BP'S RESPONSE TO DEADLINE 6

CONTENTS

BP'S RESPONSE TO DEADLINE 6

1. OVERVIEW

1.1 BP Exploration Operating Company Limited ("bp") has prepared this submission in response to Deadline 6 and provides:

1.1.1 bp's written submissions to address the oral submissions made by bp and Orsted at Issue Specific Hearing 7 (ISH7) on the draft DCO and specifically the protective provisions proposed to be included in the draft DCO for the benefit of bp (as the representative for the carbon storage licensees (Licence CS001)), and in response to the actions points identified by the ExA following ISH7;

1.1.2 Version 4 of bp's proposed protective provisions (clean copy as Annex 1 and tracked-change version as Annex 2), together with the corresponding protective provisions plan (Annex 3 – cosmetic updates only);

1.1.3 bp's further submissions in response to the "Sewell Report" submitted by Orsted at Deadline 5, to supplement the initial submissions made by bp in Annex 1 to its Deadline 5a response (REP5a-025) (Annex 4); and

1.1.4 bp's limited submissions in response to the matters discussed at Issue Specific Hearing 9 (ISH9) on offshore environmental matters, including the additional materials requested by the ExA at Action Point 4 (individually included as Annex 5 to 7).

1.1.5 A decision-making 'flow-chart', which distils the key queries and their resultant implications in relation to the submissions before the ExA (Annex 8).

1.2 bp is happy to address any queries the ExA may have in respect of these submissions in writing at a subsequent deadline should the ExA require any further clarification or information.

2. EXECUTIVE SUMMARY

2.1 It is crucial that the ExA and, in turn, the Secretary of State in making a determination is not misled into believing that Orsted's protective provisions will enable co-location between Hornsea Project Four and the NEP project in the Exclusion Area.

2.2 bp's extensive submissions into the Examination have explained clearly and rationally why there is no basis on which to find that co-location is possible ("bp's Technical Case", most recently presented in Annex 1 to bp's response to Deadline 5a (discussed above) and in Annex 4 to this response). Those submissions are not repeated here, other than to re-emphasise their central conclusion that the Exclusion Area is needed to preserve the full extent of the Endurance Store, and in turn the viability of the ECC plan.

2.3 Orsted's converse technical case is not credible (for the reasons explained in bp's Technical Case), which in turn fatally undermines the effect of their protective provisions which are premised on co-location being possible. In circumstances where wind turbines are proposed in the Exclusion Area, NEP will not develop the Endurance Store in that same area.

2.4 Accordingly, the ExA, and in turn, the Secretary of State must therefore consider the choice between:

2.4.1 development of Hornsea Project Four in full (including in the Exclusion Area), with the result that NEP will limit their development to the residual approximate 30% of the Endurance Store capacity available without the Exclusion Area, so rendering the ECC plan unviable (resulting in the loss of 10-11MTPA of CO_2 injection capacity, greater than 50% of the Government's minimum CCUS capacity target for 2030); or

2.4.2 development of Hornsea Project Four outside the Exclusion Area only, so preserving the full extent of the Endurance Store and the viability of the ECC plan.

2.5 **In circumstances where the ExA and SoS favour bp's Technical Case and the need to preserve the full extent of the Endurance Store, only bp's protective provisions provide the means by which to secure that outcome. This is reflected in the decision-making flowchart provided at Annex 8.**

2.6 Whilst private agreement is always preferable, and remains bp's preferred outcome, there is no indication at present that the interface issues will be resolved in that way ahead of the end of the Examination. As such**,** the ExA and, in turn, the SoS will need to consider the scenario that the DCO needs to provide the complete solution to the interface between the projects.

3. BP'S WRITTEN SUBMISSIONS FOLLOWING ISH7

3.1 bp's written submissions in response to the matters discussed at ISH7 are broadly split into three categories:

3.1.1 why Orsted's protective provisions remain fundamentally flawed (being premised on co-location being possible), and there is no basis on which they would be acceptable, making any attempt to comment on their drafting (even on a without prejudice basis), redundant.

3.1.2 a summary of the changes made to bp's updated proposed protective provisions (Version 4, as submitted in Annex 1 to this Deadline 6 response); and

3.1.3 clarification as to how those provisions, and particularly the compensation mechanism, are materially different from the existing construct under the Interface Agreement.

Orsted's protective provisions

3.2 At ISH7, bp was asked to comment on a without prejudice basis on the terms to Orsted's proposed protective provisions included as Part 8 to Schedule 9 of the DCO, including in relation to the appropriateness of the proposed timescales set out within (in paragraphs 6, 7 and 8) those provisions.

3.3 These requests have subsequently been captured as action points emerging from the Hearing (actions 19 and 21).

3.4 As explained at the Hearing and in Section 7 of Annex 1 to bp's Deadline 5a submission (REP5a-025, paragraphs 7.4 to 7.8, electronic page 12), there are two fundamental flaws undermining the approach put forward by Orsted in those protective provisions, and which make seeking to comment on their terms effectively redundant in practice:

3.4.1 they are predicated on the premise of co-location/co-existence (used interchangeably in this context) over the same area of seabed being possible between Hornsea Project Four and the NEP project's development of the

Endurance Store[1], with such co-location being facilitated by an 'evaluation' study which bp submits is unworkable and pointless in the circumstances[2]; and

3.4.2 they do not address the risk of significant compensation liability arising under the Interface Agreement.

3.5 By consequence, amendments (even on a without prejudice basis) regarding the timescales informing the processes stipulated in Orsted's protective provisions will not serve to remedy or ameliorate these flaws and may serve to distract from, or worse - represent a fig leaf to, these core issues.

3.6 The macro considerations are the feasibility of co-location in the Exclusion Area, and the risk of significant compensation liability arising under the Interface Agreement were Orsted to be excluded from developing in the Exclusion Area.

3.7 Orsted's provisions in respect of both of these key considerations are defective, with the result, as bp explained in paragraphs 5.10 to 5.14 of Annex 2 to its Deadline 5a response (REP5a-025, electronic page 35) that the SoS would not have the ability to preserve the full extent of the Endurance Store, with the corresponding public interest benefits, were he to be persuaded by bp's Technical Case.

3.8 There are no revisions to the timescales stipulated within Orsted's provisions which would address these more fundamental points and make the provisions, by consequence, workable from bp's perspective.

3.9 The alternative drafting, which would address bp's concerns, would require the imposition of the Exclusion Area and provision dealing with the risk created by the Interface Agreement (together with a longstop); however, these are already provided for in bp's protective provisions and it would not seem a useful exercise to simply mark-up Orsted's protective provisions to replicate those already put forward by bp.

3.10 In view of the polarity of the provisions/approaches put forward by bp and Orsted, and the ExA's need to potentially consider those counter-factual scenarios in its recommendation to the SoS, bp considers there to be two contrasting options:

3.10.1 Option 1 – in circumstances where the ExA were recommending Orsted's submissions on the feasibility of co-location be preferred and their protective provisions included, then this would need to be framed in the acknowledgment that where wind turbines were proposed in the Exclusion Area then this would lead to the NEP partners not developing the Endurance Store within such area, resulting in the loss of up to 70% of the Endurance Store capacity, rendering the ECC plan unviable and the loss of the significant public interest benefits in delivery of the same; or

3.10.2 Option 2 – in circumstances where the ExA were recommending bp's Technical Case be preferred, that bp's protective provisions be included. The inclusion of both the Exclusion Area and provision addressing the risk of a significant compensation claim from being triggered under the Interface Agreement would collectively preserve both the deliverability and viability of the full extent of the Endurance Store and, by consequence, the ECC plan and their associated public interest benefits.

3.11 Given the divergence of the positions and their inherent consequences, it may be the ExA considers appropriate to put forward both options to the SoS, explaining their consequences and allowing the SoS to determine which they prefer in full cognisance of the same.

3.12 To attempt to clarify the rationale on which the decision could be made, bp has set out a 'flow-chart' in Annex 8, which distils the key queries and their resultant implications.

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1 This is expressly noted in para 1.1.1.3 of Orsted's submission at Deadline 5a in commenting on The Crown Estate's Deadline 5 submission (REP5a-021).

2 Sections 7 and 8 of Annex 1 to bp's Deadline 5a submission (REP5a-025).

Protective provisions commentary

3.13 bp explained in its Deadline 5a submission (REP5a-025) that, in acknowledgment of the submissions made by Orsted and The Crown Estate at Deadline 5 and in an effort to assist the ExA and SoS' consideration of this complex issue, it was proposing a revised approach to address the risk of significant compensation liability accruing under the Interface Agreement as a result of the imposition of the Exclusion Area. Specifically:

3.13.1 rather than seeking to disapply the effect of the Interface Agreement, the protective provisions would preserve the rights and obligations as exist under the agreement, save that they would remove bp's liability to Orsted under it; and

3.13.2 in lieu of such liability, the protective provisions would provide for bp (on behalf of NEP) to make a compensation payment to Orsted.

3.14 This approach was further discussed in ISH7, and is now reflected in Version 4 of bp's protective provisions submitted as part of this Deadline 6 submission in clean (Annex 1) and tracked-change (Annex 2) format, with explanatory footnotes provided where specific clarification (in addition to the below) is considered helpful, together with the corresponding protective provisions plan (Annex 3). To confirm, only cosmetic updates have been made to the protective provisions plan and there have been no changes to the areas depicted. This has been provided in response to the request from the ExA to do so.[3]

Compensation provision

3.15 In respect of the compensation provision (included as paragraph 7 to Version 4 of bp's protective provisions), two alternative forms of drafting have been proposed.

3.16 Both are put forward on the basis that the amount of compensation will not be a matter for evidence and debate during this Examination, but rather will be a matter for determination by the Secretary of State, who will take on responsibility for striking the right balance (in the public interest) between the commercial interests and viability of the two projects.

3.17 The information that the Secretary of State is likely to wish to see in order to strike this balance and make a determination of the amount of compensation is likely to be highly commercially sensitive. It is not, therefore, information which would be appropriate for the parties to put before the Examination.

3.18 In addition, it is considered that ultimately the issue of the compensation to be awarded and its impact on two significant infrastructure projects must appropriately fall to the Secretary of State in the highly unusual circumstances of this case – where two hugely important projects find themselves at an impasse.

3.19 We propose therefore that the Secretary of State seeks whatever information he considers appropriate to determine a sum of compensation which recognises the loss of Orsted's ability to develop in the Exclusion Area (and the corresponding removal of bp's liability to Orsted under the Interface Agreement in relation to the same), but does not require bp (on behalf of NEP) to provide a payment which is at a level which compromises the viability of the ECC plan. With regard to the latter, the Secretary of State will have the advantage of being able to call upon the expertise of members of his CCUS team should he wish to seek their views to validate any commercial information submitted by bp with regard to viability.

3.20 We envisage that the Secretary of State would seek information from Orsted and bp on an open-book closed audience basis. This would allow both Orsted and bp to share commercially sensitive information which will enable the Secretary of State to make a more informed decision. We envisage that both Orsted and bp would be able to see the information submitted by the other, although this (as for the whole of the process) would be a matter for the Secretary of State's discretion subject only to general principles of procedural fairness (and any other relevant confidentiality considerations). In this regard,

[3] the "Protective Provisions Plan" referred to in bp's protective provisions is distinct from Orsted's referenced "Protective Provisions Plan" in their version of the protective provisions (understood to be that submitted at Deadline 2, REP2-057). However, it is confirmed that the 'Exclusion Area' referred to in bp's plan mirrors that referred to as the "Overlap Zone" on Orsted's plan.

we note that Orsted agreed in ISH7 to submit their view on an appropriate compensation figure into the Examination on a confidential basis.[4]

3.21 bp's preference would be that this process takes place in the period between receipt of the ExA's report and the Secretary of State's decision. The Secretary of State is used to seeking additional information from applicants and interested parties during this decision-making phase, and taking it into account in his determination.

3.22 bp's preferred form of drafting (as referred to in the protective provisions) simply states that bp will pay Orsted a specified sum of money (to be determined by the Secretary of State during the decision period and inserted into the DCO) - and that this sum must be paid by the earlier of (i) the date no more than 60 days after the Commercial Operation Date of Hornsea Project Four (as defined) or (ii) 1 February 2029. The certainty of the specific backstop date is intended to provide Orsted with comfort as to the latest point by which they'll receive the compensation payment and to plan accordingly (assuming bp has not exercised its 'walk-away' right prior to the Longstop Date (discussed further below)).

3.23 This approach would ensure that there is no delay or uncertainty as to the amount of compensation required. This would be set out in the DCO itself and therefore known as soon as the DCO is granted, in February 2023 (assuming current programme). That would then ensure that there was sufficient time for the NEP partners to ascertain whether the sum was deemed to be potentially allowable under the TRI model, and to then take the final investment decision ("FID") with that knowledge.

3.24 As an alternative approach for the Secretary of State to consider, bp has also included drafting which provides for the Secretary of State to make a determination within two months of the DCO being granted (unless the parties have reached prior agreement in the interim period, which would of course remain the preferred option). This drafting provides simply that in determining the compensation, the Secretary of State will balance the loss of Orsted's ability to develop in the Exclusion Area and corresponding removal of bp's liability under the Interface Agreement pursuant to the Order with the public interest in preserving the full extent of the Endurance Store and delivery of the ECC plan.

3.25 The drafting is purposely non prescriptive as to the process that the Secretary of State would follow to arrive at his judgement as to compensation. We believe that the Secretary of State does not generally favour DCO drafting which mandates specific actions to be taken by him – preferring to leave such processes to his discretion, subject only to general public law principles, and human rights law in this case. However, in practice we would anticipate he would follow the same process which he might if undertaking this balancing exercise in the decision phase (as outlined earlier).

3.26 We recognise that there is no direct precedent for either approach, and that the Secretary of State would doubtless prefer not to be placed in the position of having to make a judgement as to compensation. However, based on current circumstances, and in the absence of any prior agreement, we do not consider there to be any alternative but for the Secretary of State to make this judgement - in the public interest, with access to the necessary financial information, and with the benefit of the knowledge of his specialist CCUS team with regard to the NEP project, the Endurance Store and ECC plan and the associated viability considerations.

3.27 We considered whether there was merit in prescribing in the DCO that the Secretary of State would appoint an arbitrator to make the decision as to compensation in the post DCO period. However, we consider that an arbitrator would not be appropriate in this case, as the judgement to be made in the public interest striking the balance between the two projects is one which is more suited to a Government minister with ultimate responsibility for energy policy, than the sort of technical calculation which an arbitrator would ordinarily make. To outsource this important political decision to an arbitrator, rather than keeping it

[4] bp is also happy to submit (on a confidential basis) the basis for its quantification of the appropriate compensation figure in view of the prevailing considerations discussed above, and anticipates this may illuminate the difference between the parties and the challenges experienced in reaching agreement.

within the Government's responsibility, does not seem appropriate. It would in effect be outsourcing the implementation of energy policy to the arbitrator.

Cessation of bp's protective provisions/"walk-away" right

3.28 In Version 3 of its protective provisions, bp had proposed (on a without prejudice basis) for the effect of the provisions to fall away in circumstances where the relevant consents for its proposed works in the Exclusion Area had not been obtained by a prescribed Longstop Date of 5 years from the date of the Order (see section 1.6 of bp's Deadline 4 submission, REP4-059, electronic page 3).

3.29 As a result of the revised approach, and specifically the payment of compensation to Orsted, it is no longer considered appropriate to link the effect of the provisions to a particular milestone with the NEP project. Rather, the drafting is now to, in effect, be a 'walk-away' right. Such drafting has the effect that:

3.29.1 if prior to the defined Longstop Date, bp (on behalf of NEP) give the Exclusion Area back to Orsted, then Orsted can construct the authorised project in that area and bp would have no obligation to pay compensation as a result; or

3.29.2 if bp has not handed back the Exclusion Area to Orsted prior to the Longstop Date, bp would be required to make the compensation payment (as determined by the SoS) at the specified trigger point.

3.30 As a result of this change in emphasis, the wording is now proposed to be included as part of bp's primary submission on the drafting and no longer on a without prejudice basis. The previous square brackets have been removed on that basis.

3.31 In recognition of Orsted's submissions at Deadline 5, bp has reduced the period for the walk-away right to be triggered from 5 years to 3 years which it is submitted provides an appropriate balance between Orsted's need for certainty as to bp's intentions in the Exclusion Area and the timescales associated with the NEP project and the corresponding financing/regulatory decisions (and any potential delay caused to any aspect of the same). This balance is contrasted with Orsted's equivalent provision, which provides for an immediate cessation of the effect of their protective provisions if bp has not secured the consents necessary to develop the NEP project within 4 months of the date of the Order (although, as noted in the earlier sections to this response, there are more fundamental problems with Orsted's provisions which render their associated timescales redundant (even were they to be extended in the manner suggested by the ExA during ISH7)).

Key differences from the compensation approach under the Interface Agreement

3.32 To now compare the above approach to the existing mechanisms provided by the Interface Agreement.

3.33 It was submitted by Orsted at ISH7 that the revised approach being put forward by bp was analogous to how compensation could be quantified under the Interface Agreement in any event, with the implication being that it was unnecessary.

3.34 bp acknowledges that Orsted had not had the benefit of the detailed drafting in advance of ISH7 and so it may be there was some confusion as to what was being proposed; however, it is clear from the above that any comparison between the approaches is only superficially similar, and that they are distinct in fundamentally important respects.

3.35 Firstly, in relation to the quantum of compensation and how it is to be calculated – the Interface Agreement provides for such figure to be informed by the 'Relocation Costs' and the 'Re-programming Costs' as defined in the agreement (and to which the ExA can refer).

3.36 The ExA will note from those definitions that, in the case of compensation to Orsted (the Wind Entity), they include the diminution in the market value of Orsted's project as a result of the loss of their infrastructure or reduced power output by consequence of the Carbon Entity's proposed activities.

3.37 Whilst this formulation is similar to one of the factors bp is suggesting be factored into the SoS' calculation of the appropriate level of compensation, it crucially lacks the counter-

balancing factor provided by bp's proposal, namely the public interest in preserving the full extent of the Endurance Store and, by consequence, the viability/delivery of the ECC plan.

3.38 Without this counter-balance, the compensation (in circumstances where Orsted are the 'Affected Entity') would be exclusively quantified by reference to Orsted's 'loss' and/or additional costs.

3.39 In discussions to date, Orsted's quantification of such potential loss has led to a series of estimates which are still of an order of magnitude which would likely render the ECC plan unviable, making it very likely, if not inevitable, that agreement would not be reached, eventually triggering the expert determination procedures under the Interface Agreement.

3.40 The Expert process under the Interface Agreement suffers from two key flaws, both expressed by bp in its previous submissions:

3.40.1 the Expert is unable to balance the public interest of preserving the full extent of the Endurance Store against the Wind Entity's loss, meaning that the quantification is inappropriately preconditioned; and

3.40.2 it is difficult to envisage how any independent industry Expert could realistically adjudicate over the matter. Orsted's own reliance on different Experts within this DCO Examination who have seemingly competing positions on a number of the same technical submissions shows the complexities that exist and it is not credible or desirable to seek to regulate these unique issues (as they are now understood today) with the type of standard expert determination clause that was included in the agreement in 2013. bp's submissions above (paragraph 3.27) explain why the SoS must be the ultimate decision-maker.

