offshore wind can make to delivering a net zero future, it cannot be developed in isolation. New development, particularly on the scale required to achieve net zero, must sit comfortably alongside other users of the busy marine space, and – crucially – we need to be reducing the pressure on nature and proactively restoring the marine environment.

At its heart, robust and accessible data will help speed up the consenting process by reducing uncertainties, encouraging innovative design measures to enhance biodiversity, and providing a better understanding of the spatial needs of user groups.

Investing in evidence, research and data is therefore vital to our future and no one organisation can do this on its own. The Crown Estate's £50 million investment in the Offshore Wind Evidence and Change programme (OWEC), launched in 2021, brings together 26 member organisations to collect, analyse and share data and evidence that will help to paint an ever-fuller picture of the whole of the seabed and its many interdependencies. Over the past year the programme has funded a broad range of pioneering new research projects on subjects such as consideration of subsea cabling and how to improve the evidence base for the coexistence of offshore wind farms and commercial fishing; and what kind of impacts floating offshore wind will have on the marine environment. For more information about the work of OWEC in 2023, read the annual report here.

Offshore Wind Evidence + Change Programme

Carbon dioxide displacement due to renewable energy

Displaced CO_2: Represents the carbon dioxide that would have been emitted by traditional power stations to generate electricity, in the absence of renewable energy.

A study of greenhouse gas emissions of the UK electricity system by R.C. Thomson (2014)[1] demonstrated that wind power displaces coal - and gas-fired power stations, and that partial loading of fossil-fuelled power stations has an efficiency penalty of 11%.

The CO_2 displaced by offshore wind can be calculated by using DESNZ emissions statistics for "all fossil fuels" and subtracting 11% to account for the induced efficiency penalty.

The Crown Estate uses this method to measure the benefit of offshore wind.

Displaced CO_2 in 2023: 18,491,935 tonnes.[2]

1 Carbon and Energy Payback of Variable Renewable Generation, Rachel Camilla Thomson (2014).
2 Figure based on 2022 emissions data published on 27 July 2023 by DESNZ.

Correct as of April 2024, unless otherwise stated.

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THE CROWN ESTATE

Appendix 2 – DONG submission

Hornsea Project One Deadline 1 Submission

1 INTRODUCTION

1.1 This document is submitted for Deadline 1 in relation to the Hornsea Project Two Examination, jointly on behalf of Heron Wind Limited ("Heron"), Njord Wind Limited ("Njord") and Vi Aura Limited ("Vi Aura"). The three companies are collectively referred to as the "Project One Companies". The undertakers in relation to the Project Two Order (Optimus Wind Limited and Breesea Limited) are referred to in this Representation as the Applicants or the Project Two Companies.

1.2 This document is structured as follows:

Written Representation

Section 2 sets out the status of the Project One Companies;

Section 3 provides background to DONG Energy Wind Power A/S to put Project One in the context of DONG Energy's UK portfolio of offshore wind farm projects;

Section 4 explains Project One's status and development timetable, and draws a high level contrast with Project Two in those terms;

Section 5 provides background information concerning existing legal agreements between Project One and Project Two;

Section 6 provides background information concerning the status of Project One in relation to The Crown Estate as landlord of the seabed;

Section 7 explains Project One's perspective on the legal mechanisms available to resolve issues between Project One and Project Two;

Sections 8 to 13 address the issues raised in the Project One Companies' Relevant Representation (Appendix 1) in more detail;

Replies to First Questions

Section 14 provides the Project One Companies' responses to the First Questions directed at them, together with responses to other Questions where they considered a response was appropriate;

Comments on Relevant Representations

Section 15 provides the Project One Companies' responses to points arising from the Relevant Representations of the Environment Agency (RR-25);

List of Appendices

A list of the appendices to accompany this Deadline 1 submission is at the end of this document.

1.3 There are ongoing constructive discussions with the Applicants to progress and agree solutions to the issues identified in sections 8 to 13, including negotiations on two confidential cooperation agreements (one offshore, one onshore) and specific Protective Provisions for inclusion in the Development Consent Order on an agreed basis. It is hoped that it will be possible to withdraw the various Representations in due course as part of a comprehensive package agreed between the two sets of project companies. The parties are aiming to have resolved these matters by Deadline 2.

Hearings and Site Visit

1.4 The Project One Companies have responded separately on the question of attendance and speaking at hearings and in relation to the site visit.

2 STATUS OF THE PROJECT ONE COMPANIES

2.1 Heron, Njord and Vi Aura are the three named undertakers under the Hornsea One Offshore Wind Farm Order 2014 (the "Project One Order") (Appendix 2). The project consented under this Order is referred to as "Project One".

2.2 Each of the Project One Companies holds a generation licence under section 6 Electricity Act 1989 and is a statutory undertaker (Appendix 3).

2.3 Heron holds all of the onshore land interests in relation to Project One. There are 282 plots (out of 522) in the Project Two Order where rights (temporary and permanent) are sought by Project Two over land within the Project One Order Limits. Accordingly, Heron is an affected party as well as an interested party.

2.4 This representation also constitutes a representation for the purposes of section 127 Planning Act 2008 on behalf of Heron.

2.5 This submission also engages section 138 Planning Act 2008 in relation to Heron, given the rights vested in or belonging to Heron in relation to its undertaking as a statutory undertaker. These rights take the form of agreements with landowners and lessees, or rights conferred under the Project One Order for the construction and maintenance of apparatus forming part of Project One.

3 BACKGROUND

3.1 Heron and Njord are owned 100% by DONG Energy Wind Power A/S ("DONG Energy"). Vi Aura is owned 100% by Heron.

3.2 DONG Energy was a minority shareholder in Heron and Njord until February 2015 when it took full ownership of Project One. SMart Wind Limited acted as agent for the Project One application but from February 2015, no longer has any involvement with Project One. DONG Energy has no legal interest in Project Two. Accordingly, the two projects are entirely at arm's length and are being promoted separately.

3.3 DONG Energy is the market leader in offshore wind power and the United Kingdom is one of its main markets. DONG Energy operates and is a full or part owner of five established operational offshore wind farms in the UK: Barrow, Burbo Bank, Walney 1 & 2, Gunfleet Sands and London Array (the world's largest offshore wind farm), and is a part owner in the Lincs Offshore Wind Farm which is operated by Centrica.

3.4 DONG Energy also operates and owns with partners the 389MW West of Duddon Sands offshore wind farm in the Irish Sea, inaugurated in October 2014, and the 210MW Westermost Rough offshore wind farm off the East of England, inaugurated in July 2015. DONG Energy's 258MW Burbo Bank Extension in the Irish Sea and 580MW Race Bank offshore wind farm off the East of England are under construction and are expected to be operational in 2017 and 2018, and the 660MW Walney Extension, is in advanced development having been awarded a Contract for Difference.

4 STATUS AND DEVELOPMENT TIMETABLE FOR PROJECT ONE

4.1 The Project One Order came into force on 31 December 2014. The Project One Companies applied for a correction order which came into force on 1 May 2015[1] (Appendix 4). At the Project Two Preliminary Meeting the Examining Authority requested that a proportionate approach was taken to submitting documents from other Nationally Significant Infrastructure Projects (NSIPs) applications and Examinations into the Project Two Examination, whilst taking into account that the Examining Authority cannot consider documents which are not formally submitted into this Examination.

4.2 Bearing that in mind, the following Project One documents are included as appendices to this submission:

(a) The Project One Order;

(b) The Project One Correction Order;

(c) The Explanatory Memorandum submitted with the draft Project One Order;

(d) The three generation licences for Heron, Njord and Vi Aura;

(e) The approved Land Plans;

(f) The approved Works Plans;

(g) The Final version of the Project One Book of Reference.

4.3 As already noted, the Project One Order was granted in December 2014. Project One has also been awarded a Contract for Difference by the Department for Energy and Climate Change under the Final Investment Decision Enabling for Renewables Process. The Contract for Difference enables the financial support mechanism that will facilitate Project One to be constructed. The Contract includes certain milestones and commits the project to a specific development programme. Project One is fully committed to meeting that programme and multiple workstreams are being taken forward ranging from detailed project optimisation, onshore and offshore procurement, through to preparation for the discharge of detailed requirements under the Project One Order and conditions under the deemed Marine Licences.

4.4 The Contract for Difference was awarded through a competitive process, with a significant number of unsuccessful applicants. A Government statement which outlines this process has been included at Appendix 5. The Contracts for Difference (or Investment Contracts) for all eight successful projects are publicly available. The statement to Parliament by the Secretary of State for Energy made when the Project One Contract was laid before Parliament is also reproduced at Appendix 5.

4.5 The Project One Companies consider that it is important that the Examining Authority has an outline understanding of the large number and range of workstreams involved in bringing forward a complex project like Project One to its Financial Investment Decision and then into construction and commissioning.

4.6 The remainder of this section seeks to provide this. The key point is that as Project One proceeds through these various workstreams it is fundamental that any interface with an emerging project opportunity like Project Two is resolved in Project One's favour in a satisfactory manner. Project One cannot accept uncertainty on this matters for any significant period of time, nor should it have to, given that it has secured its Development Consent Order and, crucially, a Contract for Difference.

[1] The Hornsea One Offshore Wind Farm (Correction) Order 2015.

4.7 By contrast, Project Two is still at an early stage and is running to a significantly later timetable. Importantly, it does not have a Contract for Difference. It will have to bid in a future Contract for Difference round against other offshore wind projects and other types of electricity generating projects. There is no guarantee that it will secure a Contract for Difference.

4.8 The Contract for Difference for Project One sets a Milestone Delivery Date of 31 March 2016. By this date, Project One will need to demonstrate to The Low Carbon Contract Company (LCCC), the Contract for Difference counterparty body, that either (i) 10% of the project pre-commissioning costs have been spent (approx. £246m) or (ii) that major supply contracts have been entered into. If this milestone is not met, then the LCCC has the right to terminate the contract.

4.9 Project One is well progressed in achieving its Contract for Difference milestones and deliverables. There are currently circa 100 people working on Project One advancing the design and procurement of the key project components. In parallel with this work are the ongoing discussions with regulators and stakeholders to discharge the requirements of the consents. In July 2015 the preferred supplier was appointed securing the supply and commissioning of wind turbines to Project One, and subject to Final Investment Decision it is intended that the wind farm will be producing electricity by 2020.

4.10 Onshore construction will commence in early 2016 with offshore construction commencing in 2018. A Final Investment Decision is targeted for 2016. The capital investment for Project One is estimated to be in excess of £3 - 4 billion which DONG Energy may seek to fund through the establishment of investor partnerships with a range of different investors requiring necessary due diligence.

4.11 In order to meet the March 2016 milestone in the Contract for Difference, Project One has significantly progressed its construction programme. Activities carried out or underway include:

(a) A detailed geotechnical survey carried out between October 2014 and April 2015. The results of this survey will provide DONG Energy with detailed information about ground conditions at each proposed wind turbine position thereby informing the selection of viable foundation locations and a feasible installation strategy. This survey was a considerable investment for the project with an estimated contract value of £13 million – data collection is complete and the data is currently being analysed.

(b) Agreement of a Planning Performance Agreement (PPA) with North Lincolnshire, North East Lincolnshire, West Lindsey and East Lindsey District Councils. Several meetings have been held to date to discuss the onshore installation programme, which is currently scheduled to commence in early 2016.

(c) Detailed design work for the onshore substation is considerably advanced with designs to inform the installation procurement process anticipated to be completed within the next four weeks. Once the design process is complete, DONG Energy will be conducting a procurement exercise to commission a construction contractor and commence work to prepare for construction.

(d) An employment and skills plan is being developed with the Local Enterprise Partnership and North Lincolnshire District Council. This will aim to highlight employment and supply chain opportunities associated with the construction, operation and maintenance of the Project. In addition, DONG Energy will be hosting events in the region for businesses interested in providing supplies and services for the wind farm.

4.12 It is the contrast between the two projects outlined in this section which sets the context for the examination of the relationship and interfaces between them. The approaches available to resolving issues between the projects are considered further in section 7.

5 EXISTING LEGAL AGREEMENTS BETWEEN PROJECTS ONE AND TWO

5.1 To assist the Examining Authority to understand the commercial context for this Written Representation the contractual background and current position is summarised in this section.

5.2 DONG Energy acquired a 33.3% stake in Project One pursuant to a complex agreement in 2011. At that time there were only two project companies, Heron and Njord. As part of the 2011 arrangements it was agreed to allow for the possibility that Project One might be delivered as three NSIPs rather than two. This led to the Project One draft Order being structured to allow for two or three NSIPs each with a separate undertaker. This is explained in the Explanatory Memorandum (Appendix 6).

5.3 Vi Aura Limited is the third undertaker under the Project One Order. It is owned 100% by Heron.

5.4 The 2011 agreement provided for cooperation between the three shareholders in taking Project One forward.

5.5 DONG Energy had an option, which it later exercised, to acquire the remaining shares in Heron and Njord resulting in DONG Energy taking full ownership of Project One (and thereby full control of Vi Aura, given that Vi Aura is 100% owned by Heron). The full effect of this option was conditional on the Project One Order being granted in accordance with certain criteria.

5.6 The acquisition of the remaining shares took place in February 2015 after the Project One Order had completed its legal challenge period without a legal challenge being made. Since that time Heron and Njord have been owned 100% by DONG Energy (and Vi Aura remains 100% owned by Heron) and are entirely separate from SMart Wind Limited and the Project Two Companies.

5.7 There are three legal agreements in place between relevant companies concerning the relationship between Project One and Project Two going forward, the details of which are commercially confidential.

5.8 One agreement relates to the onshore cable route and related matters and was entered into in December 2011.

5.9 Two other agreements, dated November 2013 and April 2014, relate principally to the onshore substation for Project One. The latter agreement envisaged the negotiation of a fully comprehensive onshore and offshore cooperation agreement between the two projects by Q4 2014, which would supersede the three agreements just mentioned. This agreement is still under negotiation, and is being taken forward as two confidential agreements – an onshore cooperation agreement and an offshore cooperation agreement.

6 THE CROWN ESTATE

6.1 Agreements for Lease are in place with The Crown Estate Commissioners in relation to the entire Project One turbine array areas. These provide for the exercise of an option to take leases over the seabed areas which constitute the consented array area for the Project One Order. They also provide for the grid connection to the shore from each lease area. These agreements are commercially confidential.

7 APPROACH TO RESOLVING ISSUES BETWEEN PROJECTS ONE AND TWO

7.1 Section 9 of the Project Two Order Cable Statement (Document 11.2) deals with "Interfaces between Project One and Project Two". The Cable Statement explains the close proximity, and partial overlap, between the two projects. It correctly states that there are a number of areas and issues, both offshore and onshore, where the interests of the two projects may conflict unless there is agreement between them.

7.2 There are two mechanisms by which conflict between Project One and Project Two can be resolved – by commercial agreement or by means of the final provisions of the Development Consent Order, assuming it is granted.

By Agreement

7.3 The Project One Companies are in active negotiation with the Project Two Companies in relation to the various issues highlighted in the Project One Relevant Representation and amplified in more detail in this Written Representation.

7.4 It is the Project One Companies' preference that these matters be dealt with by way of confidential commercial agreements, as long as it can be reached on satisfactory terms which properly protect the interests of Project One. As already noted it is intended that these be resolved by Deadline 2.

7.5 If binding agreements can be reached before the end of the Examination which resolves all matters between Project One and Project Two, then the Project One Companies will notify the Examining Authority of that fact and submit an agreed Statement of Common Ground. The Statement will outline the areas covered by the agreement and, in accordance with the terms of such agreement, will withdraw, vary or confirm the various Project One representations as part of such agreement. It may also provide for the inclusion of agreed Protective Provisions and Development Consent Order amendments.