3.41 Further, the timings involved in the Expert process under the Interface Agreement are not compatible with the timescales for the NEP FID decision necessary to deliver the ECC plan and the corresponding uncertainties that would still exist pending such determination would likely deter debt funders from investing in NEP, or from progressing were any subsequent compensation claim proposed to fall to the NEP investors (if disallowed by the TRI regulator). These risks are compounded by NEP's status as a First of a Kind project.

3.42 These are fundamental and fatal flaws in the ability of the Interface Agreement to properly govern and determine compensation due to the Affected Entity in the current circumstances. Whilst it does cater for a determination of compensation, it does so by reference to the loss to the Affected Entity only, without the counter-balance of considering the implications to the viability of the other project. It is a crude and basic mechanism, which is wholly inadequate for the complexity of the current circumstances facing the projects.

3.43 It is for these reasons that bp originally sought the disapplication of the Interface Agreement; however, in response to the representations from Orsted and The Crown Estate, has now sought to more specifically address the risk of significant compensation liability arising from it only.

3.44 Simply, the Interface Agreement neither properly balances any compensation due under its terms, nor provides for an appropriate arbiter to determine such amount in the current circumstances. These flaws may have been less of an issue in circumstances where co-location were possible, at least to some extent; however, in bp's submissions, co-location is not possible.

3.45 In contrast, bp's protective provisions provide for such a balance to be taken into account in any compensation determination and allow the SoS to be that decision maker, as must surely be most appropriate considering the macro-economic and political nature of the decision which impacts two major infrastructure projects and the wider decarbonisation targets.

Voluntary Agreement

3.46 Finally, at ISH7, the ExA enquired as to the prospects of an agreement being reached between the parties prior to the close of the Examination. The ExA also noted the ability to vary the terms of the Interface Agreement.

3.47 bp's previous submissions have made clear that the ability to vary the agreement or reach separate agreement is not under dispute. We acknowledge that is a basic principle of contract and applies to any agreement, regardless of whether there are express terms within the agreement providing for that option. Reaching private agreement would of course be bp's preferred outcome. However, the parties have been engaging for a considerable period of time and agreement has remained elusive, with no imminent prospect of that changing and no guarantee that such agreement will be reached prior to the SoS' determination on the Hornsea Project Four DCO application.

3.48 Orsted's submissions at ISH7 also confirmed their view that agreement was unlikely to be reached prior to the close of Examination.

3.49 As a result, the submissions put forward in this Examination are to seek to provide a solution within the Hornsea Project Four DCO to apply in circumstances where no commercial resolution is reached.

3.50 Both parties will no doubt provide an update if the position changes; however, the ExA and, in turn, the SoS will need to consider the scenario that the DCO needs to provide the complete solution to the interface between the projects.

4. BP'S WRITTEN SUBMISSIONS FOLLOWING ISH9

4.1 bp confirmed at ISH9 that its previous submissions regarding the anticipated timescales for the offshore consents associated with the NEP project remain accurate (Section 5 of Appendix 5 to its Deadline 3 submission, REP3-047, electronic page 89).

4.2 bp also noted that following Orsted's submission of the 'No Overlap EIA and HRA' at Deadline 5a (REP5a-016), the ExA and the SoS do now have the comfort that the practical effect of bp's protective provisions (namely the imposition of the Exclusion Area) has been environmentally assessed (and confirmed as not giving rise to any material change to its previous assessment conclusions). bp confirmed its previous submissions in relation to the 'Overlap' scenario as presented in Chapter 11 of Orsted's ES remain unchanged, with such assessment conclusions remaining flawed as a result of the reliance on mitigation (a co-location and proximity agreement) which will not occur (for the various technical submissions bp has previously made and to which the ExA noted, and as are further elaborated upon in Annex 4 to this Deadline 6 response).

4.3 Action 4 from ISH9 (here) requested bp provide certain materials referred to in the Xodus report submitted by Orsted at Deadline 5 (REP5-075, Appendix A).

4.4 To correct and clarify a previous cross-reference in bp's submission at Deadline 5a (REP5a-016) which is relevant to this Action 4 request, the reference to a "December 2021" presentation in paragraph 2.3.5 of Annex 1 (electronic page 5) and the responses to the requests for additional information from Mr Sewell numbers 4 and 5 (electronic pages 20 and 21) should have been to a "February 2021" presentation. Orsted has the document in question, but bp has re-provided it as Annex 5 to this submission for completeness. To confirm, the referencing error does not change any of the surrounding text in that paragraph 2.3.5 or the responses to requests numbered 4 and 5, which otherwise remain accurate.

4.5 The further materials referenced in Action 4, specifically the presentation from October 2021 and subsequent Q&A issued in November 2021, are included as Annexes 6 and 7 to this response). bp is happy for the information in the material in Annexes 5 to 7 to be published in full, and their 'confidential' watermarks can be ignored.

4.6 As the ExA will be aware, Annexes 5 to 7 represent materials from a point in time and the position continued to evolve in the subsequent period, with bp's position crystallising in December 2021 (detailed in the bp Technical Assessment shared with Orsted, TCE, BEIS

and the OGA (as they were then known, now the NSTA) and included as Annex 1 to bp's Deadline 1 submission (REP1-057, electronic page 146), where it was concluded that co-location between Hornsea Project Four and the Endurance Store would not be feasible. Such submissions are represented by bp's Technical Case in this Examination.

5. BP'S FURTHER SUBMISSIONS IN RESPONSE TO THE SEWELL REPORT

5.1 Finally, bp's further submissions in response to the "Sewell Report" submitted by Orsted at Deadline 5, to supplement the initial submissions made by bp in Annex 1 to their Deadline 5a response (REP5a-025), are included as Annex 4 to this response.

5.2 In preparing these further submissions, bp has sought to highlight for the ExA which aspects of the extensive technical submissions continue to be in issue between Orsted and NEP, and which ones have been effectively resolved through the acknowledgments made in the Sewell Report (in place of the earlier OREC/NZTC report to which Orsted previously relied upon for its technical case). It is bp's understanding from Orsted's submissions (both at Deadline 5, and then made subsequently orally at ISH9) that the Sewell Report supersedes the earlier OREC/NZTC report and that they no longer place reliance on that earlier report as continued evidence in support of their case and so can be disregarded from the Examination. If that is not correct, bp would welcome clarification as to which parts of that report Orsted maintain as part of their case in this Examination.

5.3 bp has explained in Annex 4 that, in effect, the only technical matter still "in-play" is whether a hybrid of dense OBN and short streamers such as P-cables could be used to undertake 4D seismic monitoring if there are wind turbines in the Exclusion Area.

5.4 However, the Sewell Report does not advocate that it could be used for such purposes (nor does the previous OREC/NZTC report), and accepts that there is no precedent for use of such a monitoring approach for oil and gas or CCS projects, whether outside or inside of a wind farm. It is purely theoretical.

5.5 bp has explained in both its initial submissions at Deadline 5a and again here in response to Deadline 6 why further investigating this theoretical approach would serve no practical purpose in the circumstances, and would simply rack up excessive and abortive cost.

5.6 Whilst bp now considers it has submitted full responses to the Sewell Report and comprehensively advocated as to why bp's Technical Case must be favoured, to the extent the ExA has any residual queries on the submissions before it, bp would be very happy to provide such further clarification or information as would assist the ExA in reaching their conclusions and making their subsequent recommendation to the SoS.

ANNEX 1
VERSION 4 OF BP'S PROTECTIVE PROVISIONS (CLEAN)

SCHEDULE [ ], PART [ ]
Protection for Carbon Dioxide Appraisal and Storage Licensee(s)

Application:

1. For the Protection of the Licensee(s) from time to time of United Kingdom Carbon Dioxide Appraisal and Storage Licence CS001, unless otherwise provided for in this Schedule or agreed in writing between the Undertaker and the Carbon Entity the provisions of this part of this Schedule shall have effect.

Interpretation:

2. In this Part of this Schedule—

“Applicable Laws” means applicable laws, rules, orders, guidelines and regulations, including without limitation, those relating to health, safety and the environment and logistics activities such as helicopter and vessel operations;

“BP Exploration Operating Company Limited” means BP Exploration Operating Company Limited, with Company Registration Number 00305943, whose registered office is at Chertsey Road, Sunbury On Thames, Middlesex TW16 7BP;

"Carbon Entity" means the entity defined as the Carbon Entity under the Interface Agreement;

“Carbon Sentinel Limited” means Carbon Sentinel Limited, with Company Registration Number 08116471, whose registered office is at 1-3 Strand, London WC2N 5EH;

"Commercial Operation Date" means the date on which the authorised project has supplied electricity on a commercial basis to the national grid;

"Endurance Store" means the geological storage facility in the 'Endurance' saline aquifer subject to the Licence;

"Entity" means the undertaker or the Carbon Entity as appropriate and "Entities" means both of them;

"Exclusion Area" means any area within the area hatched orange on the Protective Provisions Plan and as delineated in the Table of Co-Ordinates;

“Good Offshore Wind Farm Construction Practice” means the application of those methods and practices customarily used in construction of wind farms in the United Kingdom Continental Shelf with that degree of diligence and prudence reasonably and ordinarily exercised by experienced operators and contractors engaged in the United Kingdom Continental Shelf in a similar activity under similar circumstances and conditions;

“Interface Agreement” means the agreement dated 14 February 2013 between (1) The Crown Estate Commissioners (2) Carbon Sentinel Limited and (3) Smart Wind Limited, as varied and adhered to by an agreement dated 12 September 2016 between (1) The Crown Estate Commissioners (2) Smart Wind Limited (3) Carbon Sentinel Limited and (4) the Undertaker and a Deed of Covenant and Adherence dated 10 February 2021 between (1) The Crown Estate Commissioners (2) the Undertaker (3) Smart Wind Limited (4) Carbon Sentinel Limited and (5) BP Exploration Operating Company Limited, or such other agreement as may be entered into by the parties in substitution for those agreements;

“Licence” means the United Kingdom Carbon Dioxide Appraisal and Storage Licence CS001;

“Licensee” means the licensee from time to time of the Licence;

"Longstop Date" means:

(a) the date three (3) years after the coming into force of this Order; or
(b) such later date as may be notified to the Entities in writing from time to time by the Secretary of State;

"Notification Area" means any area within the area hatched blue on the Protective Provisions Plan and as detailed in the Table of Co-Ordinates;

“Plan of the Undertaker’s Works” means a construction programme, method and details of the proposed location of the Undertaker’s Works and minimum requirements known at that time such as safety in accordance with Good Offshore Wind Farm Construction Practice and Applicable Laws to enable the Undertaker to construct and operate the Undertaker’s Works;

“Smart Wind Limited” means Smart Wind Limited, with Company Registration Number 07107382, whose registered office is at 5 Howick Place, London, England SW1P 1WG;

“The Crown Estate Commissioners” means The Crown Estate Commissioners on behalf of Her Majesty the Queen, acting in exercise of the powers of the Crown Estate Act 1961;

"the Protective Provisions Plan” means the plan entitled Endurance Store Protective Provisions Plan and certified as the Endurance Store Protective Provisions Plan for the purposes of this Part of this Schedule;

"the Table of Co-Ordinates" means the following table:

Exclusion Area	
Latitude	Longitude
54°8'51.929"N	1°0'34.075"E
54°9'13.497"N	1°0'43.850"E
54°10'49.480"N	0°58'21.782"E
54°12'37.143"N	0°58'31.095"E
54°12'17.413"N	1°12'18.263"E
54°10'48.297"N	1°15'35.528"E
54°9'52.770"N	1°13'54.364"E
54°8'17.458"N	1°11'0.989"E
Notification Area	
Latitude	Longitude
54°7'57.201"N	1°0'9.286"E
54°8'51.943"N	1°0'34.082"E
54°8'17.458"N	1°11'0.989"E
54°9'52.770"N	1°13'54.364"E
54°7'57.603"N	1°13'55.408"E

"Undertaker's Works" means the indicative works permitted by this Order; and

"Wind Entity" means the entity defined as the Wind Entity under the Interface Agreement.

The Undertaker's Works

3. The undertaker must not construct any of the authorised project within the Exclusion Area.

4. The undertaker must not commence construction of any of the authorised project within the Notification Area unless the undertaker has submitted to the Carbon Entity, not less than 56 days' prior, a Plan of the Undertaker's Works within that area.

5. Nothing in this paragraph precludes the undertaker from submitting at any time or from time to time, but in no case less than 56 days before commencing construction, a new plan, instead of the plan previously submitted in accordance with paragraph 4 above.

Interface Agreement

6. Nothing in this Part of this Schedule shall affect any rights or obligations that exist under the terms of the Interface Agreement, save that the Carbon Entity shall have no liability to the Wind Entity under that agreement due to or arising from the imposition of the provisions of this Part of this Schedule or its impact upon the authorised project and no claim may be made by, nor award granted to, the Wind Entity for any damages as a result of any alleged antecedent breach of the Interface Agreement prior to the date of this Order.

[Compensation[1]

7. Unless otherwise agreed between the Entities, the Carbon Entity will pay to the Wind Entity [£…] on the earlier of:
(a) the date no more than 60 days after notification by the undertaker to the Carbon Entity of the Commercial Operation Date; or
(b) 1 February 2029,
provided that the provisions of this Part of this Schedule have not ceased to have effect in accordance with paragraph [8][2] by that date (in which case no payment shall be due).[3]

OR

7. Unless otherwise agreed between the Entities and notified to the Secretary of State in writing, the Secretary of State shall within 2 months of this Order coming into force determine and notify the Entities of the Compensation[4] to be paid by the Carbon Entity to the Wind Entity, such Compensation to be paid on the earlier of:
(a) the date no more than 60 days after notification by the undertaker to the Carbon Entity of the Commercial Operation Date; or
(b) 1 February 2029,
provided that the provisions of this Part of this Schedule have not ceased to have effect in accordance with paragraph [12] by that date (in which case no payment shall be due).

8. In determining the Compensation, the Secretary of State shall balance the impact of the imposition of the Exclusion Area on the authorised project (and the removal of the Carbon Entity's liability to the Wind Entity under the Interface Agreement) pursuant to this Order with the public interest in preserving the full developable area of the Endurance Store;

9. In making a determination of Compensation under paragraph 8, the Secretary of State shall take into account relevant submissions made by the Entities during the examination of the Order (application reference: EN010098), and such further information (if any) provided by the Entities pursuant to paragraph 10.

10. Where the Secretary of State considers that further information is necessary to determine Compensation under paragraph 8, he or she may request this from the Entities, who shall provide it within the period specified in the request.

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1 Two alternative forms of drafting are proposed, which achieve the same basic purpose and would have the same general process, with the distinction being whether the SoS determines the quantum of compensation prior to determining the DCO and writes the figure into the made Order (bp's Preferred Option) or in the period immediately after the DCO is determined (the Alternative Option). The drafting is included in this version on an 'either/or' basis for the ExA and SoS' consideration. bp's main Deadline 6 submission elaborates on the reasoning.

2 This refers to the 'Cessation of Provisions' paragraph below, which would be paragraph 8 in circumstances where the Preferred Option compensation drafting was included.

3 This is the 'Preferred Option'.

4 If included, 'Compensation' to be defined as *'means a sum of money payable to the Wind Entity in recognition of the removal of the Carbon Entity's liability under the Interface Agreement pursuant to the provisions of this Part of this Schedule*'

11. Any information provided pursuant to paragraph 10 shall be treated as confidential and commercially sensitive by the Secretary of State and (in the event that it is shared by the Secretary of State with that Entity as part of the process of determining Compensation) by the non-disclosing Entity.[5] **]**

Cessation of provisions

12. Save for paragraph 6, the provisions of this Part of this Schedule shall cease to have effect in the event that prior to the Longstop Date, the Carbon Entity notifies the undertaker that the authorised project may be constructed within the Exclusion Area.

Notices

13. Any notice or other written communication required shall be sufficient if made or give to the other Party by personal delivery or by first class post, postage prepaid, to the address set out below:

if to the undertaker, at:

[ ]

if to the Carbon Entity at:

Andy Lane, VP hydrogen, UK
[redacted]

By way of copy to Clare Haley
[redacted]

14. Notices or written communications made or given by personal delivery shall be deemed to have been sufficiently made or given when sent (receipt acknowledged), or if posted, 5 business days after being placed in the post, postage prepaid, or upon receipt, whichever is sooner.

[5] This is the 'Alternative Option'.

ANNEX 2
VERSION 4 OF BP'S PROTECTIVE PROVISIONS (TRACKED-CHANGE)

SCHEDULE [ ], PART [ ]
Protection for Carbon Dioxide Appraisal and Storage Licensee(s)

Application:

1. For the Protection of the Licensee(s) from time to time of United Kingdom Carbon Dioxide Appraisal and Storage Licence CS001, unless otherwise ~~[~~provided for in this Schedule or~~]~~ agreed in writing between the Undertaker and the ~~Licensee~~ Carbon Entity[1] the provisions of this part of this Schedule shall have effect.

Interpretation:[2]

2. In this Part of this Schedule—

~~"Activity" or "Activities" means either (i) the activity or those activities (as appropriate) that the Licensee plans to undertake within the Exclusion Area or (ii) the Undertaker's Works and/or any other activity or activities (as appropriate) which the undertaker is proposing that may have an impact on the Licensee's activities within the Exclusion Area;~~

"Applicable Laws" means applicable laws, rules, orders, guidelines and regulations, including without limitation, those relating to health, safety and the environment and logistics activities such as helicopter and vessel operations;

~~"Authority" means an authority whether statutory, public, local, European, government department, agency or otherwise;~~

"BP Exploration Operating Company Limited" means BP Exploration Operating Company Limited, with Company Registration Number 00305943, whose registered office is at Chertsey Road, Sunbury On Thames, Middlesex TW16 7BP;

"Carbon Entity" means the entity defined as the Carbon Entity under the Interface Agreement;

"Carbon Sentinel Limited" means Carbon Sentinel Limited, with Company Registration Number 08116471, whose registered office is at 1-3 Strand, London WC2N 5EH;

"Commercial Operation Date" means the date on which the authorised project has supplied electricity on a commercial basis to the national grid[3];

~~"Consultation Process" means the consultation processes undertaken by or on behalf of an Entity in respect of its project as required by an Applicable Law and/or regulation but excluding any bilateral consultations between the Entity and a particular individual or organisation;~~
"Endurance Store" means the geological storage facility in the 'Endurance' saline aquifer subject to the Licence;

"Entity" means the undertaker or the ~~Licensee~~ Carbon Entity as appropriate and "Entities" means both of them;

"Exclusion Area" means any area within the area ~~coloured yellow~~hatched orange on the Protective Provisions Plan and as delineated in the Table of Co-Ordinates;

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[1] Tweak made to reflect change in terminology in these provisions. The protection is still linked to the Licence and so other definitions retained.
[2] As a result of the revised approach to these protective provisions and the more limited modification to the Interface Agreement, a number of the previous definitions are no longer relevant and so have been deleted.
[3] Suggested definition; however, bp is happy to consider a revised definition if Orsted have alternative wording specific to the context of their project.