By way of the Secretary of State's decision and the terms of any Development Consent Order

7.6 It is imperative to the delivery of Project One that its interests are protected in all eventualities. Given that the Project Two application was submitted without agreement of the confidential cooperation agreements having been reached between Project One and Project Two, Project One was obliged to submit a Relevant Representation highlighting the various areas of potential conflict between the two projects. It has furthermore been necessary for Project One to submit this Written Representation to explain the areas of conflict in more detail, to explain the adverse impact of these issues on Project One unless they are addressed, and to propose solutions which are necessary to protect the interests of Project One.

7.7 It should be noted that Project Two has not included any Protective Provisions in the draft Development Consent Order which seek to protect Project One from Project Two. The Project Two Companies have assumed that a confidential commercial agreement will be reached.

7.8 When considering the changes to the Project Two draft Development Consent Order which Project One requires, the Examining Authority and the Secretary of State are required to apply the test in section 104 Planning Act 2008. In particular, the Secretary of State:

(a) Must decide the application in accordance with any relevant national policy statement, except to the extent that (among other things) the Secretary of State is satisfied that the adverse impact of the proposed development would outweigh its benefits;

(b) In deciding the application must have regard to any relevant national policy statement and (among other things) any other matters which she thinks are both important and relevant to the decision.

7.9 It is submitted that in this case, where Project Two and the terms of the Development Consent Order sought by the Project Two Companies are adverse to the delivery of Project One that:

(a) Such adverse effects constitute matters which should be regarded as "important and relevant" the Secretary of State's decision and which must therefore be had with regard to;

(b) Such adverse effects would represent an "adverse impact" which is capable of outweighing the benefit of the proposed development i.e. Project Two, such as to justify amending the Development Consent Order;

(c) The principles set out in Section 2.6 of National Policy Statement for Renewable Energy Infrastructure (EN-3) should apply when deciding whether Project Two is "in accordance" with the relevant national policy statements (i.e. EN-1, EN-3 and EN-5).

7.10 Section 2.6 relates to the impacts of offshore wind farms on oil, gas and other offshore infrastructure and activities. It is does not specifically address the interaction between two offshore wind farms, but the principles to be applied in that situation must be the same. In particular:

(a) Paragraph 2.6.179: the promoter of an offshore wind farm should undertake an assessment of the potential effect of the proposed development on existing or permitted infrastructure or activities.

(b) Paragraph 2.6.180: the promoter should engage with interested parties (in this case the Project One Companies) early in the development phase with an aim to resolve as many issues as possible prior to the submission of an application;

(c) Paragraph 2.6.181: such engagement should continue throughout the life of the development to ensure that solutions are sought to exist that allow offshore wind farms and other uses of the sea to successfully co-exist.

(d) Paragraph 2.6.183: the decision maker should adopt a pragmatic approach where a proposed offshore wind farm potentially affects other offshore infrastructure or activity. The decision maker should expect the applicant to minimise negative impacts and reduce risks to as low as reasonably practicable.

(e) Paragraph 2.6.184: the decision maker should be satisfied that the site selection and site design of the proposed offshore wind farm has been made with a view to avoiding or minimising disruption or economic loss or any adverse effect on safety to other offshore industries. The decision maker should not consent applications which pose unacceptable risks to safety after mitigation measures have been considered.

(f) Paragraph 2.6.185: where a proposed development is likely to affect the future viability or safety of an existing or approved/licensed offshore infrastructure or activity, the decision maker should give these adverse effects substantial weight in its decision-making.

(g) Paragraph 2.6.186: providing proposed schemes have been carefully designed by the applicants and the necessary consultation has been undertaken at an early stage, mitigation measures may be possible to negate or reduce effects on other offshore infrastructure or operations to a level sufficient to allow the decision maker to grant consent.

(h) Paragraph 2.6.187: detailed discussions between the applicant and relevant consultees should have progressed as far as reasonably possible prior to the submission of an application. As such appropriate mitigation should be included in any application and ideally agreed between relevant parties.

7.11 The tests set out in this section are those which must be applied when considering the issues considered below in sections 8 to 13.

Compulsory acquisition and Statutory Undertakers

7.12 In addition to the tests under section 104, where powers of compulsory acquisition are sought, the Secretary of State is also obliged to consider the tests for compulsory acquisition, which are set out in the Statement of Reasons and are not repeated here. This is particularly the case where another NSIP has already secured powers of compulsory acquisition as is the case here. Furthermore, where a statutory undertaker is affected by proposed compulsory acquisition, the Secretary of State must consider the "serious detriment" test under section 127 and the test under section 138 that the impact on the statutory undertaker is "necessary".

7.13 As already explained, whilst the manner of resolving matters in the absence of agreed cooperation agreements have just been highlighted, the Project One Companies are working towards an outcome where fully testing those issues in the Examination can be avoided and these representations can be withdrawn as part of an agreed package with Project Two.

8 OVERLAP OF ORDER LIMITS - ONSHORE TEMPORARY AND PERMANENT WORKING AREAS AND COMPOUNDS

8.1 In sections 8 to 13, the Project One Companies have followed a consistent approach in setting out the relevant part of the Relevant Representation, explaining the issues in more detail, proposing the solution or solutions required and highlighting the risks to Project One if those solutions cannot be achieved.

8.2 **Relevant Representation:** "There are a number of locations identified within the Project Two Work Plans where there is a complete overlap and, as a consequence, possession proposed for the usage of temporary working areas. This is particularly clear at the onshore substation site."

8.3 "There is an area of proposed permanent acquisition of part of the Project One substation area. This should either be removed, or made subject to Protective Provisions which mean that land/rights can only be acquired with Project One's consent."

8.4 **Issue in detail:** The Project Two application seeks a full set of powers of compulsory acquisition and temporary use to deliver Project Two. There is a considerable overlap between the works proposed and the powers sought for Project Two and the land arrangements already in place for Project One. The Project One Order contains a full set of compulsory acquisition powers and temporary use powers to deliver Project One, which underpin, where applicable, the numerous voluntary agreements which have been entered into by Heron with relevant land owners and those holding land interests. These powers have been granted after full consideration in the Examination into the Project One application and found to satisfy the various tests for compulsory acquisition under the Planning Act 2008.

8.5 The Statement of Reasons for Project Two, with one exception (the compensation compounds), does not address the overlap between the granted powers for Project One and those sought for Project Two. There are no Protective Provisions in the draft Development Consent Order to provide protection to Project One in relation to how the powers sought might be utilised. Section 9 of the Cable Statement (Document 11.2)

does, however, acknowledge the issue in general terms and highlights the need for a confidential cooperation agreement, which is under active negotiation.

8.6 The Project One Companies have reviewed the overlap of the powers sought for Project Two with the powers already secured in the Project One Order. The interaction between the powers is shown on 54 plans included at Appendix 7 referred to in this submission as the Project One Project Two Onshore Overlap Plans (the Overlap Plans). These plans show which Plots in the Project Two Land Plans affect the Plots in the approved Land Plans (Appendix 8) under the Project One Order. In addition the Overlap Plans show the full red line of the Project One Order Limits with the land unaffected by Project One shown in dark grey. Finally, the plans show in light grey the Project Two Order Limits land which does not overlap with the Project One Order Limits.

Project One Substation

8.7 There is a particular conflict between the Project Two proposals and the approved Project One substation, shown on Overlap Plan 1. Plot 506 in part seeks permanent acquisition of a significant part of the Project One substation land where Project One already has powers to acquire the land permanently. (The remainder of Plot 506 seeks permanent acquisition of land which Project One has temporary use powers for the purpose of constructing the neighbouring Project One substation.) In addition, Plot 505 seeks temporary occupation of the majority of the Project One substation land where Project One already has powers to acquire the land permanently. Finally, Plots 503 and 507 seek powers of temporary occupation and acquisition of permanent rights over land where, again, Project One already has powers to acquire the land permanently.

8.8 Since the grant of the Project One Order, Project One has significantly progressed its detailed design phase for the onshore substation. The designs show that Project One requires the full extent of the consented Order Limits designated for permanent use for the substation. Figure 1 below provides a visualisation of the Project One substation showing how the electrical infrastructure will fill the full extent of the Project One Order Limits at the substation site.

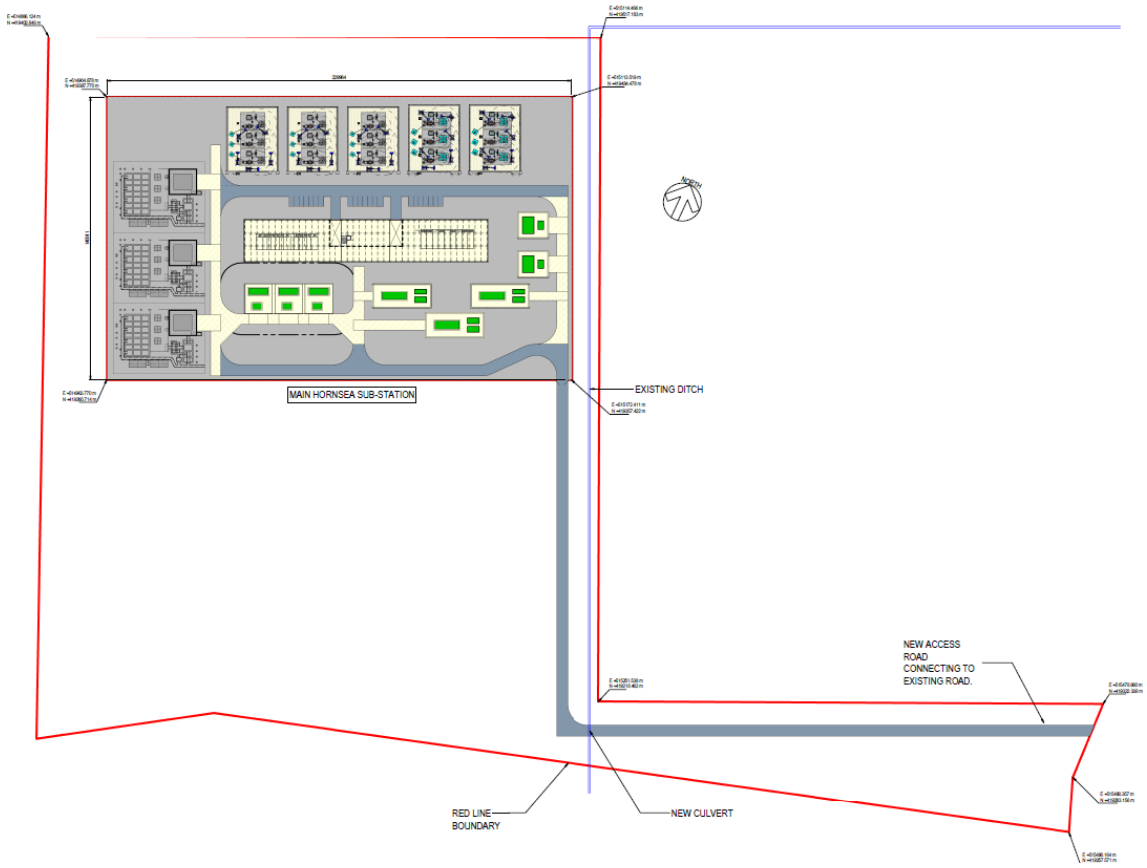

Figure 1: Diagram showing the Project One substation infrastructure illustrating full utilisation of the Order Limits for the substation.

8.9 The Statement of Reasons does not explain why Project Two requires permanent acquisition of part of this land, as part of Plot 506, in the light of its intended use for Project One (paragraph 5.2.5, for example, does not address the issue[2]). Given Project One's proposed use and the fact that it has already secured the land by agreement (and, as a fall back, successfully secured powers of compulsory acquisition under the Project One Order), the Project One Companies' request the compulsory powers sought are not granted and that this land is removed from the Book of Reference. If this is not done the uncertainty created by Project Two having competing powers of compulsory acquisition over part of its main substation site would adversely affect delivery of the project and would cause serious detriment to the undertakings of the Project One Companies given that all three statutory undertakers are relying on the delivery of the substation for delivery of the three NSIPs within the Project One Order.

8.10 An alternative approach would be for Protective Provisions to be included in the Project Two Order which prevented use of the powers of compulsory acquisition without the agreement of the Project One Companies. This, however, is not appropriate in this instance where it is known in advance that the land will not become available.

8.11 The same point applies to the request for powers of temporary use over Plot 505, 503 and 507. These are inconsistent with the delivery of the Project One substation across the full substation land and should be removed from the Order. In addition, the use of the remainder of Plot 506 as a lay down area for Project One needs to be preserved in Protective Provisions or a confidential cooperation agreement.

[2] The reference to Plot 508 should be to Plot 506.

Other Project One Land

8.12 There are various other Plots where Project Two is seeking permanent rights and/or powers of temporary occupation where Project One already has powers for permanent rights and/or temporary occupation under the Project One Order. These are shown in full in the Overlap Plans. If these powers are to be granted, they can only be granted if Project One has certainty as to how and when the powers will be used so that the Project One Companies have the ability to ensure that the construction and maintenance of Project One is not adversely affected. This can either be delivered by way of Protective Provisions or a confidential cooperation agreement or both.

8.13 The one area where the Statement of Reasons and the Project Two Development Consent Order acknowledges a potential impact on Project One relates to the use of construction compounds for Project One. This is addressed in paragraph 6.5 onwards. The Project One Companies understand and agree with the principle which Project Two is seeking to address. It is essential that the mechanics of proposals work satisfactorily to provide the necessary certainty and protection for Project One. These are the subject of discussions with Project Two as part of the onshore confidential cooperation agreement.

8.14 **Proposed solution:** The Project One Companies require the removal of Plots 503, 505, 507 and the northern part of Plot 506 (shown separately on Overlap Plan 1) from the Project Two Development Consent Order and the Book of Reference.

8.15 The Project One Companies require suitable Protective Provisions to be included within the Development Consent Order in relation to the other Plots where there is overlap between the powers sought for Project One and Project Two and/or for the relevant matters to be dealt with under a confidential cooperation agreement between the two projects.

8.16 The mechanism for the Compensation Compounds needs to provide sufficient certainty and control to Project One in the event that it is triggered. The provisions on the face of the Development Consent Order may require some amendment and may need to be supplemented in a confidential cooperation agreement.

8.17 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of Heron Wind Limited".

Risk if proposed solution not implemented: If the relevant part of Plot 506, together with Plots 503, 507 and 508 are not removed from compulsory acquisition it will expose Project One to unacceptable risks in terms of the timely delivery and operation of the substation to be installed and therefore the project as a whole. One important aspect of this is the need to satisfy a future Offshore Transmission Owner that there are suitable protections in place in relation to the transmission assets which it will take over on appointment.

8.18 In relation to the remaining Plots where powers overlap, if suitable Protective Provisions are not included within the Development Consent Order to protect Project One (and/or a suitable confidential cooperation agreement is not entered into), it will expose Project One to unacceptable risks in terms of the timely delivery, operation and maintenance of the onshore works to be installed and therefore the project as a whole. Again, an important aspect of this is the need to satisfy a future Offshore Transmission Owner that there are suitable protections in place in relation to the transmission assets which it will take over on appointment.