"Good Offshore Wind Farm Construction Practice" means the application of those methods and practices customarily used in construction of wind farms in the United Kingdom Continental Shelf with that degree of diligence and prudence reasonably and ordinarily exercised by experienced operators and contractors engaged in the United Kingdom Continental Shelf in a similar activity under similar circumstances and conditions;

"Interface Agreement" means the agreement dated 14 February 2013 between (1) The Crown Estate Commissioners (2) Carbon Sentinel Limited and (3) Smart Wind Limited, as varied and adhered to by an agreement dated 12 September 2016 between (1) The Crown Estate Commissioners (2) Smart Wind Limited (3) Carbon Sentinel Limited and (4) the Undertaker and a Deed of Covenant and Adherence dated 10 February 2021 between (1) The Crown Estate Commissioners (2) the Undertaker (3) Smart Wind Limited (4) Carbon Sentinel Limited and (5) BP Exploration Operating Company Limited, or such other agreement as may be entered into by the parties in substitution for those agreements;

"Licence" means the United Kingdom Carbon Dioxide Appraisal and Storage Licence CS001;

"Licensee" means the licensee from time to time of the Licence ~~(or any one of them)~~;

~~[~~"Longstop Date" means:

(a) the date ~~five~~ three (~~5~~3) years after the coming into force of this Order; or

(b) such later date as may be notified to the Entities in writing from time to time by the Secretary of State;[4] ~~]~~

~~"Necessary Consent" means all consents, licenses, permission, orders, exemptions and approvals required from any Authority in relation to the Activities and shall include, for the avoidance of doubt, all assessments that may be required to be undertaken before the issue of any of the foregoing;~~

"Notification Area" means any area within the area ~~coloured turquoise~~hatched blue on the Protective Provisions Plan and as detailed in the Table of Co-Ordinates;

"Plan of the Undertaker's Works" means a construction programme, method and details of the proposed location of the Undertaker's Works and minimum requirements known at that time such as safety in accordance with Good Offshore Wind Farm Construction Practice and Applicable Laws to enable the Undertaker to construct and operate the Undertaker's Works;

"Smart Wind Limited" means Smart Wind Limited, with Company Registration Number 07107382, whose registered office is at 5 Howick Place, London, England SW1P 1WG;

"The Crown Estate Commissioners" means The Crown Estate Commissioners on behalf of Her Majesty the Queen, acting in exercise of the powers of the Crown Estate Act 1961;

"the Protective Provisions Plan" means the plan entitled Endurance Store Protective Provisions Plan and certified as the Endurance Store Protective Provisions Plan for the purposes of this Part of this Schedule;

"the Table of Co-Ordinates" means the following table:

Exclusion Area	
Latitude	Longitude
54°8'51.929"N	1°0'34.075"E
54°9'13.497"N	1°0'43.850"E

[4] bp has noted Orsted's submissions in relation to the previous Longstop Date period and sought to reduce the timescale insofar as practicable. It is acknowledged that this period still goes beyond the scheduled FID date for the NEP project (as part of the ECC plan); however, there are factors outside of bp's control which may import delay (e.g. government delay to the TRI licensing model, meaning partners need more time to decide whether to press ahead with the project and crystallise the compensation liability) and which needs to be recognised in this period.

54°10'49.480"N	0°58'21.782"E
54°12'37.143"N	0°58'31.095"E
54°12'17.413"N	1°12'18.263"E
54°10'48.297"N	1°15'35.528"E
54°9'52.770"N	1°13'54.364"E
54°8'17.458"N	1°11'0.989"E
Notification Area	
Latitude	Longitude
54°7'57.201"N	1°0'9.286"E
54°8'51.943"N	1°0'34.082"E
54°8'17.458"N	1°11'0.989"E
54°9'52.770"N	1°13'54.364"E
54°7'57.603"N	1°13'55.408"E

"Undertaker's Works" means the indicative works permitted by this Order; and.

"Wind Entity" means the entity defined as the Wind Entity under the Interface Agreement.

The Undertaker's Works

3. The undertaker must not construct any of the authorised project within the Exclusion Area.

4. The undertaker must not commence construction of any of the authorised project within the Notification Area unless the undertaker has submitted to the LicenseeCarbon Entity, not less than 56 days' prior, a Plan of the Undertaker's Works within that area and must have regard to any written representation received from the Licensee on the same.[5]

5. Nothing in this paragraph precludes the undertaker from submitting at any time or from time to time, but in no case less than 56 days before commencing construction, a new plan, instead of the plan previously submitted in accordance with paragraph 4 above, and having done so the provisions of this Schedule will apply to and in respect of the new plan.

Interface Agreement

6. From the date of this Order, the Interface Agreement shall no longer have effect, and no claim may be made, nor award granted, for any damages as a result of any alleged antecedent breach of the Interface Agreement prior to the date of this Order. Nothing in this Part of this Schedule shall affect any rights or obligations that exist under the terms of the Interface Agreement, save that the Carbon Entity shall have no liability to the Wind Entity under that agreement due to or arising from the imposition of the provisions of this Part of this Schedule or its impact upon the authorised project and no claim may be made by, nor award granted to, the Wind Entity for any damages as a result of any alleged antecedent breach of the Interface Agreement prior to the date of this Order.

[Compensation[6]

[5] The ExA queried whether additional provision was needed here to require the Carbon Entity to submit comments in return within a prescribed timescale. Given the 'Notification Area' is outside of the Exclusion Area, the intention was purely for notice to be given to the Carbon Entity of Orsted's proposed works in the area, rather than expecting any changes to be made to the works following consultation. We have removed the positive obligation from the drafting on this basis, which we believe also addresses the ExA's point in an indirect way. The correlative change to the subsequent paragraph has also been made.

[6] Two alternative forms of drafting are proposed, which achieve the same basic purpose and would have the same general process, with the distinction being whether the SoS determines the quantum of compensation prior to determining the DCO and writes the figure into the made Order (bp's Preferred Option) or in the period immediately after the DCO is determined (the Alternative Option). The drafting is included in this version on an 'either/or' basis for the ExA and SoS' consideration. bp's main Deadline 6 submission elaborates on the

7. Unless otherwise agreed between the Entities, the Carbon Entity will pay to the Wind Entity [£…] on the earlier of:
(a) the date no more than 60 days after notification by the undertaker to the Carbon Entity of the Commercial Operation Date; or
(b) 1 February 2029,
provided that the provisions of this Part of this Schedule have not ceased to have effect in accordance with paragraph [8][7] by that date (in which case no payment shall be due).[8]

OR

7. Unless otherwise agreed between the Entities and notified to the Secretary of State in writing[9], the Secretary of State shall within 2 months of this Order coming into force determine and notify the Entities of the Compensation[10] to be paid by the Carbon Entity to the Wind Entity, such Compensation to be paid on the earlier of:
(a) the date no more than 60 days after notification by the undertaker to the Carbon Entity of the Commercial Operation Date; or
(b) 1 February 2029,
provided that the provisions of this Part of this Schedule have not ceased to have effect in accordance with paragraph [12] by that date (in which case no payment shall be due).

8. In determining the Compensation, the Secretary of State shall balance the impact of the imposition of the Exclusion Area on the authorised project (and the removal of the Carbon Entity's liability to the Wind Entity under the Interface Agreement) pursuant to this Order with the public interest in preserving the full developable area of the Endurance Store;

9. In making a determination of Compensation under paragraph 8, the Secretary of State shall take into account relevant submissions made by the Entities during the examination of the Order (application reference: EN010098), and such further information (if any) provided by the Entities pursuant to paragraph 10.

10. Where the Secretary of State considers that further information is necessary to determine Compensation under paragraph 8, he or she may request this from the Entities, who shall provide it within the period specified in the request.

11. Any information provided pursuant to paragraph 10 shall be treated as confidential and commercially sensitive by the Secretary of State and (in the event that it is shared by the Secretary of State with that Entity as part of the process of determining Compensation) by the non-disclosing Entity.[11]]

~~**Collaboration**~~[12]

~~7. Each Entity shall consult early and fully with the other as part of any Consultation Process it is conducting for the purpose of applying for and procuring any Necessary Consent required in connection with their Activities (as relevant).~~

reasoning.

[7] This refers to the 'Cessation of Provisions' paragraph below, which would be paragraph 8 in circumstances where the Preferred Option compensation drafting was included.

[8] This is the 'Preferred Option'.

[9] This gives room for an agreement on compensation to be reached privately between the two parties and thus avoid need for SoS determination of compensation under this provision

[10] If included, 'Compensation' to be defined as *'means a sum of money payable to the Wind Entity in recognition of the removal of the Carbon Entity's liability under the Interface Agreement pursuant to the provisions of this Part of this Schedule'*

[11] This is the 'Alternative Option'.

[12] As it is no longer proposed to disapply the effect of the Interface Agreement, it is no longer necessary to re-provide some of the collaboration provisions contained within its terms. These provisions have been deleted on that basis.

~~8. The Entities shall set up an interface management group comprising the project managers for each Entity's proposed Activities, and such other technical person as each determines necessary, who shall meet at six monthly intervals or at such frequency as the Entities reasonably determine necessary to discuss and understand the respective Entities' Activities and their impact on each other's Activities.~~

~~9. In or pursuant to such six monthly meetings held in accordance with paragraph 8 above, each Entity shall act reasonably in providing to the other Entity information (other than third party proprietary information) on its Activities, and such information shall be at a sufficient level of detail to allow the other Entity to understand the impact on their proposed Activities.~~

~~10. The Entities shall act in good faith in seeking to negotiate any crossing agreement required to facilitate each Entity's projects. The form of crossing agreement will be based on the Oil and Gas UK Industry Model Form: Pipeline Crossing Agreement (2015) or such other form published by Oil and Gas UK as may be current from time to time amended as necessary to reflect crossing of a pipeline by an electricity cable or cables, or vice versa.~~

Cessation of provisions

12. Save for paragraph 6, the provisions of this Part of this Schedule shall cease to have effect in the event that prior to the Longstop Date, the Carbon Entity notifies the undertaker that the authorised project may be constructed within the Exclusion Area.[13]

~~**[Longstop Date**~~

~~11. If the Licensee has not obtained by the Longstop Date the Necessary Consents to undertake its Activities, the provisions of this Part of this Schedule shall cease to have effect, subject to paragraph 12.~~

~~12. Notwithstanding the operation of paragraph 11, paragraph 6 (Interface Agreement) shall remain in effect.]~~

Notices

13. Any notice or other written communication required shall be sufficient if made or give to the other Party by personal delivery or by first class post, postage prepaid, to the address set out below:

if to the undertaker, at:

[ ]

if to the ~~Licensee~~ Carbon Entity at:

Andy Lane, VP ~~CCUS Solutions and MD Net Zero Teesside~~hydrogen, UK
[redacted]

By way of copy to Clare Haley
[redacted]

14. Notices or written communications made or given by personal delivery shall be deemed to have been sufficiently made or given when sent (receipt acknowledged), or if posted, 5 business days after being

[13] As it is now contemplated that bp (on behalf of NEP) will make a compensation payment to Orsted in recognition of the imposition of the Exclusion Area and the removal of bp's liability to Orsted under the Interface Agreement, it is no longer appropriate for the Longstop Date to be linked to NEP securing its offshore consents. Rather, the trigger should be at NEP's discretion only and allow the Exclusion Area to be surrendered back to Orsted within 3 years of the date of the Order without the compensation falling due.

placed in the post, postage prepaid, or upon receipt, whichever is sooner.

ANNEX 3
BP'S PROTECTIVE PROVISIONS PLAN

Endurance Store Protective Provisions Plan

Exclusion Area		
Point ID	Latitude	Longitude
1	54°8'51.929"N	1°0'34.075"E
2	54°9'13.497"N	1°0'43.850"E
3	54°10'49.480"N	0°58'21.782"E
4	54°12'37.143"N	0°58'31.095"E
5	54°12'17.413"N	1°12'18.263"E
6	54°10'48.297"N	1°15'35.528"E
7	54°9'52.770"N	1°13'54.364"E
8	54°8'17.458"N	1°11'0.989"E

Notification Area		
Point ID	Latitude	Longitude
1	54°7'57.201"N	1°0'9.286"E
2	54°8'51.943"N	1°0'34.082"E
3	54°8'17.458"N	1°11'0.989"E
4	54°9'52.770"N	1°13'54.364"E
5	54°7'57.603"N	1°13'55.408'E

Legend

- Exclusion Area
- Notification Area
- UKCS Carbon Storage Licence Area CS001
- Hornsea 4 DCO RLB
- Exclusion Area
- Notification Area

Service Layer Credits: Light Gray Base: Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS, World_Topography/ ESRI_WorldCountries_Topographic: Esri, HERE, Garmin, USGS, Light Gray Reference: Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS

Scale at A3 page size **1:200,000**

metres

0 2,500 5,000 7,500 10,000

GCRS: GCS European 1950
Geodetic Datum: European 1950
PCRS: ED 19500 UTM Zone 31N
Projection: Transverse Mercator

Rev	Creator	Checker	Approver	Date
01	G MCLACHLAN	M HARRISON	B KEK	27/07/2022
-	-	-	-	-
-	-	-	-	-

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Chart No: BP-NSE-NEP-PRJ-0017

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ANNEX 4
BP'S FURTHER SUBMISSIONS IN RESPONSE TO THE SEWELL REPORT

Deadline 6 submission

Annex 4

BP'S FURTHER TECHNICAL RESPONSE TO THE JUNE 2022 REPORT BY ANDREW SEWELL (OF XODUS GROUP LIMITED) COMMISSIONED BY ORSTED

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1. INTRODUCTION

1.1 In its Deadline 5a submissions (REP5a-025), BP Exploration Operating Company Limited ("bp"), as the operator of the Northern Endurance Partnership ("NEP") project:

1.1.1 summarised its position in relation to the conclusion and recommendations in the June 2022 report by Andrew Sewell of Xodus Group Limited that was commissioned by Orsted and submitted to the Planning Inspectorate at Deadline 5 ("Sewell Report") (bp's Initial Response to the Sewell Report");

1.1.2 responded to the specific "Request to bp for additional information" set out in Section 4.1 of the Sewell Report ("bp's Response to Specific Requests"); and

1.1.3 advised that at Deadline 6 it would submit a further technical response to wider issues raised by the Sewell Report.

1.2 In addition to bp's Initial Response to the Sewell Report and bp's Response to Specific Requests, many of the issues discussed in the Sewell Report also are addressed in:

1.2.1 bp's report, 'A Technical Assessment of the Endurance Reservoir and Hornsea Project Four Wind Farm' ("bp Technical Assessment"), which was provided to Orsted, The Crown Estate ("TCE"), BEIS and the Oil and Gas Authority (which is now known as the North Sea Transition Authority ("NSTA")) in December 2021 and submitted to the Examining Authority with the Joint Position Statement of bp and Orsted (REP1-057, Annex 1 of Appendix 2, electronic pages 147 – 207); and

1.2.2 "BP's Response to the 24 January 2022 Northern Endurance CCUS Co-Location Review Report Prepared by Offshore Renewable Energy Catapult and Net Zero Technology Centre" ("bp's Response to the OREC/NZTC report") submitted at Deadline 3 (REP3-047, Appendix 1, electronic pages 6 – 36).

Those documents should be read in conjunction with the Sewell Report and this submission.

1.3 As noted in bp's Initial Response to the Sewell Report, and addressed further below, the Sewell Report supports the case that bp has put forward for the need for an Exclusion Area. However, there are some aspects of the Sewell Report that are not addressed in bp's Initial Response to the Sewell Report and which bp does not agree with, and to the extent there are material differences, they are addressed within this document.[1]

1.4 It is important, when reviewing the Sewell Report and Orsted's submissions concerning possible co-location in the Exclusion Area, to understand which technical issues continue

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[1] bp addresses in this document and its Initial Response to the Sewell Report what bp considers to be the most important points rather than identifying every instance where there is disagreement. Accordingly, the Examining Authority should not assume that the absence in this document (or bp's Initial Response to the Sewell Report) of a specific response to a particular point in the Sewell Report means that it is

to be in issue between Orsted and NEP, and which ones have been resolved. bp addresses this below in Sections 2 and 3, before turning to specific aspects of the Sewell Report in Section 4.

1.5 In summary, based on what is in the OREC/NZTC report and the Sewell Report[2], only one technical matter continues to be in issue, namely whether a hybrid of dense OBN and short streamers such as P-cables ("OBN and P-cables Hybrid") could be used to undertake 4D seismic monitoring if there are wind turbines in the Exclusion Area.[3]

1.6 However, neither the OREC/NZTC report or the Sewell Report:

1.6.1 says that dense OBN and P-cables could, in fact, be used to undertake 4D seismic monitoring for an offshore CCS project;

1.6.2 says that dense OBN and P-cables could be used for the seismic monitoring that will be required at Endurance;

1.6.3 recommends that dense OBN and P-cables be used at Endurance;

1.6.4 finds that wind turbines could be installed in the Exclusion Area if dense OBN and P-cables were used to undertake the necessary 4D seismic monitoring at Endurance.

1.7 Importantly, the above issues are not addressed in the OREC/NZTC report, and although Mr Sewell claims that dense OBN combined with a very short streamer system such as P-cables is (or should be[4]) the "*only viable*" technology for seismic acquisition where CCS and a wind farm need to co-exist, what he actually does in his report is limited to saying that further investigation would need to be undertaken to determine whether an OBN and P-cables Hybrid could be used for seismic acquisition at Endurance:

> "*The key recommendation of this report is that comprehensive evaluation of different seismic acquisition processing techniques and survey designs, using an approach such as forward modelling, is needed to investigate the impact on imaging from seabed to Bunter, and thus the ability to monitor the spread of the CO2 plume. Part of this evaluation should include field trials investigating, for example, if the sand waves on the seabed at the Endurance site will cause a significant problem for the use of ocean bottom systems."* (at pages 8 and 36)[5]

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agreed or accepted by bp. To the extent that the Examining Authority has questions about specific elements of the Sewell Report that are not addressed in this report and bp's Initial Response to the Sewell Report, bp would, of course, be happy to respond to such questions and provide additional information.

2 As noted in bp's main response to Deadline 6, whilst bp has addressed both the OREC/NZTC report and the Sewell Report in this submission (and that submitted at D5a), it is bp's understanding from Orsted's submissions (both at Deadline 5, and then made subsequently orally at ISH9) that the Sewell Report supersedes the earlier OREC/NZTC report and that they no longer place reliance on that earlier report as continued evidence in support of their case and so can be disregarded from the examination.

3 As explained below, bp's position in relation to the access requirements relating to rigs, wells and helicopters as set out in bp's Technical Assessment has not been challenged by OREC/NZTC or Mr Sewell.

4 At times Mr Sewell states that some form of OBN and P-cables "is" or "will be" the only viable seismic acquisition technology (see pages 8 and 13). However, in other parts of his report he is not as categorical and only says that something like P-cable and OBN "*should be*" a viable solution: "*bp also describes [in bp's Technical Assessment] how a 2D/4D approach is not suitable, and I agree that 2D/4D and P-cable are not going to be suitable on their own, but something like P-cable in combination with OBN* ***should be a viable solution.***" (emphasis added) (REP5-075, Appendix A, electronic page 28).

5 REP5-075, Appendix A, electronic pages 14 and 42

1.8 The recommendation that further work be undertaken reflects the fact (as is recognised by Mr Sewell himself in his report) that:

1.8.1 an OBN survey (whether dense or sparse) has never been used for 3D CO2 monitoring;

1.8.2 P-cables have not been used for 3D CO2 monitoring;

1.8.3 a hybrid of OBN and P-cables has never been used for 4D monitoring of CO2; and

1.8.4 a hybrid of dense OBN and P-cables has never been used to carry out 4D seismic monitoring for CO2 in an area with wind turbines.[6]

1.9 At page 28 of his report Mr Sewell states:

> "*bp is correct that OBN has not been used for 3D CO2 monitoring before. Similarly, neither P-cable nor any other very short streamer systems have been used for this purpose. I am also not aware of OBN and P-cable being used together in a planned 4D "hybrid" survey, either for oil and gas or for CO2 monitoring."*

Crucially, a hybrid of OBN (whether dense or sparse) and P-cables also has never been used for 4D seismic monitoring for oil and gas projects or CCS projects, whether outside or inside of a wind farm.

1.10 Accordingly, Mr Sewell recognises in his report that all he can say about using an OBN and P-cables Hybrid at Endurance is that a thorough investigation would need to be undertaken to assess whether, in fact, it might be feasible to use OBN and P-cables at Endurance in order to allow wind turbines to be located in the Overlap Zone.[7] For reasons explained below and in bp's Initial Response to the Sewell Report, carrying out the time consuming and costly work recommended by Mr Sewell is not necessary and would serve no purpose.

2. TECHNICAL ISSUES THAT HAVE BEEN RESOLVED

2.1 For reasons explained in detail in bp's Technical Assessment and the "Summary of BP's Position with Regard to the Impact of Hornsea 4 on the Northern Endurance Partnership Project" submitted at Deadline 1 (REP1-057, Appendix 2, electronic pages 115 – 145), after undertaking extensive work during 2019 - 2021, including various discussions and workshops with Orsted, TCE, BEIS and the OGA/NSTA, bp and its NEP partners reached the following technical conclusions:

2.1.1 4D vessel towed streamer seismic acquisition would allow NEP to obtain the quality of imaging data necessary to evidence CO2 migration and settlement.

2.1.2 4D vessel towed streamer acquisition has specific operational requirements and the presence of wind turbines in the Exclusion Zone would prevent the survey vessels from sailing in the pattern required to collect the data and create a complete seismic image. As a result there would be significant "gaps" or blind

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6 At page 14 of his report, Mr Sewell states: "*All seismic acquisition systems are unproven for use within a large windfarm."* He also notes that neither of the two existing offshore saline aquifer CCS projects use OBN and/or P-cables for monitoring CO2: "…*there are only two offshore saline aquifer CCS projects globally at the moment, Sleipner and Snohvit. These both used (sic) towed streamer for 4D seismic …"* (at page 32) (REP5-075, Appendix A, electronic pages 20 and 38). Importantly, neither of those projects involves a wind farm.

7 As noted in paragraphs 1.7 and 3.1 – 3.5 of bp's Initial Response to the Sewell Report (REP5a-025, Annex 1, electronic pages 3 – 16). Mr Sewell's approach fails to take account of the fact that bp is not saying there can be no wind turbines in the Overlap Zone. Instead, bp's proposed Protective Provisions only preclude wind turbines being located in a portion of the Overlap Zone, namely the Exclusion Area.

spots that would prevent the imaging of CO2 across the whole Endurance reservoir.

2.1.3 The only other option to towed streamer would be dense Ocean Bottom Node (OBN) seismic monitoring at the seabed. However:

"*Dense OBN may be feasible but it is not yet proven. No one has conducted an OBN survey in a windfarm, and there are definitely no 4D examples. A dense OBN survey will still have significant gaps in offset coverage, and sailing of a source vessel through the wind farm will be difficult and not without risk. With the strong currents (Figure 34) it may be challenging to fully replicate source-receiver pairs. Weather conditions will be very important and could lengthen the survey, increasing the risk of timely data acquisition. The 10-15X cost increase of a dense OBN survey over a 3DHR towed streamer survey cannot be ignored."* [8]

2.1.4 Having reviewed the possible use of hybrid monitoring (such as a combination of towed streamers and OBN) as a means of acquiring seismic data within the Overlap Zone, NEP determined that this would not be acceptable for a variety of reasons, including:

"Such hybrid solutions are not proven technology for CO2 monitoring and do not provide a consistent, reliable and repeatable seismic image, particularly as OBN at the seabed in this location (which has large sand waves present) would be susceptible to tidal movement. This would ultimately prevent NEP from imaging the complete Endurance Store, which is something that needs to happen in order to enable adequate monitoring of the reservoir behaviour in a UK FOAK [First of a Kind] project." [9]

2.1.5 In order to safely and efficiently develop the Endurance Store for CO2 storage, there needs to be a reasonable and practicable degree of separation from the Hornsea 4 wind turbines in order to access wells and drilling rigs, and the location and associated corridors required for the wells can only be determined progressively over time as CO2 injection takes place, monitoring occurs and data concerning the migration and settlement of the CO2 plume is acquired and analysed.

2.1.6 Wind turbines in the Overlap Zone would limit the amount of seabed that could be accessed for drilling injection wells (and, if needed, relief wells[10], which form a core part of the Corrective Measures within the storage permit application NEP needs to submit to NSTA). It also would restrict where rigs could be located in the Overlap Zone and affect helicopters which would be needed to support crew changes on rigs as well as to carry out medical evacuations and respond to emergencies.

2.2 In light of the above technical conclusions, bp and its partners in NEP determined that unfortunately co-location across the entirety of the Overlap Zone would not be feasible for delivering the ECC plan and accordingly are seeking protective provisions in the Hornsea 4 DCO that would prevent the construction of wind infrastructure in that portion of the Overlap Zone referred to as the Exclusion Area.

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8 REP1-057, Annex 1 of Appendix 2, electronic page 195

9 REP1-057, Appendix 2, paragraph 7.7, electronic page 129

10 See paragraphs 3.12.6 and 3.17 of bp's Response to the OREC/NZTC report (REP3-047, Appendix 1, electronic pages 29 and 30) and Section 7.1.2.1 of bp's Technical Assessment (REP1-057, Annex 1 of Appendix 2, electronic pages 177 – 183)

NEP's MMV Plan needs to include 3D/4D seismic imaging and cannot rely upon any emerging technologies

2.3 At Deadline 1, Orsted submitted the OREC/NZTC report in support of its position that co-existence could occur in the entirety of the Overlap Zone and Orsted said:

"*In the Applicant's view, the OREC Co-location Review provides a more realistic overview on risks and opportunities of co-existence.* ***The OREC Co-location Review states that there are current solutions but also emerging technologies relating to the proposed MMV plan that allow for future coexistence*** *but does not opine upon the timescales within which those emerging technologies will become available."* [11] (emphasis added)

2.4 bp's Response to the OREC/NZTC report addressed in detail:

2.4.1 why the emerging technologies discussed in the OREC/NZTC report would not, in fact, enable co-existence in the entirety of the Overlap Zone; and

2.4.2 why it was necessary to use 3D/4D seismic for NEP's Measurement, Monitoring and Verification (MMV) plan.[12]

2.5 The Sewell Report supports bp's position on both issues, with Mr Sewell concluding that:

2.5.1 "***The alternate MMV technologies discussed at the end of section 3.3.1 on pages 19 and 2 0 [of the OREC/NZTC report] are unlikely to replace the need for good quality 3D/4D seismic data.*** *These alternate technologies include electromagnetism, mirror imaging, compressive sensing, and full wavefield migration (FWM) amongst others. …*

In my opinion it is unlikely that there will be a replacement technology for 3D seismic with the availability (sic) to provide monitoring over the whole areal extent of a CO2 storage site for a long time. The use of 3D/4D seismic in the MMV plan for Northern Endurance is a necessity." (emphasis added) (at page 11)[13]

2.5.2 *"****The use of wind turbines, or anything else, as a passive seismic source, will not replace the need for conventional 3D seismic with active source.*** *The temporal frequency range of the "noise" produced by wind farms is too restricted to provide useful 3D imaging.*

It is unlikely that any alternative technology will be able to work around the fundamental of the need for a certain density of spatial sampling to obtain an adequate seismic image. Particularly so when trying to image a relatively shallow (1km) reservoir in shallow water depths (<100m)." (emphasis added) (at page 13)[14]

2.5.3 *"Section 5.8 [of Orsted's Deadline 1 position statement] states that "It is understood on bp's timescales that the third survey is therefore unlikely to occur before 2031.* ***The Applicant therefore considers it highly likely that*** *either the cost of Ocean Bottom Node seismic monitoring will have significantly reduced or* ***emerging technology would have reached maturation to allow for seismic to be undertaken with wind turbines in situ, particularly with the added certainty of a sparser layout."***

I don't agree that this is highly likely*."* (emphasis added) (at page 26)[15]

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11 REP1-057, paragraph 5.7, electronic page 14

12 See paragraphs 2.30, 2.32, 2.36 and 2.42 – 2.43 of bp's Response to the OREC/NZTC report (REP3-047, Appendix 1, electronic pages 19 – 25)

13 REP5-075, Appendix A, electronic page 17

14 Ibid, electronic page 19

15 Ibid, electronic page 32

2.5.4 In the table summarising the "key conclusions" of his report, Mr Sewell says the following concerning the issue that he describes as "bp's argument that new technology will not be available for another 10-20 years":

"*I agree with bp's comments about unproven technology*." (at pages 9 and 34)[16]

2.6 Given Mr Sewell's agreement with bp's position concerning emerging technologies and the need for NEP's MMV plan for Endurance to use 3D/4D seismic imaging, the evidence before the Examining Authority does not support finding that emerging technologies would allow co-existence to occur in the Exclusion Area or that NEP does not need to use 3D/4D seismic imaging in its MMV plan.

Neither the grid formation of one turbine every 2 km or the "conceptual view" of sparse Permanent Reservoir Monitoring suggested in the OREC/NZTC report is feasible

2.7 In terms of Orsted's claim in its Deadline 1 Submission that the OREC/NZTC report "*states that there are current solutions"* that allow for co-existence, that is not correct.

2.8 Instead, and as explained in bp's Response to the OREC/NZTC report, the only "solutions" identified within the OREC/NZTC report are (i) a suggestion to do something that the authors of the report make clear is not a proven solution to allow co-location to occur, and (ii) something the authors identify as a "*conceptual view*". As noted in bp's Response to the OREC/NZTC report, that report does not conclude that co-location within the entirety of the Overlap Zone is, in fact, feasible, and the authors of the OREC/NZTC report are careful not to suggest that they have identified a solution to the serious obstacles that are acknowledged to exist.[17]

2.9 The unproven "solution" identified in the OREC/NZTC report is the suggestion of using a "*standard minimum grid formation of one turbine every 2 km".* However, as explained in bp's Response to the OREC/NZTC report, all the OREC/NZTC report says is that this layout "*opens the potential to use towed streamer acquisition for monitoring storage conformance and CO2 plume development away from wells*" and it is clear from the following that the report does not go so far as to say that, in fact, this could be done at Endurance and would work at Endurance. Instead, the authors of the OREC/NZTC report clearly state that further work would need to be carried out to determine whether their suggested layout could allow co-existence to occur in the Overlap Zone:

"*Although the report provides context and answers to many of the original questions, the ETA has concluded that while there is information available on the individual aspects of CCUS and Offshore Wind there is a lack of literature on, and therefore understanding of, the impact of co-locating projects. This is specifically around the impact of turbine layout and noise on MMV activities and how to monitor plume development away from wells. Further studies are required before a definitive conclusion can be made. Until these issues have been addressed**, a standard minimum square grid formation of one turbine every 2 km would need to be implemented**. **This** relates to around nine diameters of the proposed turbines and would allow for rig access and **opens the potential to use towed streamer acquisition for monitoring storage conformance and CO2 plume development away from wells.** This would be unless the cost of Ocean Bottom Node technology can be justified/reduced or a series of other MMV technologies can be compiled to provide full coverage. **This layout would need to be investigated by the wind and CCUS operator to identify if this is feasible and economical for the project to continue**.*

[16] Ibid, electronic pages 15 and 40
[17] Paragraph 2.3 of bp's Response to Deadline 3 (REP3-047, electronic page 4)

Further areas of study are not limited to but include:

- *CCUS operator to provide current MMV requirements for CO2 plume monitoring for the Northern Endurance site*
- *Detailed independent study on MMV technologies based on current understanding of storage site characteristics and proposed MMV plan to understand viable options for co-location*
- *Real world study on the impact of offshore wind turbine noise on MMV survey activities"* (emphasis added) (at page 58)[18]

2.10 Crucially, the Sewell Report concludes that what is suggested in the OREC/NZTC report would not work in the Overlap Zone:

"One of the conclusions on page 58 of the OREC-NZTC report [3] is "… a standard minimum square grid formation of one turbine every 2 km would need to be implemented… and opens the potential to use towed streamer acquisition for monitoring storage conformance and CO2 plume development away from wells." I don't agree with this conclusion if this is referring to conventional length (2km or longer) streamers. Clearly turbine spacing will have an impact on seismic acquisition designs. A typical towed streamer configuration, such as used at Sleipner [11], would have 10 streamer cables with 75m cross line separation between streamers. This means the cables cover a swath width of 750m, and allowing a 100m buffer to each side, means the streamers cover almost 1 km with each sail line. ***So, while it should be feasible to sail such a streamer configuration though a wind farm with 2 km turbine spacing safely, the gaps in the coverage of seismic data that would result make this approach impractical for CO2 monitoring at Northern Endurance****."* (emphasis added) (at page 13)[19]

2.11 The conclusions in the Sewell Report concerning the idea of using a grid formation with one turbine every two kilometres are consistent with bp's determination that the idea suggested by OREC/NZTC is not feasible for Endurance.[20] This is another technical issue that is no longer a "live" issue, and the evidence before the Examining Authority does not support finding that a layout of one turbine every 2 km would allow co-location in the Exclusion Area (and bp assumes Orsted will confirm the same in response to Action 2 from ISH9 in response to the ExA's query in view of the above)[21].

2.12 For the reasons detailed in paragraphs 2.44 – 2.48 and 5.4 of bp's Response to the OREC/NZTC report, the "conceptual view" of sparse Permanent Reservoir Monitoring ("PRM") set out in that report would not allow co-location in the Exclusion Area. Importantly, in setting out their "conceptual view", the authors of the OREC/NZTC report make it clear that they are not saying that sparse PRM could or should be used at Endurance, and Mr Sewell does not contend that the "conceptual view" set out in the OREC/NZTC report is viable. Accordingly, the evidence before the Examining Authority does not support finding that the use of PRM would allow co-location in the Exclusion Area.

Other Resolved Technical Issues

2.13 The issue of whether NEP could use towed streamers for seismic acquisition in the event there was co-location in the Exclusion Area also now has been resolved as a result of the Sewell Report agreeing with bp's position (summarised above in sub – paragraphs 2.1.1 and 2.1.2). Specifically, Mr Sewell says that:

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18 REP1-057, Appendix 1.1, electronic page 88
19 REP5-075, Appendix A, electronic page 19
20 See paragraphs 1.8, 1.10.2 and 2.28 of bp's Response to the OREC/NZTC report (REP3-047, Appendix 1, electronic pages 9, 10 and 18)
21 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010098/EN010098-001803-Action%20Points%20ISH9.pdf

"It is likely to be highly impractical for a vessel towing streamers of several km length to operate in a wind farm. And even if it is possible, the gaps in the data acquisition would be so large that basic 3D imaging would be badly compromised, and therefore the use of the data for CO2 monitoring would not be possible." (at page 11)[22]

2.14 Mr Sewell also concludes that even with a sparser layout of a 2x2km grid formation NEP would not be able to use conventional towed streamers to acquire the necessary seismic data:

2.14.1 In his conclusion concerning the issue that he describes as "*The impact of a more sparse wind turbine layout without a 2x2km grid on the options for seismic monitoring",* Mr Sewell says:

*"**A sparser turbine grid** will make any seismic acquisition easier, but **will not allow conventional towed streamers longer than 1km to be feasible within a windfarm**."* (emphasis added) (at pages 9 and 34)[23]

2.14.2 he also says the following: *"bp goes on to state [in bp's Technical Assessment] that "Given the stated minimum distance between wind turbines and array density in the Hornsea 4 wind farm development consent order (DCO), it is not possible to run conventional towed streamer seismic acquisition within the wind farm." **I understand that the original 1km x 1km turbine spacing could be relaxed to 2km x 2km in the overlap zone. However, I agree with bp that it will not be possible to acquire data of sufficient quality with conventional (1km or longer) streamers through a wind farm with an acceptable level of risk**."* (emphasis added) (at page 19)[24]

2.15 Mr Sewell also agrees with bp's conclusion that it could not use short streamers of 200m or less for acquiring seismic if wind turbines were present in the Exclusion Area:

2.15.1 *"… I agree with bp that it would not be recommended to try to image a target at depths of over 1km with a streamer length of only 200m or less."* (at page 22)[25]

2.15.2 *"The rest of this section [section 2.28.1 of bp's Response to the OREC/NZTC report] explains why (a) the short streamer systems such as P-cable will not be able to image the Bunter reservoir adequately on their own; and (b) it will not be possible to use towed streamers of any length sufficient to image the Bunter reservoir, and I agree with this assessment."* (at page 33)[26]

2.16 Given Mr Sewell's agreement with bp's position on these issues, the evidence before the Examining Authority does not support finding either that a grid formation of 2x2km would allow co-location in the Exclusion Area or that NEP could use short streamers of less than 200m to acquire seismic data in the event wind turbines were present in the Exclusion Area.

Access Requirements for Rigs, Wells and Helicopters

2.17 In terms of access requirements for rigs, wells and helicopters (see paragraphs 2.1.5 and 2.1.6 above):

22 REP5-075, Appendix A, electronic page 17
23 Ibid, electronic pages 15 and 40
24 Ibid, electronic page 25
25 Ibid, electronic page 28
26 Ibid, electronic page 39

2.17.1 these are addressed extensively in bp's Technical Assessment;[27]

2.17.2 although the OREC/NZTC report discusses access requirements, it fails to refer to or take account of relevant information in bp's Technical Assessment;

2.17.3 comments in the Sewell Report indicate that Orsted did not provide bp's Technical Assessment to the authors of the OREC/NZTC report[28] (and during ISH9 held on 19 July 2022 Orsted's legal team confirmed that the authors of the OREC/NZTC report did not review what was in bp's Technical Assessment);

2.17.4 in reviewing and commenting on bp's Technical Assessment, Mr Sewell does not address what bp said about access requirements;

2.17.5 accordingly, bp's conclusions in its Technical Assessment concerning access requirements have not been challenged by either the authors of the OREC/NZTC report or Mr Sewell;

2.17.6 as explained in bp's Response to the OREC/NZTC report, in discussing access requirements the OREC/NZTC report makes a number of incorrect assumptions about what will be needed and the report does not take into account the specific access requirements that will exist at Endurance. As a result, its conclusions about access need to be subjected to careful scrutiny. Additionally, Mr Sewell does not contend that the analysis of access requirements in the OREC/NZTC report is correct. Accordingly, the evidence does not support finding that the rig, wells and helicopter access requirements at Endurance could be satisfied if there are wind turbines in the Exclusion Area.