9 CONNECTION INTO KILLINGHOLME SUBSTATION

9.1 **Relevant Representation:** "There are three new generating stations seeking to connect into Killingholme substation - Project One, Project Two and North Killingholme Power

Project (promoted by C.GEN North Killingholme Limited). Project One's current proposal is to begin works for the onshore substation in January 2016. In light of this Heron is in discussion with the Applicant and with C.GEN in relation to the routing of cables to the Killingholme substation."

9.2 **Issue in detail:** Project One has a connection agreement with National Grid Electricity Transmission Limited to connect into the Killingholme substation. The Project One Order authorises the construction of that connection. The route(s) available under the Development Consent Order are to be supplemented by a planning permission which has been designed to dovetail with the works powers under the Development Consent Order. This application is currently with North Lincolnshire Council for determination.

9.3 Heron has the benefit of powers of compulsory acquisition under the Project One Order, to enable it to secure the necessary property rights to deliver the grid connection, in addition to the rights obtained by agreement.

9.4 C.GEN North Killingholme Limted ("C.GEN") does not have planning permission or, it is understood, real estate rights, to connect its project to the Killingholme substation. Its attempt to obtain compulsory acquisition rights for a corridor were rejected by the Secretary of State. Nevertheless, the Project One Order includes protective provisions in favour of C.GEN North Killingholme Limited ("C.GEN"), which provide for the de facto reservation of a route for the grid connection for C.GEN's project to the Killingholme substation. The operation of these protective provisions were varied by way of a confidential agreement dated 20th January 2015. It is not intended that a further agreement will be entered into between the Project One Companies and C.GEN as the matter is already addressed. The Project One Companies are maintaining a dialogue with C.GEN generally going forward.

9.5 Project Two also has a grid connection agreement to connect to the Killingholme substation and is seeking development consent and associated compulsory powers in the Project Two Development Consent Order. The issues associated with the interaction between the Project One grid connection and the Project Two grid connection and associated powers of compulsory acquisition form part of the matters under discussion with Project Two as explained in section 8.

9.6 **Proposed solution:** The solution proposed in relation to Project Two has already been addressed in Section 8 i.e. a commercially confidential cooperation agreement and/or Protective Provisions. The C.GEN position has been explained by way of background as it does not require further measures in connection with the Project Two application from Project One's perspective.

10 INTERTIDAL ACCESS

10.1 **Relevant Representation:** "The interaction between the two projects during construction and maintenance must be controlled to ensure that the delivery of services to Project One is not adversely impacted."

10.2 **Issue in detail:** The Project Two draft Development Consent Order includes a condition in the deemed Marine Licences (Project A: Transmission assets and Project B: Transmission assets, Schedule 1, Part 1) stating that, where works authorised by the Project One Offshore Wind Farm Order 2014 are planned to take place within the Project Two Order Limits, the undertaker must not construct or install licensable activities comprised in Work numbers 4A and 5B within 1km of the sea wall. The condition as stated in the draft Project Two Development Consent Order states:

"*In the event that works authorised by the Hornsea One Offshore Wind Farm Order 2014(a) are planned to take place in the intertidal area comprised within the offshore Order limits or within the area whose co-ordinate in paragraph (5) below, the undertaker must not construct or install those licensable activities comprised in Work Nos. 4A and*

5A within one kilometre seaward of the seawall during the period of time commencing two hours before a high tide greater than 7.7 metres (as measured at Grimsby) and ending two hours after a high tide greater than 7.7 metres (as measured at Grimsby) between 1 April and 31 May (inclusive) and 1 August to 30 September (inclusive), unless otherwise approved in writing by the MMO, in consultation with Natural England."

10.3 The Project One deemed Marine Licence 4 carries a similar condition which states:

"*In the event that the MMO notifies the licence-holder that other works are planned to take place in the intertidal area comprised within the offshore Order Limits or within the area whose coordinates are set out in Table 8, the licence holder must not construct or install those licensable activities comprised in Work Nos. 6 and 7 within one kilometre seaward of the seawall during the period of time commencing two hours before a high tide greater than 7.7 metres (as measured at Grimsby) and ending two hours after a high tide greater than 7.7 metres (as measured at Grimsby) between 1st April and 31st May (inclusive) and 1st August to 30th September (inclusive), except to the extent approved in writing by the MMO, in consultation with Natural England*."

10.4 There is some ambiguity between these two conditions. On the one hand the condition within the Project Two draft Development Consent Order states that relevant works in the intertidal area will not be carried out if Project One activities are being carried out in the same area however, the Project One deemed Marine Licence states that Project One activities cannot be carried out in the same area if "other works" are planned to take place.

10.5 Project One is a consented project and has been awarded a Contract for Difference. As set out earlier in this Written Representation, Project One has to meet a series of milestones related to project development costs or supply contracts. As a consequence of this, the construction programme must align closely with the Contract for Difference to avoid any termination of the contract. The Project One intertidal cable installation is currently programmed for 2018. According to Document 7.1.3: Project Description; Section 3.5, Project Two is anticipated to commence construction in 2017 with intertidal cable installation anticipated to take place in Year 2. This suggests that the Project Two cable could be installed in the intertidal area in 2018.

10.6 Although, in theory, the intertidal section of the Project One export cable could be installed by the time the Project Two intertidal cable installation commences, Project One may still need access to the cable for installation and inspection purposes and ultimately during commissioning which will take place in 2018, 2019 and possibly 2020. Whilst the drafting in the Project Two draft Development Consent Order provides some protection for planned Project One works, it does not provide protection if emergency repairs works are needed. In the instance that Project Two cable installation is in progress, on the basis of the deemed Marine Licence conditions stated above, access may not be granted to Project One for unplanned works unless Project Two construction activities are halted. Project One and Project Two must come to an agreement about how to prioritise works in the intertidal area – both during construction so as not to risk Project One's Contract for Difference and to facilitate planned and emergency maintenance works.

10.7 **Proposed solution:** The Project One Companies require Protective Provisions to be included within the Development Consent Order or a confidential cooperation agreement (which is under negotiation) which will provide confidence that the detailed design of the route of the export cable (and associated equipment) and their subsequent construction can proceed in a timely manner without unacceptable interference from Project Two. The Protective Provisions will also need to enable the operations and maintenance of the circuits once installed are protected from unacceptable interference from the construction, operation and maintenance of any Project Two circuits.

10.8 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of Heron Wind Limited".

10.9 **Risk if proposed solution not implemented:** If a suitable confidential cooperation agreement is not in place or suitable Protective Provisions are not included within the Development Consent Order to protect Project One, it will expose Project One to unacceptable risks in terms of the timely delivery and operation of the circuits to be installed and therefore the project as a whole. One important aspect of this is the need to satisfy a future Offshore Transmission Owner that there are suitable protections in place in relation to the transmission assets which it will take over on appointment.

11 OVERLAP OF ORDER LIMITS - PERMANENT INFRASTRUCTURE OFFSHORE

11.1 **Relevant Representation:** "The export cable area for Project Two crosses the consented wind farm array area for Project One. The Cable Statement explains that this is intended to allow for the possibility of a shorter grid connection for the north eastern area of Project Two. Such a route would, however, have substantial adverse consequences for Project One and consequently Project One must be specifically protected under the Project Two Order."

11.2 "The offshore export corridor for Project Two overlaps with that already consented for Project One. The interaction between the two projects during construction and maintenance must be controlled to ensure that the safe and timely delivery of Project One is not adversely impacted.

11.3 **Issue in detail:** Work Numbers 4A and 4B of the Project Two application (Document 5.1) overlap entirely with Project One's Order Limits. The intention is for Project Two to use this area for permanent infrastructure as described in Figure 3.2 in document 7.1.3 Project Description – this area is identified as a 'shared cable corridor'. There are three areas where protection must be guaranteed to Project One.

Overlap between Project Two export cable route(s) and Project One array

11.4 A large part of the area covered by Work Numbers 4A and 4B has already been granted consent in the Project One Order as the location for wind turbine generators (WTGs), array cabling and export cables. Installation of any permanent infrastructure within areas already identified and consented for Project One infrastructure presents a risk to the integrity of the assets.