3. THE REMAINING TECHNICAL ISSUE

Based on its review of the OREC/NZTC report and the Sewell Report, bp understands the only remaining technical matter in issue is whether the use of an OBN and P-cables Hybrid would allow co-location in the Exclusion Area.

3.1 As noted above in paragraphs 2.1.3 and 2.1.4 (and discussed in bp's Technical Assessment), bp previously considered the use of OBN and concluded that if there were wind turbines in the Exclusion Area, then for various reasons NEP would not be able to use OBN (or a hybrid of OBN and P-cables) to acquire seismic data. Given the claim in the Sewell Report that using an OBN and P-cables Hybrid to acquire seismic data is the only "*viable*" way of ensuring co-existence of the Hornsea 4 and Endurance projects, bp has revisited this issue. However, for the reasons explained in bp's Technical Assessment, bp's Initial Response to the Sewell Report and in this submission, bp's view has not changed and:

3.1.1 bp continues to believe that if there are wind turbines in the Exclusion Area, then using OBN and P-cables to acquire seismic data would not provide the necessary consistent, reliable and repeatable seismic image to enable NEP to image the complete Endurance store;

3.1.2 bp does not believe that using an OBN and P-cables Hybrid would allow co-location in the Exclusion Area; and

3.1.3 undertaking a time consuming and costly forward modelling and field trial(s) exercise would not result in NEP being able to use dense OBN and P-cables for monitoring if there are wind turbines in the Exclusion Area.

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27 See Section 7 of bp's Technical Assessment (REP1-057, Annex 1 of Appendix 2, electronic pages 172 – 197)

28 See page 37 of the Sewell Report (REP5-075, Appendix A, electronic page 43)

4. RESPONSES TO SPECIFIC ASPECTS OF THE SEWELL REPORT

4.1 bp's Initial Response to the Sewell Report identified various issues and problems arising from Mr Sewell's recommendation that modelling and field trial work be undertaken to investigate the possible use of an OBN and P-cables Hybrid for NEP's MMV plan if wind turbines were present in the entirety of the Overlap Zone. This included problems and issues relating to certain technical issues raised by the Sewell Report, namely:

4.1.1 the complexities involved in ensuring that the inputs to any model are appropriately robust;

4.1.2 the need to undertake pre-modelling field trial(s) to inform the assumptions to be made in the model in terms of the operational constraints that would exist in using an OBN and P-cables Hybrid to undertake seismic acquisition at Endurance with wind turbines present in the Exclusion Area;

4.1.3 the need to undertake field trial(s) following the modelling;

4.1.4 the timing and costs involved in undertaking modelling and field trials; and

4.1.5 the illustrative 9 month timeline for modelling and field studies set out by Mr Sewell being unrealistic given the amount of time required to undertake reliable modelling and field trial work and the scheduled date for NEP's final investment decision ("FID") being June 2023.

(see paragraphs 8.2 – 8.17 of bp's Initial Response to the Sewell Report)[29].

4.2 bp's Initial Response to the Sewell Report also identified other problems arising from the Sewell Report, including:

4.2.1 the framing of the question addressed by Mr Sewell being focussed only on public interest in the development of CCS and wind farms and desirability of both being able to co-locate and failing to take account of other highly relevant factors including: (a) NEP's directors having legal duties in respect of FID; (b) how the NSTA (in issuing the necessary store permit to the NEP project) will approach the question of what is acceptable in terms of safe and effective monitoring of the Endurance store and what constitutes "best available technology" for monitoring; and (c) the relative costs of using dense OBN versus towed streamers at Endurance;[30]

4.2.2 the misconceived suggestion throughout the Sewell Report that bp bears the burden of proving that an OBN and P-cables Hybrid would not provide adequate seismic data to allow co-location in the Exclusion Area;[31]

4.2.3 the Sewell Report dealing only with the question of monitoring and failing to address the other substantial problems with co-existence in the Exclusion Area in terms of access requirements for rigs, wells and helicopters;[32] and

4.2.4 the form of Protective Provisions submitted by Orsted at Deadline 5 failing, in the event modelling and field studies were undertaken, to adequately protect the NEP project or to clearly give the Secretary of State the opportunity to provide for the

[29] REP5a-025, Annex 1, electronic pages 13 – 16
[30] See Sections 3, 4 and 6 of bp's Initial Response to the Sewell Report (REP5a-025, Annex 1, electronic pages 6 – 9)
[31] Ibid, Section 5, electronic page 9
[32] Ibid, Section 9, electronic page 16

Exclusion Area at a later date should the "*evaluation"* proposed by Orsted determine that co-location was not possible in the Exclusion Area[33].

4.3 This submission is directed at the technical points raised by the Sewell Report, and rather than reproducing its prior comments on the technical issues, bp provides below further detail concerning various issues and problems arising from those technical points. bp also responds to certain statements made in the Sewell Report.

OBN and P-Cables Are Not Proven for CO2 Monitoring or For Use in Wind Farms

4.4 Mr Sewell states in his report that:

4.4.1 "*OBN can provide a technically sound method of acquiring 4D seismic data for CO2 monitoring at the Endurance site, particularly if backed up by the use of something like P-cable for investigating the very near surface in specific areas of concern"* (at page 23)[34]

4.4.2 "*As I have already described, both OBN and P-cable are established technology and do not need further development to be applicable to CO2 monitoring."* (at page 30)[35]

4.5 OBN and P-cables may be "established" and "technically sound" technologies that currently are used for seismic acquisition. However, to the extent that Mr Sewell is suggesting that the fact that OBN and P-cable are known technologies means they could be used for seismic monitoring at Endurance if there were wind turbines in the Exclusion Area, bp strongly disagrees that is the case.

4.6 Mr Sewell himself notes that neither OBN or P-cables have not been used for 3D CO2 monitoring and a hybrid of OBN and P-cables has never been used for 4D seismic monitoring for oil and gas projects or CCS projects.[36] Crucially, a dense OBN and P-cables hybrid has not been used for seismic monitoring in a wind farm. In other words, even if in theory OBN and P-cables did not "*need further development to be applicable to CO2 monitoring",* the use of either of those technologies (or a combination of the technologies) to actually carry out 4D seismic monitoring of CO2 has never been proven, let alone:

4.6.1 in a wind farm that overlaps with a saline aquifer;

4.6.2 for a saline aquifer with the characteristics and size of Endurance.

4.7 Additionally, and importantly, the statements by Mr Sewell that are set out above in paragraph 4.4:

4.7.1 do not say that, in fact, an OBN and P-cables Hybrid could be used at Endurance if wind turbines were present in the Exclusion Area; and

4.7.2 do not take account of the fact that even if in theory it might be possible to use OBN to acquire good quality seismic data at Endurance, if there were wind turbines in the Exclusion Area, then no matter how good the quality of the data, there would be "gaps" in the seismic data at the location of the wind turbines. This would be the case even if it was possible to acquire data up to within 100m of the turbines (which bp does not accept would, in fact, be possible[37]). In other words, even if a vessel operator was willing to sail within 100m of a wind turbine in the

33 Ibid, Section 7, electronic page 11 – 12
34 REP5-075, Appendix A, electronic page 29
35 REP5-075, Appendix A, electronic page 36
36 See paragraphs 1.8 and 1.9 of this submission.
37 See paragraphs 8.2.1 and 8.14 of in bp's Initial Response to the Sewell Report and bp's Response to Specific Request number 4 (REP5a-025, electronic pages 13, 15 and 20 – 21)

Exclusion Area and take on the resulting safety risk to personnel on board, there would still be seismic data gaps around each turbine installation. This means that no matter how good the seismic data acquired by OBN and P-cables might be, it would not be sufficient for NEP's MMV plan as NEP would not be able to image the complete Endurance store and therefore it could not meet the requirement to demonstrate reservoir conformance.

The Modelling and Field Trial Exercise Recommended by Mr Sewell Is Not Feasible or Necessary

4.8 As explained in Section 8 of bp's Initial Response to the Sewell Report:

4.8.1 by its nature, forward modelling is at best only indicative of a likely "best-case" scenario of what is theoretically possible;

4.8.2 the utility and reliability of such a model is dependent on the quality and robustness of the inputs used in the modelling This is particularly so when (as here) the assumptions and inputs used would, given the First of A Kind Nature of the Endurance project, be subject to intense scrutiny as any such model will not be able to fully represent real world conditions given that neither OBN or P-cables have been used for 4D seismic monitoring (in either an oil and gas project or CCS) and also have never been used for monitoring in a wind farm;

4.8.3 accordingly, pre-modelling field trial(s) representative of the Hornsea 4-Endurance marine and subsurface conditions would need to occur in order to collect information about various operational constraints that would need to be taken into account in formulating the inputs to the model; and

4.8.4 bp believes more than one pre-modelling field trial would be needed. However, even if there was only a single post-modelling field work it would be costly and time consuming to undertake the modelling and field trial exercise recommended by Mr Sewell. This is due to a number of factors, including practical matters such as the ability to lay the requisite density of nodes within a single season given the weather related constraints in the southern North Sea and there being a finite global pool of specialist vessels, crews and equipment who could undertake such work.

4.9 In terms of how long it would take to carry out the recommended modelling and field trial work, the Sewell Report includes a flow chart that Mr Sewell says "*illustrates a process for how the proposed investigations could progress to enable a fully informed decision to be made on the feasibility of co-location from a seismic data acquisition perspective.*"[38] The flow chart is premised on:

4.9.1 it taking 9 months to complete all of the modelling and field work as well as have seismic contractors cost various options resulting from the modelling and field studies and BEIS make its "*decision on co-location*"; and

4.9.2 all of the work being completed by June 2023 (the scheduled FID date).

4.10 bp believes the 9 month timeline outlined in the Sewell Report is not only extremely optimistic, it (for a number of reasons) also is unachievable. For example:

4.10.1 The 9 month timeline includes a total of 7 months to scope the modelling as well as complete the modelling and field trial work. However, based on bp's extensive experience of planning and conducting seismic surveys using OBN and its detailed knowledge and understanding of the Endurance Store and related

[38] See page 36 of the Sewell Report (REP5-075, Appendix A, electronic page 42)

seabed conditions, bp calculates that it would take 9 – 10 months just to carry out the detailed modelling that would need to be undertaken to take account of the movement of sand waves and other issues relevant to using OBN and P-cables to acquire seismic data if there were wind turbines in the Exclusion Area.[39] bp calculates it would take approximately 6-8 weeks to carry out a field trial. Accordingly, even if there was only one field trial[40], bp believes it would take at least 10 ½ - 12 months to carry out modelling and one field trial;

4.10.2 Even if the modelling and field work could be completed in 7 months as suggested in the 9 month timeline in the Sewell Report, in order for the work to be completed by June 2023, the modelling and field work would need to begin by no later than September 2022;

4.10.3 Even if scoping and modelling work began in September, completing the modelling and field trial work within 7 months would require that the field trial work be completed by the end of March. However, the weather constraints that apply to carrying out seismic acquisition at Endurance mean a field trial could not take place during the winter months;

4.10.4 Additionally, the 9 month timeline outlined in the Sewell Report assumes that during the seven months of modelling and field trial work, the NSTA would "*review results*". Indeed, the boxes in the flow chart in the Sewell Report include arrows that appear to suggest that the NSTA would not only "review results" but also would provide feedback/comments concerning the results. Mr Sewell does not explain why he thinks this would happen, and based on its experience and the NSTA's responsibilities as a regulator, bp considers it unlikely that the NSTA would be willing to:

(1) agree to "review" the "results" of a modelling and field trial exercise, let alone provide any feedback/comments either during the course of, or at the end, of such an exercise; and/or

(2) formally agree that bp could rely upon any such feedback/comments for the purposes of NEP obtaining the required storage permit.

4.11 bp has summarised above some of the reasons why it would not be possible to carry out a forward modelling and field trial exercise of the nature recommended by Mr Sewell in time for the NEP project's FID scheduled for June 2023, and why bp believes it would, in any event, take more than 9 months to carry out a modelling and field trial exercise concerning whether an OBN and P-cables Hybrid could be used for monitoring CO2 at Endurance if wind turbines were present in the Exclusion Area.

4.12 The cost of carrying out such an exercise would be substantial, and bp noted in its Initial Response to the Sewell Report that it would cost in the region of US $4 million to carry out

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39 At page 36 of his report Mr Sewell suggests that modelling work undertaken prior to 2016 as part of the White Rose project planning and described in the K42 report could be used "*as a basis [for a forward modelling exercise] and refreshed."* Based on its review and evaluation of the White Rose related modelling and data, bp determined that the modelling carried out in relation to White Rose does not reflect current understanding of the Endurance reservoir, and as explained in bp's Specific Response to Request number 9, after reviewing the 2013 Polarcus seismic data acquired by White Rose, bp determined that the data was not suitable for use as a baseline and NEP is creating a new baseline by having acquired a new 3D high resolution towed streamer survey over Endurance in 2022. Accordingly, it would not be suitable to use the White Rose modelling work as a basis for carrying out a forward modelling exercise.

40 As explained in Section 8 in bp's Initial Response to the Sewell Report, bp believes that any modelling and field trial exercise would need to include both pre and post modelling trials (REP5a-025, electronic pages 12 – 16)

a 9 – 10 month modelling exercise and approximately US $10-15 million for a single 6-8 week field trial.

4.13 In addition to time, cost and practical considerations such as weather constraints, there are other reasons why there is no need to undertake any type of forward modelling and field trial exercise to determine whether an OBN and P-cables Hybrid might be able to be used for monitoring if there were wind turbines in the Exclusion Area. In particular:

4.13.1 bp previously considered the feasibility of using OBN and P-cables for NEP's MMV plan for Endurance and determined that using OBN (even dense OBN) would still lead to there being significant gaps in offset coverage which would prevent NEP from imaging the complete Endurance store (and as explained above, this would be the case even if it was possible to acquire seismic data as close as 100m from wind turbines);

4.13.2 bp would not be willing to put forward to the NSTA a MMV plan for the NEP project that included a hybrid of dense OBN and P-cables as the monitoring component for the Endurance store because of insufficient certainty that it would provide a workable solution in practice either (i) for predicted conditions or (ii) for unexpected circumstances were critical corrective measures are required or additional monitoring is needed;[41]

4.13.3 undertaking modelling and field trial work would serve no purpose because the rig, well and helicopter access requirements identified by bp (which, as explained above in paragraph 2.17 have not been challenged by Mr Sewell or the authors of the OREC/NZTC report) mean there could not be co-existence in the Exclusion Area.

4.14 For the reasons explained above and in bp's Initial Response to the Sewell Report:

4.14.1 undertaking a modelling and field trial exercise of the nature recommended in the Sewell report will not enable co-location in the Exclusion Area;

4.14.2 Orsted's form of protective provisions submitted at Deadline 5, and any other version of protective provisions premised on delaying a decision on co-location in the Exclusion Area until after further studies (either of the nature recommended by Mr Sewell or of some other type of study) take place are not workable; and

4.14.3 if the Government wishes to have both the ECC plan and HP4 delivered, this can only be achieved through protective provisions in the HP4 DCO that exclude wind turbines in the Exclusion Area.

4.15 In addition to the modelling and field trial exercise recommended in the Sewell Report not being necessary (or achievable by June 2023), other problems arise from the analysis set out in the Sewell Report that need to be considered in reviewing and considering the report. Examples of these problems are set out below.

Wind Turbine Noise

4.16 The Sewell Report recognises that an issue exists in respect of how the noise from wind turbines could affect seismic acquisition. Although Mr Sewell recognises that further work would need to be done in the context of how this could affect monitoring at Endurance, his report fails to adequately explain how potentially significant a factor this could be in terms of NEP being able to acquire seismic data of the required consistency, reliability and repeatability in circumstances where there are wind turbines in the Exclusion Area.

[41] See paragraphs 8.11 – 8.14 of bp's Initial Response to the Sewell Repot (REP5a-025, electronic page 15)

4.17 For example, the following statement about turbine noise is made at pages 7-8 of the Sewell Report:

"*There are two main issues with regards to seismic data where CCUS and wind farm projects overlap. … The second is how much additional noise is added to the seismic data by operating wind turbines through "shaking the sea bed", and does this decrease s/n [signal-to-noise ratio] enough to hamper the use of 4D seismic for MMV. For this latter point, there could also be a mitigation to turn off those turbines in the overlap area for the duration of the seismic acquisition, which may only be a few months every two to five years, and therefore not a huge economic impact for the wind farm operator."*[42]

4.18 The issue of the potential impact of turbine noise on seismic acquisition is very complex[43] and Orsted being willing to turn off turbines in the Exclusion Zone would not be adequate mitigation. For example, it would not address the fact that even when wind turbines are not operating, they will catch the wind which transfers noise into the subsurface area where the turbine is located, and that could affect the acquisition of seismic data. Additionally, turbine noise can have an impact beyond where the particular turbine is located because the noise can travel away from the turbine, e.g. as a water bottom ground roll.

4.19 The following passage at page 13 of the Sewell Report is another example of an oversimplification of a very complex and significant issue that would exist if there were wind turbines in the Exclusion Area:

"*Section 3.4 [of the OREC/NZTC report] discusses acoustic noise that may be added to the seismic data by the presence of a wind farm. It is clear that a seismic survey should not be acquired during the construction phase of a wind farm as the noise from piling and other activities will be significant. However, that phase of a wind farm is relatively short (1-2 years) and it should be possible to co-ordinate activities between the CCUS operator and the wind farm operator such that this is not an issue. The noise generated by running turbines during the operational life of the wind farm would be picked up by seismic sensors, but there is general agreement that this can be attenuated sufficiently during the seismic data processing. However, it would be worth having some additional studies and modelling on this. Be that is (sic) it may, there is always the last resort of turning off the turbines that overlap the seismic survey for the duration of the survey, which should be a few months every 5 years."* [44]

4.20 It is not clear to bp on what basis Mr Sewell claims that there is "*general agreement"* that the noise picked up by seismic sensors from operating turbines "*can be attenuated sufficiently during seismic data processing".* The ability to remove noise from seismic data is largely driven by sampling requirements. Wind turbines in the Exclusion Area would create obstructions in terms of acquiring seismic data which means there will be gaps in the acquisition geometry. In turn, this creates sampling issues that will result in hampering the removal of noise during the seismic data processing.

4.21 Additionally, as explained above, Mr Sewell fails to explain that because turbines generate noise even when they are not operating and the noise turbines generate travels beyond the location of the particular turbine, there is no certainty that the "last resort" of turning off turbines would ensure that if there were wind turbines in the Exclusion Area, NEP in fact would be able to acquire seismic data of the required consistency, reliability and repeatability.

4.22 It also is worth noting that the assumption that surveys would only occur every 5 years is incorrect. As explained in bp's Response to Specific Request number 10 (REP5a-025, electronic page 24), NEP currently plans for there to an initial time-lapse survey 3 years after initial injection and another survey three years later (i.e. 6 years after initial injection), followed by further surveys during the injection phase. Although it currently is expected that those would occur every 5 years, the actual timing of those surveys will be based upon the

42 REP5-075, Appendix A, electronic page 13 – 14
43 See for example paragraph 1.2 of bp's Response to Specific Request number 1 (REP5a-025, electronic page 18)
44 REP5-075, Appendix A, electronic page 19

conformance that is observed after injection and the full integrated analysis of all MMV data (which could lead to surveys occurring more frequently than every 5 years).