11.5 As explained in section 4 of this submission, Project One is already progressing towards construction. Wind turbine generator and offshore substation foundations are currently planned to be installed in 2018 and 2019; inter array cabling is planned to be installed in 2018 and 2019.

11.6 Installation of Project Two cabling across the entire Project One array area(s) would involve a disproportionate number of cable crossings with the associated risk of damage to cables. The Cable Statement acknowledges that this has been included as an option, rather than a necessary part of the project. It must be the case that any cost savings arising from a shorter export cable route will be materially reduced by the extra costs of laying cables across a fully or partially installed array.

11.7 **Proposed solution**; The Project One Companies would strongly prefer that consent is not granted for export cables to run across the Project One array area and that Works 4A and 4B are revised accordingly. If, however, that is not accepted, then the Project One Companies require that Protective Provisions are included in the Development Consent Order which give the Project One Companies the ability to approve the detailed arrangements for the interface between Project One and Project Two during the construction, operation and maintenance of the projects.

11.8 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of the Project One Companies".

Overlap between Project Two cable corridor and Project One cable corridor

11.9 A similar issue arises in relation to the export corridor for Project One. The Project Two export corridor (Works 4A and 4B) overlaps with the full length of the Project One export corridor (Work 6). The Project One Companies require a confidential cooperation agreement (which is under negotiation) or that Protective Provisions are included in the Development Consent Order which give the Project One Companies the ability to approve the detailed arrangements for the interface between Project One and Project Two during the construction, operation and maintenance of the projects.

11.10 A variation on these themes arises as the Project Two export corridor approaches landfall and in the intertidal area. Here Works 5A and 5B are drawn such that the Project Two export cable corridor passes just to be north of the consented corridor for Project One, though, importantly, there is overlap in relation to compulsory powers sought for permanent rights for access and anchorage and temporary occupation over Project One's export cable corridor.

11.11 **Proposed solution**: Again, the Project One Companies require a confidential cooperation agreement or that Protective Provisions are included in the Development Consent Order which give the Project One Companies the ability to approve the detailed arrangements for the interface between Project One and Project Two during the construction, operation and maintenance of the projects.

11.12 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of Heron Wind Limited".

11.13 **Risk if proposed solution not implemented:** If a suitable confidential cooperation agreement is not in place or suitable Protective Provisions are not included within the Development Consent Order to protect Project One, it will expose Project One to unacceptable risks in terms of the timely delivery and operation of the circuits to be installed and therefore the project as a whole.

11.14 One important aspect of this is the need to satisfy a future Offshore Transmission Owner that there are suitable protections in place in relation to the transmission assets which it will take over on appointment.

12 PROJECT TWO BUFFER AREA AND WAKE EFFECTS

12.1 **Relevant Representation:** "If Project Two is constructed up to the Order Limits there will be wake effects which will impact Project One. This has been recognised in the 4 indicative layouts included in the Project Description (Figure 3.5) forming part of the Environmental Statement. Each of these layouts shows a buffer zone (area of no turbine installation) along the full length of the boundary with Project One. This is not however reflected in Project Two's Development Consent Order submission. Project One requires a provision in the Project Two Order which prevents the construction of turbines within the buffer area unless otherwise agreed by Project One. For the avoidance of doubt Project One will require a co-operation agreement in relation to these impacts."

12.2 **Issue in detail:** As a wind turbine extracts energy from the wind, it reduces the momentum of and increases the turbulence in the air that has passed through the rotor. This means that the wind passing through a location immediately downwind of a turbine will have a reduced wind speed and decreased electricity production potential. The wind gradually recovers its electricity production potential as it travels onward from the turbine, increasing back towards the level of useful energy it possessed before passing through the first wind turbine.

12.3 Turbines that are in the wake of another turbine (in a downwind position) will have a reduced energy production than those in an upwind location as there is less potential energy available in the wind. This loss of energy for downwind turbines relative to

turbines that are not in the wake of another turbine, is called 'wake loss'. The wake loss value for the wind farm is taken as an average of all turbine locations and includes the full distribution of wind speeds and directions. As wake losses represent a loss to the potential power production of a wind farm, they impact the productivity resulting in lower energy yields which in turn will reduce the contribution the wind farm can make to the Government's targets for renewable energy. This is also an important aspect in developing the business case which informs the Final Investment Decision for the project. Wind farm projects therefore seek to reduce wake losses to maximise energy production and to better understand the long term business case for the project.

12.4 The wake losses of a wind farm are affected by site conditions such as the wind speed and wind direction. They are also affected by wind farm design factors such as the turbine type, the turbine layout and turbine spacing. In general a windfarm layout optimisation to reduce wake losses seeks to allow each turbine the maximum free space surrounding the turbine, with a bias toward the prevailing wind directions. This means that wind farm layouts optimised for wake losses seek large spacing between turbines, but can have smaller turbine spacing on the windfarm boundaries. The Hornsea Project One layout has been optimised to reduce wake losses as well as considering a large number of other important factors such as navigation and Search and Rescue requirements as well as seabed conditions. The Project One layout has been developed such that the intended layout maximises the yield from Project One.

12.5 If Hornsea Project Two is constructed it will increase the wake losses of Project One (and hence decrease the productivity and revenue of Project One) by the above described mechanism as there will be turbines downwind of the Project One turbines in a large range of wind directions. There is some uncertainty within the current understanding of wake effects over very large turbine arrays, such as those seen at Hornsea Project One and Project Two. However, a conservative estimate of the impact that Project Two may have on Project One is an increase in the wake losses by approximately 40%, based on a Project Two layout designed only to reduce wake losses on Project Two.

12.6 The current drafting of the Project Two Development Consent Order leaves significant uncertainty as to the level of negative impact that Project Two will have on the business case of Project One. This uncertainty makes taking financial investment decision on the project much harder as well as significantly decreasing the value of the project to potential investors or financial partners, due to the significant increase in the uncertainty on the return of the project.

12.7 It is the view of Hornsea Project One that a buffer zone around Project One is required. Within this buffer, Project Two would have to seek approval for any turbine installation. The scale of such a buffer will be agreed by way of a confidential cooperation agreement between Project One and Project Two or Protective Provisions. Such a buffer would not compromise the potential for Project Two to design an efficient turbine layout.

12.8 **Proposed Solution:** The Project One Companies require a suitable confidential cooperation agreement (which is under negotiation) or Protective Provisions to be included within the Development Consent Order which will provide confidence that Project Two must agree to the scale of a wake loss mitigation buffer. The exact scale of the wake loss mitigation buffer will be agreed by way of a confidential cooperation agreement between Project One and Project Two.

12.9 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of the Project One Companies".

12.10 **Risk if proposed solution not implemented:** If suitable Protective Provisions are not included within the Development Consent Order to protect Project One, Project One are at risk of having significant wake losses imposed by Project Two and they will not be able to maximise energy production from the wind farm. This will affect the long term business case for the project. A lack of Protective Provisions surrounding a buffer area

would also increase the uncertainty on the Project One energy yield and hence financial return, this could significantly reduce the ability of Project One to raise finance for the project.

13 PROXIMITY OF PROPOSED PROJECT TWO DREDGED DISPOSAL AREAS TO PROJECT ONE TRANSMISSION ASSETS

13.1 **Relevant Representation:** "The Project Two Order includes the designation of specific areas within the offshore Order Limits as disposal areas for dredged spoil generated during construction. These areas are located within the shared export cable corridor and the Project One Companies are concerned that these activities are controlled to ensure that they will not adversely affect the Project One transmission assets offshore."

13.2 **Issue in detail:** Project Two has issued a site characterisation report to the Marine Management Organisation and Cefas (Document 7.4.3.8 Dredging and Disposal Site Characterisation) to request three sites for the disposal of material produced during the construction of the Project Two project. This material will be produced as a consequence of:

a. Foundation installation i.e. any drilled material produced during installation of wind turbines, accommodation platforms, offshore substations where drilling is used; and

b. Cable installation i.e. from dredging sandwaves where dredging is used as a method to prepare the seabed for laying the export cables.