Tidal Currents

4.23 The Sewell Report claims that to the extent that the tidal currents in the area of the Endurance store may create repeatability problems in terms of matching baseline and subsequent surveys, this will be a bigger problem for streamers compared to OBN and will be a problem even if wind turbines are not present. For example, Mr Sewell says:

"… The currents will also be a problem for towed streamer acquisition to repeat source and receiver locations even with modern steerable streamers, with or without a wind farm in place." (at page 14) [45]

"*Data acquisition problems related to strong tides are going to be worse for streamers compared to OBN when it comes to matching source-receiver pairs between survey, whether or not there is a wind farm in place*." (at page 23) [46]

"… bp also makes reference to the strong tidal currents in this area being a particular problem for OBN. In general strong currents would be more of a problem for 4D with long towed streamers than OBN." (at page 32) [47]

4.24 When bp discusses strong tidal currents in the Endurance area creating problems for using OBN for monitoring it is referring to strong tidal movement at the seabed level and the effect this could have in terms of moving (or covering) nodes located on the seabed. The impact of currents on 4D towed streamer surveys are well understood in the industry and can be corrected for both in survey design as well as during operations due to live positioning measurements of the equipment in the water. With OBN those options do not exist.

Sand Waves

4.25 Mr Sewell agrees with bp that the potential for sand waves on the seabed in the Endurance area to move nodes will be a technical challenge for using OBN to acquire seismic data:

"*In 2.19 to 2.24 [of bp's Response to the OREC/NZTC report] bp makes the argument that ocean bottom systems, and OBN in particular, will be susceptible to the receivers being moved around by the sand waves on the seabed in the Endurance area.* ***In my opinion this is likely to be the main technical challenge for the use of nodes in this area. If too many nodes change position during the acquisition of a survey than it will degrade the 3D imaging and the utility of the data for 4D monitoring***. " (emphasis added) (at page 32)[48]

4.26 However, Mr Sewell suggests that bp has not undertaken sufficient work to allow it to determine the extent to which, in fact, this could be a problem:

"*bp states [in slide 7 of the October 2021 slide pack presentation] that "The mobile sand waves on the seabed have caused significant problems for previous ocean bottom acquisition in the area." I agree that these sand waves on the seabed could be a challenge for OBN, but bp does not describe in detail the problems with previous surveys in the area, nor does there seem to have been any testing or other work to quantify how big a problem*

45 Ibid, electronic page 20
46 Ibid, electronic page 29
47 Ibid, electronic page 38
48 Ibid, electronic page 38

this might be at the Endurance site. The answer provided by bp to question 5 in the Q&A document [8] that followed the workshop says "Regarding sand waves – we have not done detailed modelling of what the impact is. Note that sand waves will create issues on 4D signals in general, also for Towed Streamer." (at page 14)[49]

4.27 bp's concerns about the problems that the sand waves pose for using OBN to acquire seismic data in the Endurance area are based upon various sources of information. As explained in bp's Response to the OREC/NZTC report, this includes the fact that a survey that WesternGeco conducted over Endurance in 1997 using Ocean Bottom Cables encountered significant problems in terms of sand wave movement causing the cables on the seabed to move during data acquisition.[50]

4.28 bp also has reviewed high resolution bathymetry data (imaged in 2021) which demonstrates the variable nature of the sand waves present in the Endurance area. That data illustrates sand wave and ripple effects on the seabed and indicates that that the sand waves and ripple effects present on the seabed when the bathymetry data was acquired are of various length scales, with some areas showing sand waves that are typically 4-10 m with subsidiary ripple effects of ~0.5 – 1 m, depending on the direction of the currents, waves and ripple (which varies depending on where they are located on the seabed). This can be seen in Appendix 2 to this document. bp also has reviewed information about the metocean conditions in the area, which indicates that the sand waves and ripple effects observed on the seabed of the Endurance area are unlikely to move at the same time or in the same direction.

4.29 Essentially, the 2021 bathymetry data illustrates the location and nature of the sand waves and ripple effects as they existed on the seabed when the data was acquired. Determining the direction in which those sand waves and ripple effects are likely to move, when they are likely to move and how often they are likely to move, takes time and contrary to what is claimed in the Sewell Report, the magnitude of the problem of sand waves moving (and possibly covering) nodes is not something that "*could be quantified with some reasonably simple field trials and modelling work*"[51] As bp explained in its Initial Response to the Sewell Report, although the location and nature of sand waves and ripple effects can be identified at a particular point in time:

4.29.1 repeat surveys would need to be done at intervals of approximately one year in order to determine the extent to which the sand waves and ripple effects move and change shape over time; and

4.29.2 it would not be sufficient to carry out a single repeat survey a year after the initial survey because there could be no/little consistency in terms of when and how the waves and ripple effects move. Therefore only carrying out a single additional survey after the initial survey may not reliably demonstrate how the sand waves and ripple effects will behave and move over a longer period of time.[52]

4.30 Although bp has not carried out such a repeated survey exercise, the information that is currently available demonstrates that there are large sand waves and substantial ripple effects present on the seabed of the Endurance area and that the strong tidal currents in the area mean there is a real risk that nodes placed on the seabed could move during the time a survey was being undertaken, which would degrade the seismic data that was acquired. There also is a risk that the movement over time of the sand waves and ripple effects could mean that when the next seismic survey was undertaken, it would not be possible to put all of the nodes in the same place that they were located when the earlier survey was undertaken. This could affect the repeatability of the seismic data.

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49 Ibid, electronic page 20
50 See paragraphs 2.19 – 2.25 (REP3-047, Appendix 1, electronic pages 15 – 17)
51 REP5-075, Appendix A, electronic page 38
52 REP5a-025, Annex 1, Paragraph 8.9 (electronic page 14)

Cost of Using Dense OBN and P-cables for Monitoring the Endurance Store

4.31 There are a number of comments in the Sewell Report concerning the costs of using OBN to acquire seismic data.

4.32 As explained in the OREC/NZTC Report, bp's Technical Assessment, bp's Initial Response to the Sewell Report and bp's Response to Specific Request number 2, the cost of using OBN for monitoring at Endurance will be significantly more than using towed streamers to acquire seismic data. The Sewell Report agrees that the high costs of OBN surveys are unlikely to reduce significantly in the next 5-10 years:

"bp is a party to various efforts to develop technologies that may improve OBN efficiency and thereby reduce the costs of such operations. The autonomous and unscrewed node technologies, shown on slide 5 will be aimed at reducing cost rather than having an impact on data quality per se. I agree with bp's conclusion that these cannot be relied upon as making a difference in the near term for Endurance." (at page 14)[53]

"I agree the costs of OBN are likely to come down faster than towed streamer, but they are also likely to remain generally higher for the next 5-10 years at least." (at page 11)[54]

4.33 Additionally, Mr Sewell disagrees with Orsted's claim (in its position statement submitted at Deadline 1) that the cost of OBN will significantly reduce in the coming years:

> **"***"Section 5.8 [of Orsted's Deadline 1 position statement] states that "It is understood on bp's timescales that the third survey is therefore unlikely to occur before 2031.* ***The Applicant therefore considers it highly likely that*** *either* ***the cost of Ocean Bottom Node seismic monitoring will have significantly reduced*** *or emerging technology would have reached maturation to allow for seismic to be undertaken with wind turbines in situ, particularly with the added certainty of a sparser layout****."***
>
> ***I don't agree that this is highly likely****."* (emphasis added) (at page 26)[55]

4.34 Elsewhere in the report, Mr Sewell says:

"*OBN is going to be the only realistic way to acquire seismic data in a wind farm, probably in combination with short streamers (such as P-cables). The main objection to OBN must be the cost rather than the technique or the data quality when compared to a streamer. …*" (at page 23)[56]

4.35 Although the costs of using OBN would be significantly higher, the claim that bp's main objection to using OBN "*must be the cost*" is incorrect. As explained in bp's Technical Assessment, its Initial Response to the Sewell Report and above, if wind turbines are present in the Exclusion Area, using OBN for monitoring creates a number of fundamental and insurmountable problems, including NEP not obtaining a complete image of the Endurance store.

4.36 It also is worth noting that the reference in the above statement to the main objection being costs "*rather than the technique or the data quality when compared to a streamer"* reflects the underlying premise in the Sewell Report that because OBN and P-cables are existing technologies that produce quality seismic data, it follows that they can be used to acquire

53 REP5-075, Appendix A, electronic page 20
54 Ibid, electronic page 17
55 Ibid, electronic page 32
56 Ibid, electronic page 29

seismic data in an area where a CCS project and wind farm are co-located. As explained above, this is unproven.

4.37 Finally, bp notes the Sewell Report refers to the cost of permanent nodes being comparable to costs of towed streamers:

"*Furre et al [14] make the point that permanent nodes could be comparable to the cost of towed streamers, depending on the density of nodes and the frequency of repeat surveys expected*." (at pages 11-12)[57]

4.38 Mr Sewell agrees with bp that permanent nodes do not have the battery power required for monitoring CO2:

"*Section 3.3.2 [of the OREC/NZTC report] discusses the use of permanent seismic arrays for CO2 monitoring. The report mentions "Seabed nodes as part of permanent reservoir monitoring" and I believe this must be referring to Ocean Bottom Cable (OBC) rather than Ocean Bottom Nodes (OBN) systems because it is not currently possible to provide battery power to nodes for the length of time needed for CO2 monitoring."* (at page 12)[58]

4.39 Accordingly, bp assumes the statement set out above in paragraph 4.37 is not intended to be a suggestion that to the extent that the high costs of using OBN for monitoring might be a reason for not using OBN at Endurance, this could be mitigated by using permanent nodes.

Means of Detecting Potential Leaks of CO2

4.40 The Sewell Report includes the following statements concerning the detection of potential CO2 leaks:

"*… Any CO2 leaks at the seabed will be detected through environmental monitoring techniques such as those described in section 5.8.2.5 of the White Rose K42 report [19]. These include monitoring of seawater chemistry, seabed sampling and gas analysis. …" (*at pages 16-17)[59]

"… According to bp's answer to Q9, even a sparse OBN survey should be able to image from the upper Triassic (500m TVDSS) down to the reservoir. If there was to be a leak of Co2 to the seabed through the overburden (as opposed to through wells which are not sealed properly) it would take many years and the CO2 would likely have to pond at various intermediate depths before breaking into the Lias. In other words, OBN 4D monitor surveys should pick up any CO2 escape through the Rot seals long before the CO2 reached the top Triassic. In addition, if there was a baseline survey acquired with good imaging of the near surface (<500 m below the seabed) before the wind farm is in place, then a repeat survey using a short streamer system such as P-cable could be run quickly after any CO2 detection at the seabed, just in the area around that detection point, and provide an ability to see how the CO2 as risen up through the shallow overburden." (at page 17)[60]

4.41 Seabed sampling, gas analysis and monitoring of seawater chemistry will be used for the purposes of detecting any potential leaks of CO2. However, these are only some of the means of detecting CO2 leaks, and as explained in bp's Technical Assessment and the Position Statement that bp submitted at Deadline 1 (REP1-057, Appendix 2), monitoring will play a critical role in detecting potential CO2 leaks, and the extent to which this can be achieved will be heavily dependent on the consistency, reliability and repeatability of the seismic data that is acquired at the Endurance store. To the extent that the Sewell Report is suggesting that the use of OBN and P-cables for monitoring where CCS and wind turbines co-locate in the Exclusion Area would not impact bp's ability to detect potential

57 Ibid, electronic pages 17 – 18
58 Ibid, electronic page 18
59 Ibid, electronic pages 22 – 23
60 Ibid, electronic page 23

CO2 leaks, that is not the case. For example, as explained above, in such circumstances bp would not be able to acquire a complete image of the Endurance Store, and that would affect the ability to detect potential CO2 leaks.

4.42 bp also disagrees with the suggestion that this problem could somehow be overcome by acquiring a baseline survey with good imaging before the wind farm was in place and then using P-cables to "*quickly*" run a survey in the area of a detection "*after any detection of CO2 at the seabed"*. This fails to take account of the fact that if OBN were used in order to allow co-location in the Exclusion Area, there will be gaps in the seismic data because it will not be possible (during the injection phase, and also after final injection occurs) to acquire seismic data for the entire area where a turbine is located. The fact that a baseline survey would contain data about a particular location where a turbine later was situated would not compensate for the fact that once the turbine was in place, there would be no way to acquire data where the turbine was installed and that would directly impact NEP's ability to monitor the movement, containment and conformance of the CO2 plume.

Technical Storage Capacity at Endurance

4.43 At page 18 of his report Mr Sewell raises a query about the technical storage capacity at Endurance: Appendix 1 contains bp's answer to the query.

The Sewell Report's Suggestion of Conducting Two Baseline Surveys

4.44 It is suggested at page 36 of the Sewell Report that the financial feasibility of acquiring two baseline surveys (one using towed streamers and the other using OBN) be evaluated on the basis that:

"Acquiring two baseline surveys would provide the greatest flexibility for future CO2 monitoring at Endurance, give more time for the two parties to agree how the projects can co-exist and provide valuable data for future CCUS projects, either with or without overlapping wind farms."[61]

4.45 Given, as explained above and in bp's Initial Response to the Sewell Report, that bp has concluded that it would not be possible to use OBN for monitoring CO2 if wind turbines were present in the Exclusion Area, there is no value in deferring making a decision concerning whether there can be co-location, and there is no reason to incur the costs of carrying out a baseline survey using OBN.

The Use of Ocean Bottom Systems at the Valhall Oilfield

4.46 The Sewell Report refers to the fact that OBC and OBN are used at the Valhall oil field in the Norwegian sector of the North Sea. As explained in bp's Response to Specific Request number 12,[62] for various reasons (including the depth of the main reservoir) the use of OBN and OBC to acquire seismic data at Valhall does not assist in determining how to acquire seismic data at Endurance or whether it would be possible to OBN at Endurance if there were wind turbines in the Exclusion Area.

The Sleipner and Snohvit CCS projects

4.47 The Sleipner and Snohvit CCS projects are referred to at various places in the Sewell Report. They are the only existing saline aquifer CCS projects globally, and both use towed streamer to obtain 3D/4D seismic data for monitoring purposes.

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61 Ibid, electronic page 42

62 REP5a-025, electronic pages 24 – 25

4.48 Section 4 of bp's Initial Response to the Sewell Response[63] addresses Mr Sewell's comments that the use of towed streamers at Sleipner and Snohvit does not mean that future CCS projects, including Endurance, will need to use streamed towers to monitor CO2.

4.49 At page 28 of his report, Mr Sewell states:

"*The history of Sleipner, and other 4D surveys generally, is that the latest technology is often used for repeat surveys, and that locations of source and receiver can differ significantly between surveys without compromising the ability of the 4D data to image the CO2 plume."*[64]

4.50 It may appear that the surveys at Sleipner that Mr Sewell refers to are significantly different. However, bp notes that those surveys actually are variations on a single design, and each one creates the opportunity to match the newer surveys to the legacy surveys. This is very different to switching to using a different type of monitoring technology during the operation of a project.

4.51 At page 26 of his report Mr Sewell sets out a quotation that he states is "*interesting as a conclusion from the operator of Sleipner as it shows that they believe ocean bottom systems are technically capable, and maybe the preferred method for CO2 monitoring."*.[65]

4.52 bp notes that:

4.52.1 the quotation set out in the Sewell Report contains generalised statements; and

4.52.2 as there is no wind farm at Sleipner, consideration of what may, or may not, in theory satisfy its CO2 monitoring requirements is not the same as considering what could be done at Endurance in the event there were wind turbines in the Exclusion Area, and the fact that people involved in Sleipner say that ocean bottom systems are technically capable and maybe a preferred method for CO2 monitoring does not mean that they are suggesting that OBN should be used for monitoring in an area involving co-location of a CCS project and wind farm.

63 Ibid, electronic pages 9 – 10
64 REP5-075, Appendix A, electronic page 34
65 Ibid, electronic page 32

Appendix 1

TECHNICAL STORAGE CAPACITY OF ENDURANCE

The Sewell Report includes the following query concerning the technical storage capacity at Endurance:

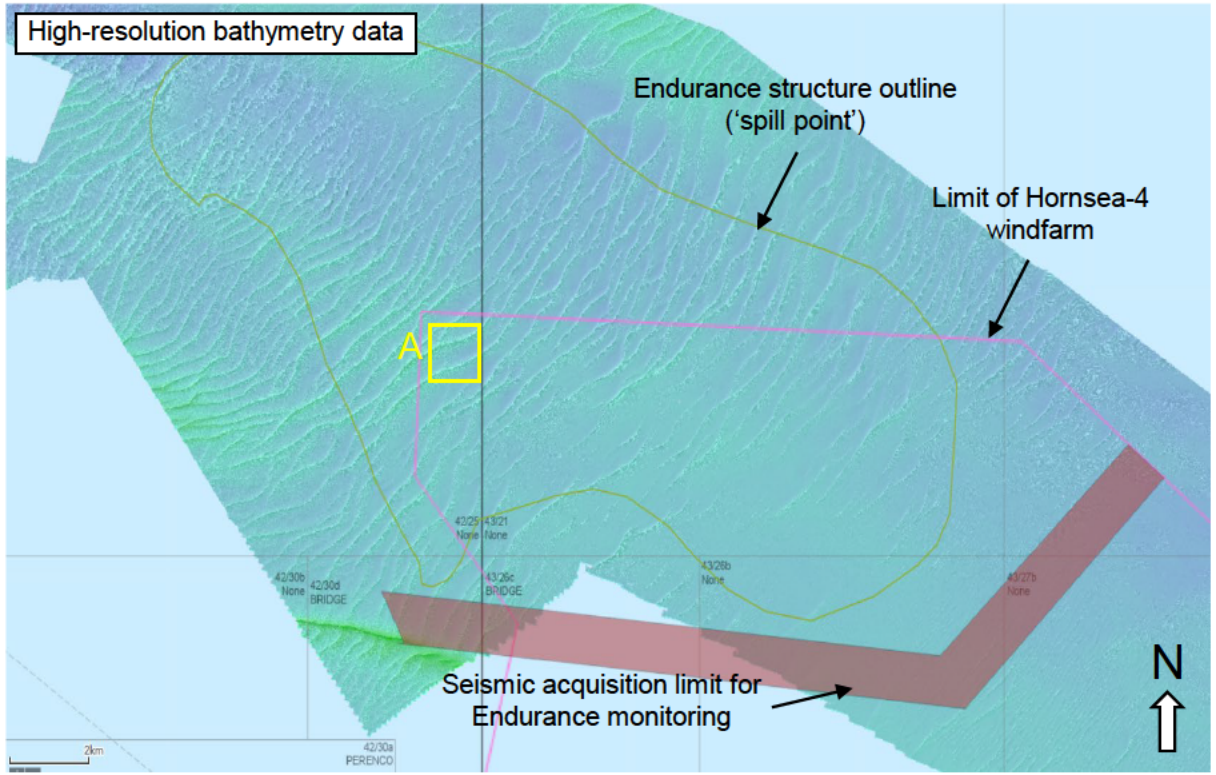
"The third paragraph on page 8 [of bp Technical Assessment] describes the issue of locating CO2 injector wells and brine producer wells and states "……. The 2016 K43 White Rose Field Development report [10] states that Endurance can store up to 2600 MT of CO2. The 50 MT from the White Rose power plant (phase 1) equates to 2% of the storage capacity. The 450 MT described by bp would therefore be 17% of the storage capacity. How has the 70% reduction in available pore space been calculated by bp from the available data?" (at page 18)[66]

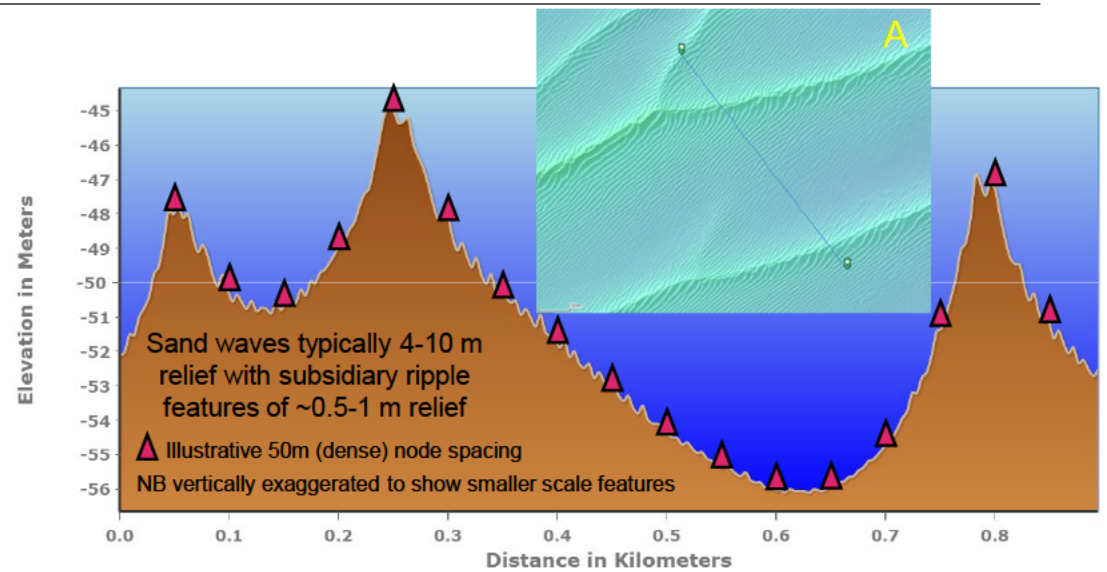
1. The reference in the K43 report to 2600 MT storage corresponds to theoretical storage capacity by replacing 85% the net pore volume above spill point with supercritical CO2 as described in K41 KKD report, i.e. leaving 15% residual water saturation (page 123, section 8.3.13.1 Endurance Maximum CO2 storage Capacity).
2. The 2600 MT represents an optimistic view over 'maximum theoretical Endurance capacity' akin to petroleum charge mechanisms spanning over geologic times. However, Endurance is filled with brine of very small compressibility. Accordingly, significant CO2 injection rates (10+ MTPA) over the project time scale will lead to aquifer pressurization which will need to be actively managed by brine extraction. This will ensure that the reservoir pressure remains below safe operating limits (caprock fracture pressure minus a safety buffer).
3. White Rose did not address the potential issue of additional reservoir pressurization caused by incremental volumes beyond the 53.6 MT that White Rose envisioned as ''*the maximum aquifer pressure increase (no more than 40bar) resulting from the injection of CO2 injection […] is estimated to be substantially lower than that required to fracture the Röt Clay primary seal''* (K43 report, section 1.2).
4. As stated in the K41 report (page 124, section 8.3.13.2), the '*magnitude of pressure increase within Endurance as a result of CO2 injection is strongly dependent on assumptions about pressure communication between the volume enclosed by the most likely structural close contour and the rest of the Bunter Sandstone formation''*. Dynamic appraisal for 3 years at 4 MTPA is therefore planned by NEP to better understand connectivity to the greater Bunter aquifer and future requirement for pressure management for the full-field development at 10+ MTPA.
5. NEP estimate of net pore volume (NPV) above spill point is circa 4.2 billion res. m3 for reference case compared to 4.6 billion res. m3 for base case White Rose (K41 report, p143) so the available pore volume above spill point calculated by bp does not significantly diverge once subsurface uncertainties, structure and reservoir properties are considered. For reference, 100 MT (Phase 1) represents circa 900 million res. barrels equivalent at reservoir conditions at end of injection (for reference NIST webbook CO2 density ~ 700 kg/m3 at Tres = 56 deg C & P = 2500 psia) hence circa 3.4 % of the net pore volume above spill point.
6. NEP estimates that the maximum technical capacity for Endurance for a full field development (which is different from theoretical capacity) is circa 450 MT which corresponds to circa 15% of the NPV above spill point replaced with CO2 based on reservoir simulation studies incorporating model pressurisation and the potential brine extraction potential required.

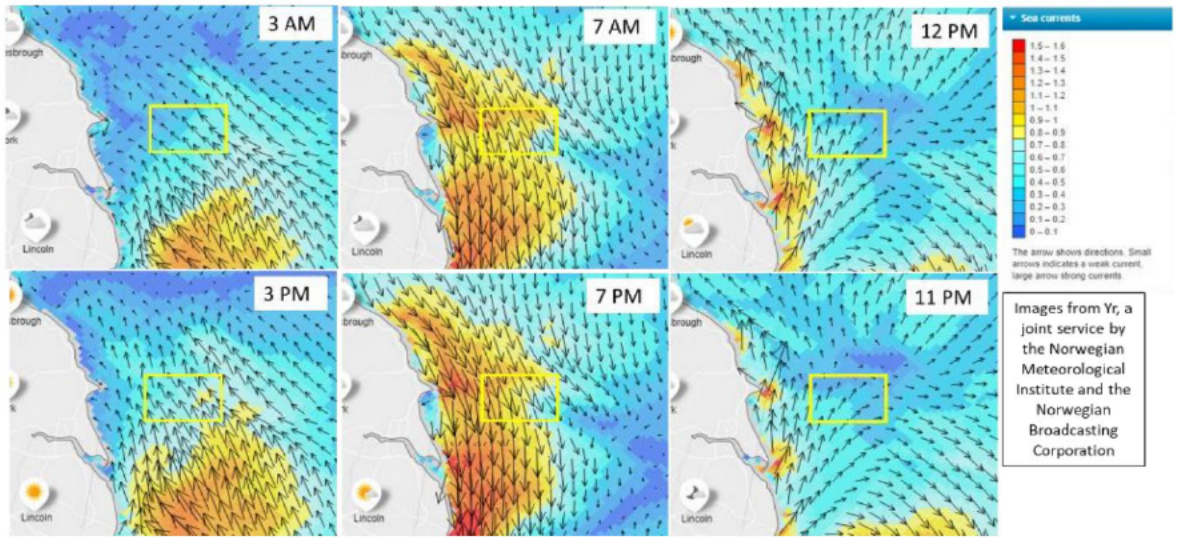
[66] Ibid, electronic page 24

Appendix 2

Endurance: illustration of seabed/metocean conditions







Example of variation in current direction and strength in the Endurance area over a 24-hr period (from bp Technical Assessment, section 7.3.3)

ANNEX 5
FEBRUARY 2021 PRESENTATION (ENDURANCE 4D SEISMIC FEASIBILITY)

Net Zero Teesside & ZEROCARBON HUMBER

NORTHERN ENDURANCE PARTNERSHIP

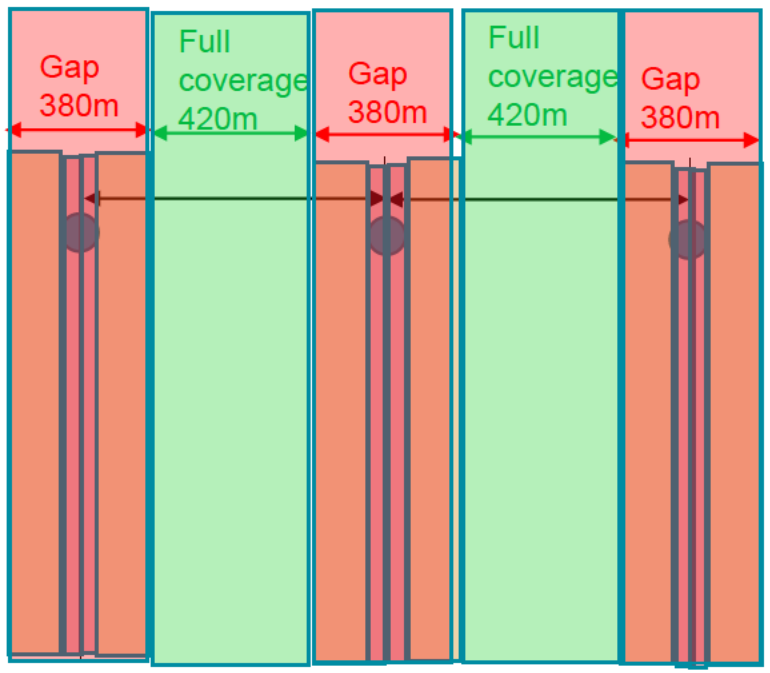
Endurance 4D Seismic Feasibility

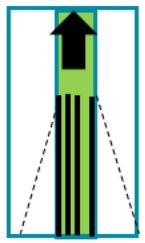
Requirements of seismic acquisition

- FOAK project in the UK
- 4D repeat seismic surveys every 3-5 years
- 3DHR is highly preferable in order to obtain the necessary resolution for intra-reservoir imaging and monitoring
- Compliance with regulations
  - Prove that the CO_2 remains in the store
- Conformance to the model
  - Demonstrate that you understand the reservoir and build up a degree of prediction
- Reservoir management
  - Be a competent and diligent operator of the store
  - Correctly position additional CO_2 injectors for expansion up to 10 Mtpa and beyond
  - Correctly position brine producers to reduce pressure in some areas

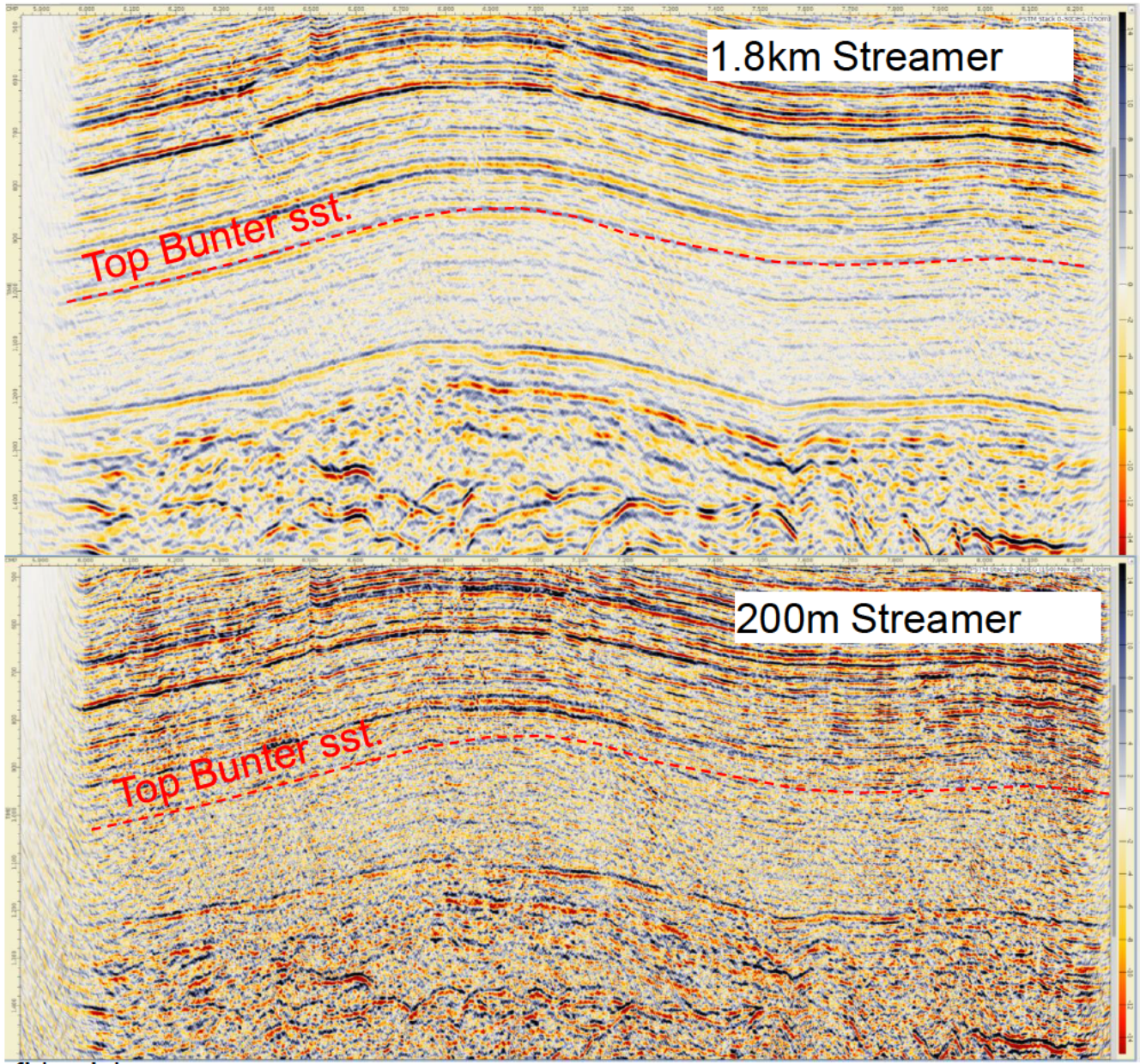
P-Cable Summary

- A short 200m streamer does not provide sufficient Bunter imaging
- Significant gaps in coverage around turbines
- Strong acquisition footprint in seismic images
- Multiple and noise are hard to remove
- P-Cable is not proven for 4D
- Velocity information will be required from additional 4D survey for correct processing
- Would be too high risk, even without the windfarm



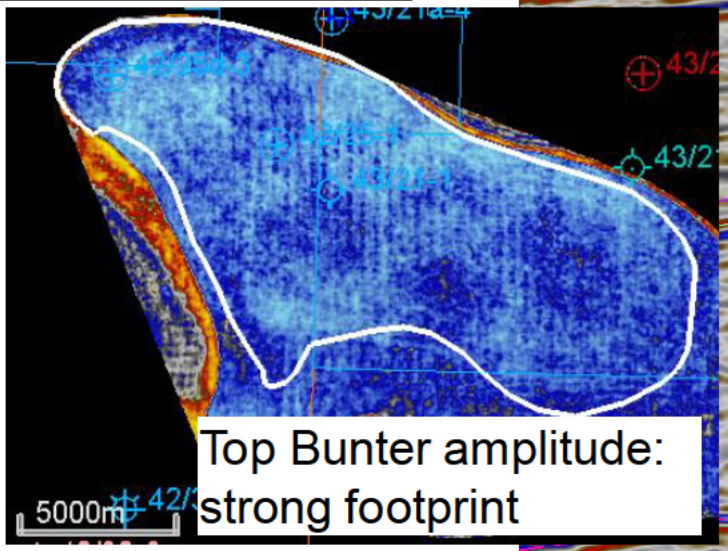


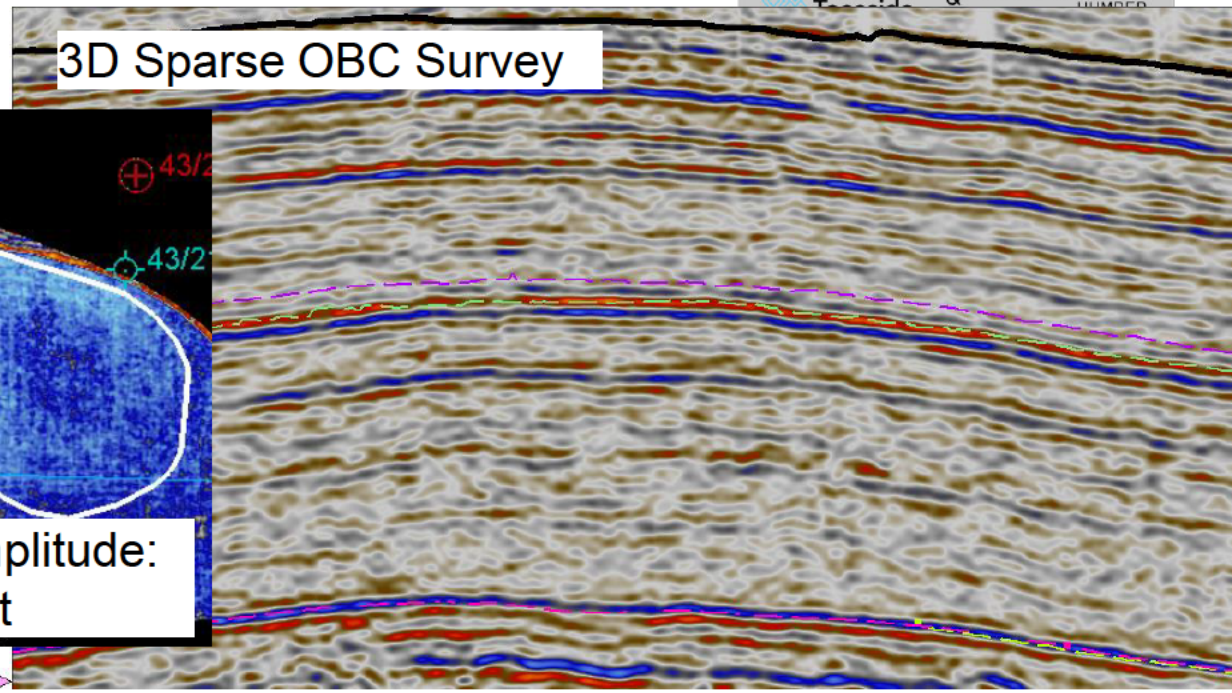
45° allowance for feathering = 140m on 200m streamer