13.3 Of the three proposed disposal sites assessed in the Project Two application, two overlap entirely with disposal sites already designated in the Project One Order. These are identified as Disposal Area 2A and Disposal Area 2B in Document 7.4.3.8 Dredging and Disposal Site Characterisation and also in the draft Development Consent Order deemed Marine Licences (Project A: Transmission Assets and Project B – Transmission Assets). Both of these sites have already been designated as disposal sites HU209 (overlap with Disposal Area 2A) and HU210 (overlap with Disposal Area 2B) for a specified maximum volume in the Project One Order.

13.4 Project One can accept the shared use of HU209 (Disposal Area 2A) and HU210 (Disposal Area 2B) provided that they are only utilised by Project Two for the disposal of sand, and only with coordination and suitable control to protect Project One. This is also subject to Project Two securing the specified increases in volume in the Project Two Development Consent Order application documents.

13.5 **Proposed solution:** A suitable confidential cooperation agreement (which is under negotiation) or Protected Provisions should specify Project One agreement of disposal plans (and any relevant technical studies that evidence these plans) prior to issue to the Marine Management Organisation detailing location, methods and timings of dredging and disposal. It is also necessary that disposal monitoring and control requirements are agreed with Project One in advance of Project Two cable installation. In addition, Project One require a Project One representative on board the vessels engaged in Project Two dredging/disposal activities to ensure disposal takes place only in agreed locations.

13.6 In the event that it is necessary for Project Two to dispose material over the Project One cables only sand is permitted to be disposed over the cables and this should not be done without prior agreement from Project One.

13.7 In the case of clay and boulders only material from cable route clearance and trenching should be disposed of within the cable corridor (but not over Project One cables). The clay should, wherever possible be used to backfill the trenches and the boulders can

only be disposed of clear of any cables in accordance with a proximity agreement which must be drafted and agreed before disposal of boulders can take place.

13.8 Material from other operations i.e. wind turbine generator and offshore substation ground preparation or drilling cannot be disposed within the cable corridor.

13.9 The Protective Provisions for Project One should be included within a new Part 11 of Schedule L "For the protection of Heron Wind Limited".

13.10 **Risk if proposed solution not implemented:** If a suitable confidential cooperation agreement is not in place or suitable Protective Provisions are not included within the Development Consent Order to protect Project One, it will expose Project One to unacceptable risks in terms of the operation of the circuits to be installed and therefore the project as a whole. One important aspect of this is the need to satisfy a future Offshore Transmission Owner that there are suitable protections in place in relation to the transmission assets which it will take over on appointment.

14 RESPONSES TO EXA'S FIRST WRITTEN QUESTIONS

14.1 The Questions directed at the Project One Companies are reproduced and responded to in the tables below.

ExA ref.	Question to:	Question	Hornsea Project One Response
PN3	Hornsea Project 1 and the Applicant	The nature of the potential relationships, sequencing and timetabling of the construction of various elements of Hornsea Project 1 and Hornsea Project 2 are unclear, in particular where co-existence is required and rights may have to be shared. Some of the issues of concern are raised in [RR15]. Please clarify what progress has been made in the development of a Co-operative Agreement between Hornsea Project 1 and Hornsea Project 2, with regard to each of the following key issues of concern: (a) Overlap of Order limits for onshore temporary workings and compounds (b) Connection into the N. Killingholme sub-station; (c) Inter-tidal access and working areas; (d) Onshore and offshore cable routes and; (e) Offshore turbine layouts. Please also update the ExA on the current position on a SoCG in relation to these issues, as requested in the Rule 6 Letter, Annex G.	The confidential cooperation agreement, which is divided into two agreements (onshore and offshore), is the subject of ongoing and constructive discussions covering all the issues identified in PN3. It is intended that these are signed by Deadline 2. The Agreements are intended to provide for workable cooperation arrangements during all phases of Project One and Project Two. A draft statement of common ground, based on an original draft prepared by the Project Two Companies, has been submitted on 14 July 2015 to Smart Wind Ltd for discussion. It is enclosed at

			Appendix 9. The Project One Companies have been concentrating their efforts on the substantive issues to be addressed in the confidential cooperation agreements. Once these are signed a suitable Statement of Common Ground can be submitted into the Examination which summarises the position at that time.

ExA ref.	**Question to:**	**Question**	**Hornsea Project One Response**
CA10	Applicant	Do the Hornsea Project 1 Companies wish to comment on the proposed compensation compounds subject to requirement 22 of the draft DCO [APP-010] and set out in the Compensation Compounds Plan [APP-069] and discussed in the SoR [APP-016] in para. 6.5 – 6.12?	See section 8 of the Written Representation in which it is explained that the principle is accepted and the detail is under discussion with Project Two as part of negotiations on a confidential cooperation agreement.

ExA ref.	**Question to:**	**Question**	**Hornsea Project One Response**
CA11	Statutory undertakers (SU), and Hornsea Project 1 companies.	In relation to Requirement 22 'Compensation compounds' of the draft DCO [APP-010] and set out in the Compensation Compounds Plan [APP-069] and discussed in the SoR [APP-016] in p.6.5 – 6.12 can the applicant: (a) Explain what mechanisms will be used to ensure that land earmarked for compensation compounds in Hornsea Project 1 will be made available to Hornsea Project 2? (b) What steps will be taken to ensure that other stakeholders, for example the local planning authorities, are aware of any land transfers and which project operator has	(a) The Project One Companies' understanding of the Project Two proposal is that this would be dealt with under a confidential commercial agreement, which is currently under negotiation. (b) The Project One Companies' understanding of the Project Two proposal

		control of which plot of land?	is that the Compensation Compound arrangements will operate under the ambit of the Project Two Development Consent Order and it is for this reason that they have made the case for them being associated development.

15 COMMENTS ON RELEVANT REPRESENTATIONS

15.1 The Environment Agency refer at paragraph 12.1 of its Relevant Representation to a land agreement dealing with issues concerning Project One and Project Two. The Project One Companies would like to point out that this agreement does not relate to Project Two.

LIST OF APPENDICES

1. Project One Companies' Relevant Representation
2. The Hornsea One Offshore Wind Farm Order 2014
3. Electricity Generation licences for Heron, Njord and Vi Aura
4. The Hornsea One Offshore Wind Farm (Correction) Order 2015
5. DECC news item dated 23 June 2013 concerning the Final Investment Decision Enabling programme and Statement to Parliament by Edward Davey
6. The Explanatory Memorandum submitted with the draft Project One Order
7. Overlap Plans
8. Project One Land Plans
9. Draft Statement of Common Ground between Project One and Project Two Companies
10. The Final version of the Project One Book of Reference
11. Project One Works Plans

SHEPHERD+WEDDERBURN

SUMMARY OF POST HEARING SUBMISSIONS ON BEHALF OF:

(1) BARROW OFFSHORE WIND LIMITED (REF: 20048546) (2) BURBO EXTENSION LTD (REF: 20048544) (3) WALNEY EXTENSION LIMITED (REF: 20048542) (4) MORECAMBE WIND LIMITED (REF: 20048547) (5) WALNEY (UK) OFFSHORE WINDFARMS LIMITED (REF: 20048545) (6) ØRSTED BURBO (UK) LIMITED (REF: 20048543) (THE "ØRSTED IPs")

IN CONNECTION WITH THE Application by Mona Offshore Wind Limited for an Order Granting Development Consent for the Mona Offshore Wind Farm

1. Summary of post-hearing submission

1.1 We represent six owners of operational offshore windfarms in the East Irish Sea (as set out relevant representations RR-004, RR-007, RR-047, RR-087, RR-088 and RR-090), who we refer to together as the "**Ørsted IPs**" for the purposes of this submission.

1.2 This document summarises the Ørsted IPs post-hearing submission provided in accordance with deadline 6 of the examination timetable for the application by Mona Offshore Wind Farm Limited (the "**Applicant**") for an Order under the Planning Act 2008 (the "**Act**") granting Development Consent for the Mona Offshore Wind Farm (the **"Project**").

1.3 The Ørsted IPs reiterate that the NPS-EN3 requires applicants for offshore wind development to seek to coexist successfully with existing development. In this context, the policies required the Applicant to assess the Project's impacts in terms of wake loss at the Ørsted IPs developments, and if necessary take steps to mitigate those effects. The Applicant has refused to do this and as a result, the Ørsted IPs commissioned their own assessment which indicates the Project will have material impacts on wake at their developments.

1.4 The Ørsted IPs consider the Applicant has taken an unduly narrow approach to interpreting the NPS-EN3, which undermines the purpose of the policy framework.

1.5 In response to issues raised at Issue Specific Hearing 6, the Ørsted IPs have outlined in detail in their post-hearing submission that:

1.5.1 there is precedent for wake effects being considered in relation to previous offshore wind development;

1.5.2 The Crown Estate's recent submission in the Outer Dowsing Offshore Windfarm examination supports the Ørsted IPs' view that the leasing round 4 process does not replace the need for assessment under NPS-EN3.

1.6 Ørsted has provided in an appendix responses to other points raised at ISH6, including relating to the future viability of developments in the Irish Sea, the reliability of wake assessments, and the rationale for excluding the proposed Mooir Vannin project from their wake assessment.

Shepherd & Wedderburn LLP

20.12.2024

WOOD THILSTED

Wake Impact Assessment Report DCO Responses

Irish Sea Cluster - Ørsted

P0253-C2021-CA-REP-002-C 19.12.2024

Ørsted

1. RESPONSES TO QUERIES RAISED AT ISSSUE SPECIFIC HEARING 6

WT provide the following written responses to the queries raised through the Issue Specific Hearing No. 6.

1.1. Independence of the report

WT stands by the statement that the report is an independent assessment of the impacts of neighbouring wind farm wakes. WT have applied the same approach that would be used for any Energy Yield (including wake effects) assessment. This is a method which has been built on a number past studies for multiple clients. WT have made our preferred selection of key parameters in the assessment as well as our derived power curves for the future proposed turbine types, independent of any client view on their use.

WT is regularly engaged by clients to provide 3rd party independent assessments of Energy Yield. This is typically in situations where Energy Yield assessments are being used to support financial decision making and have been undertaken by a separate consultant and the Client has their own internal assessment. In these situations WT retain full control of the analysis choices for our best practice approaches that we have developed. Use of multiple independent assessments using similar but slightly different methods and tools is common wind industry practice.

1.2. Baseline definition

WT would like to clarify that the Baseline scenario included all existing operational wind farms in the Irish Sea, not just Orsted IP assets. As such, the effect of wakes from existing wind farms interacting with themselves (internal wake) and each other (external wake) has already been accounted for in the Baseline. This includes for example Gwynt y Môr, Rhyl Flats, North Hoyle and Ormonde. Reference is made to Table 5-1 in our report.

The operating performance of the existing assets is included in the baseline and crucially, this doesn't change between scenarios. Other factors affecting production, such as maintenance or specific operational considerations are not specifically considered in the model, however are assumed to be constant between scenarios. As such the key benefit of the modelling approach applied is that the assessment is a difference analysis, where everything is kept constant between the scenarios except for the external wake environment which differs between the scenarios. This approach is similar to other modelling methods used for EIA assessment for significance of effect.

Additionally, it is noted that Awyl y Môr was included within the final scenario (Scenario 5) as it has the latest Commercial Operation Date according to public statements from developers of the farms (even though it is currently consented), therefore its effect will likely be later than those of the Mona, Morgan and Morecambe sites, hence the approach undertaken in the scenario assessments.

1.3. Annual variability

A question was raised regarding the context of the wake effect with respect to inter annual variability. It should be noted that the difference % values provided in Table 5-4 and 5-5 are the difference in the long term Annual Energy Production (AEP). The Measure Correlate Predict (MCP) method used within the Wake Assessment undertaken by WT seeks to incorporate interannual variability as a long term effect in the assessment, therefore it is not correct to compare the wake results directly to what a farm would see between one year and the next.

The wake loss would vary between low average wind years and high average wind years as the turbines across the farm would spend different amounts of time at different points on their power curves, causing the resulting wake impacts to vary, but never disappear. The MCP process accounts for annual variability, by allowing calculations over longer time scales representative of the wind farm's potential life, and improves statistical significance of calculated net AEP.

To provide context for the values provided, it may be worth considering the uncertainty associated with the main loss of interest to this study, namely the wake losses. In a Wind Farmer assessment, the uncertainty due to the wake loss can vary. For Scenario 5 in the assessment a mean wake loss of -3.8% is predicted across all Orsted assets. Assuming a normal distribution at 1 standard deviation from the mean this could lead to a variance of between -3.1 % and -4.5 %. As such, the uncertainty in the wake loss in the assessment can lead to a variability of less than 0.7% of the Annual Energy Production.

1.4. Model choices

The Wind Farmer analyst model used for this difference analysis assessment is a tool created by DNV, an Offshore Wind industry consultancy and certification body. Wind Farmer was developed to enable more consistent application of the AEP methodologies and the technical components that can otherwise influence the analysis outcomes. These tools are as close to an industry standard as is available and are often the first of several tools that are applied in this type of assessment. The tools have been validated by DNV on hundreds of wind farm projects, and importantly form the basis for many of the assessments of AEP that are being taken forward around the world. This type of tool is also particularly effective for looking at relative wake loss effects, which form the basis of the report submitted to the Examining Authority.

It is important to note that more complex engineering models exist. However, the work by RWE & DNV referenced in our conclusions, which validates a range of models against operational data, compares well with the study undertaken by WT. The wake loss approach applied as part of WT's preferred approach was very similar to that selected in the RWE study (specifically the use of Wind Farmer Analyst with the Eddy Viscosity Model with the Large Wind Farm correction).

These methods are being used on hundreds of projects by a range of practitioners around the world to estimate the potential effects of internal and external wake effects on AEP estimates for proposed wind farms.

1.5. Confidential input information

Power Curves of turbine manufacturers are confidential, but it is common practice that these are shared with practitioners, under NDA restrictions, to enable assessments to be made of the AEP and for other relevant studies. As such, these critical values have been redacted from the WT report, but are included in the assessment.

Many other inputs in the WT assessment have been derived from publicly available information, and importantly WT have used derivations of power curves for two potential future turbines, namely the WT 15MW-236m and WT 22.6MW-276m. These power curves are not confidential and have been supplied in Appendix B.

It is also noted that a query was raised over the future scenarios not being for the maximum design envelope of the proposed wind farms. Due to the availability of suitable power curves, as noted above, as well as the uncertainty in turbine selection two potential turbine sizes for the project commencement years were assumed.

1.6. Decommissioning

It was noted in the hearing that a question was raised around the timeline of potential decommissioning and how this would affect the analysis. The values of % loss presented in the report are on annual energy production, not over the lifetime of the project.

The approach for the assessment undertaken is that in the Scenarios, it is assumed that the operation of the proposed wind farms overlap with the existing assets. If an asset in the existing farms was removed as part of decommissioning (or re-powered) this would change the interaction of wakes, and this type of scenario could be assessed in a similar manner to the future scenarios already assessed, and the magnitude of their impact considered. The annual wake loss impact estimated in the report will be applicable for every year where this overlap exists.

Important to consider is that the distribution of the wind resource is dominated by winds from a south-westerly quadrant. For example, the oldest site at Barrow is

located to the north-east of the Walney cluster, therefore the change to the overall wake would be when winds are from the non-dominant direction.