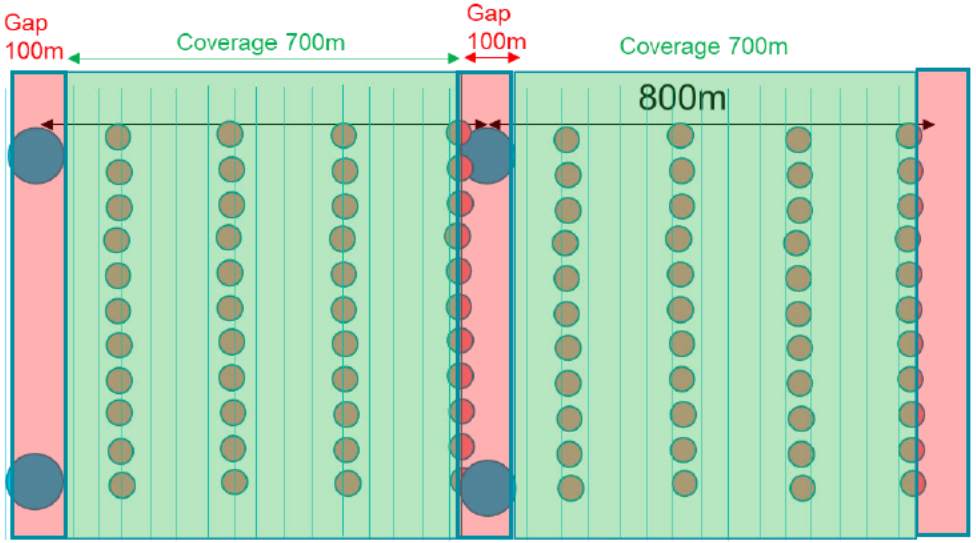


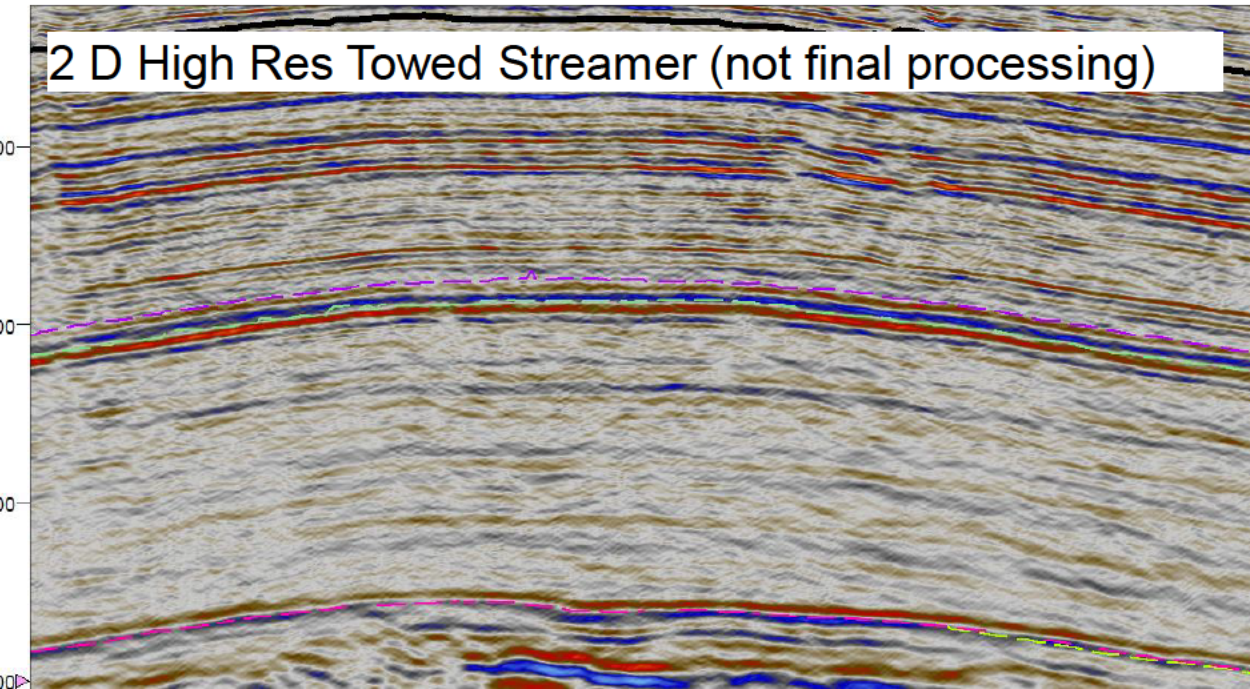
OBN Summary

- A sparse OBN will not provide sufficient reservoir imaging – the Bunter is shallow and fold is too low
- Attributes will have strong footprint
- Mobile seabed will create extra 4D noise
- A dense shooting pattern will be required, which will still be logistically and economically challenged in the windfarm









Seismic imaging

Looking in detail at CO_2 synthetics can help to understand what we need from CO_2 monitoring:

1. Resolution

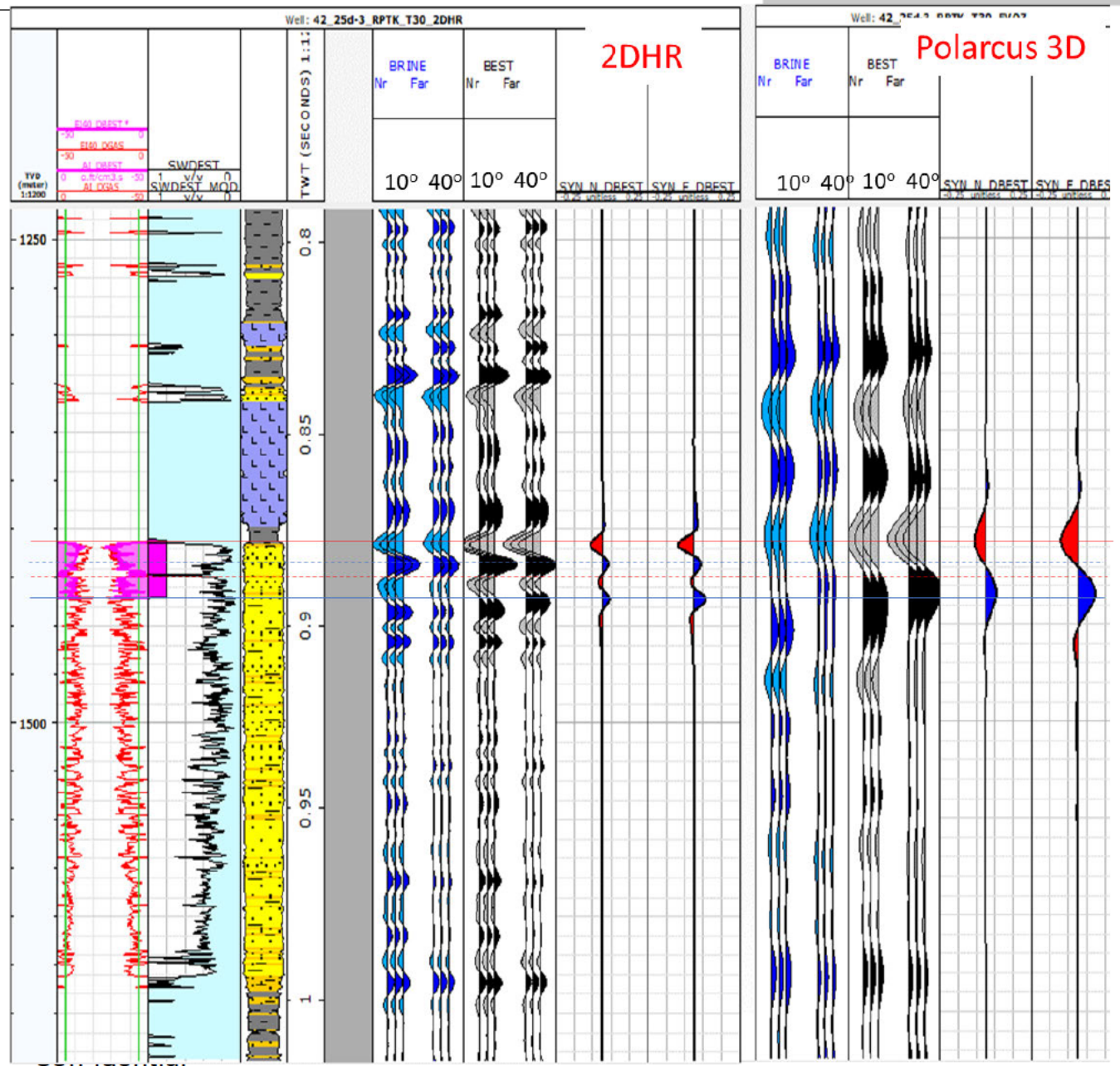
Having higher frequencies allow us to see variations within the reservoir rather than just the top and base of the zone of CO_2 – necessary to be able to understand the movement of CO_2 within the reservoir

2. Offsets

There is a large difference between near and far offsets, the near offsets have a weaker response and the near volume alone may not place the CO_2 boundary correctly

3. Accurate 4D differencing

The seismic alone does not provide a clear image of the CO_2, we need accurate 4D differencing to see this.

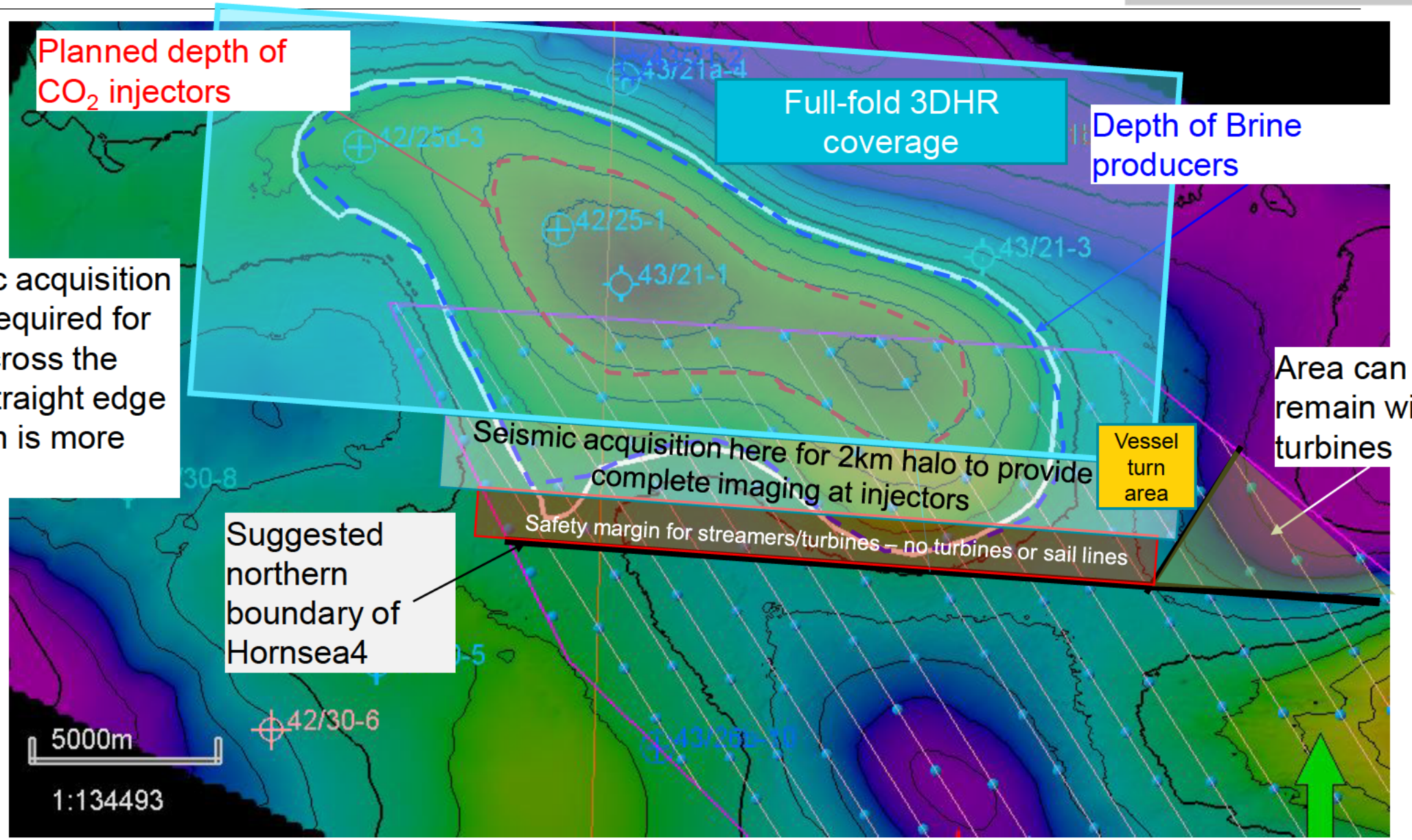


Summary

Survey Type	Imaging quality	4D feasibility	Windfarm compatibility
3DHR (~1.8km streamer)	Very good – high resolution	Good	Not compatible
P Cable (200m streamers)	Poor (Bunter not imaged)	Not proven, difficulty with velocities	Yes, but with significant sampling gaps
2DHR (~1.8km streamer)	Good – but only as an addition. Does not provide 3D coverage	Complicated but possible, would be back-up rather than main option	Yes, but limited coverage, crosslines may not be possible
Sparse OBN (500x500m)	Not sufficient for reservoir monitoring	Good but mobile seabed may create 4D noise	Yes, but shooting pattern may be impacted slightly
Dense OBN (200x50m)	Good	Good but mobile seabed may create 4D noise	Yes, but shooting pattern may be impacted slightly

Extra

3DHR seismic acquisition



For seismic acquisition access is required for the boat across the store – a straight edge of windfarm is more suitable

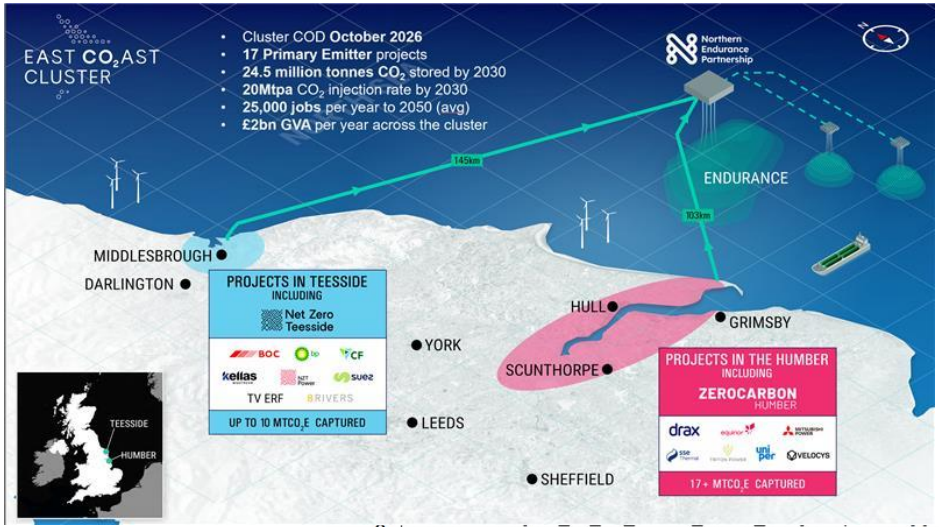
ANNEX 6
OCTOBER 2021 PRESENTATION (ENDURANCE SEISMIC ACQUISITION – TECHNOLOGY SELECTION)

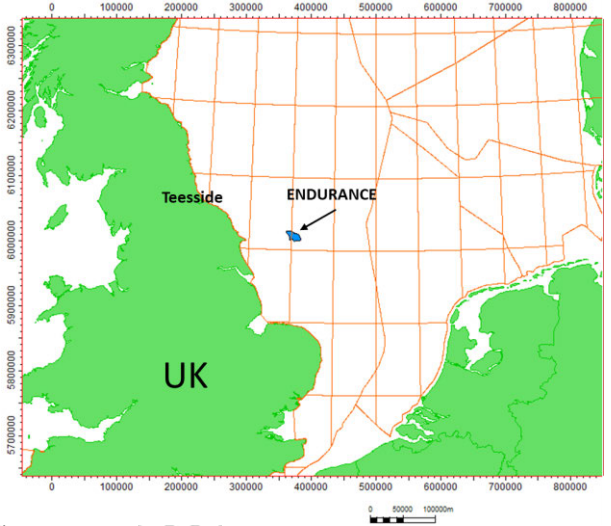
Endurance Seismic Acquisition
Technology Selection

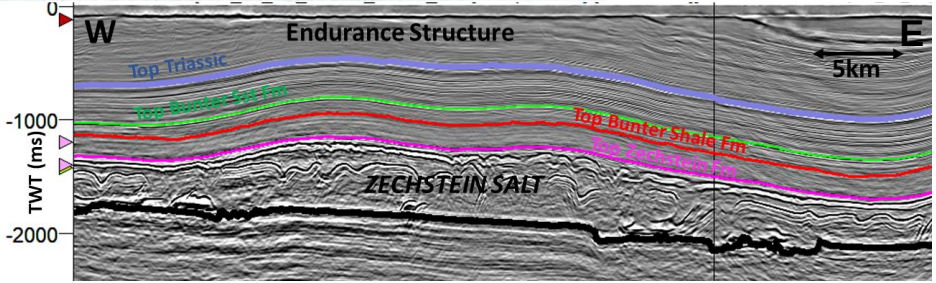
bp will show example images of seismic technology from external vendors - this does not mean that bp endorses these vendors or necessarily plans to use their specific technology at Endurance.

Disclaimer

Endurance

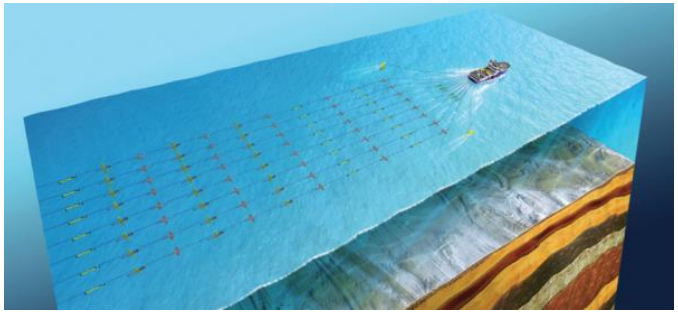






Summary

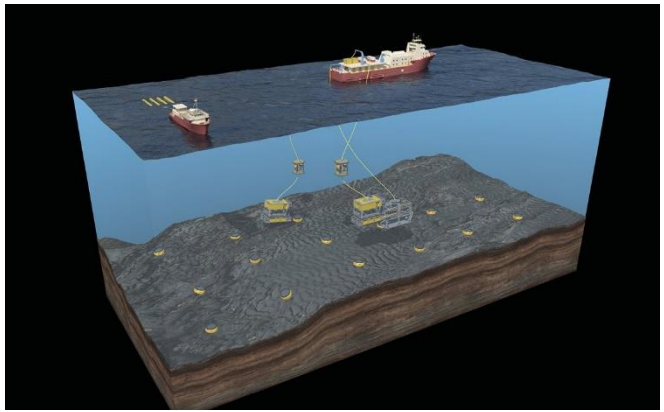
- **High resolution (HR) seismic** will underpin CO_2 plume monitoring and risk management
- **Towed-streamer is the best available technical solution** for acquiring HR seismic at Endurance
- Ocean Bottom Nodes (OBN) have been assessed as **neither the best technical or commercial solution**
  - poorer data image quality
  - unproven use within a windfarm or at such large scale
  - up to 15x cost of towed streamer at required density
- Government and regulators (technical / economic) will expect use of best available seismic technology in the Monitoring, Measurement and Verification (MMV) plan for transition of long-term storage liability to HMG
- Public stakeholders concern on CO2 storage safety was identified in BEIS's CCUS public dialogue (July 2021) and CCUS industry will need to demonstrate the highest standards in safety and risk management
- Additionally, the windfarm presents an **obstacle for rig access and safety exclusion zones** impacting the ability to utilise the full storage capacity of the structure, as covered in previous technical workshops in 2021



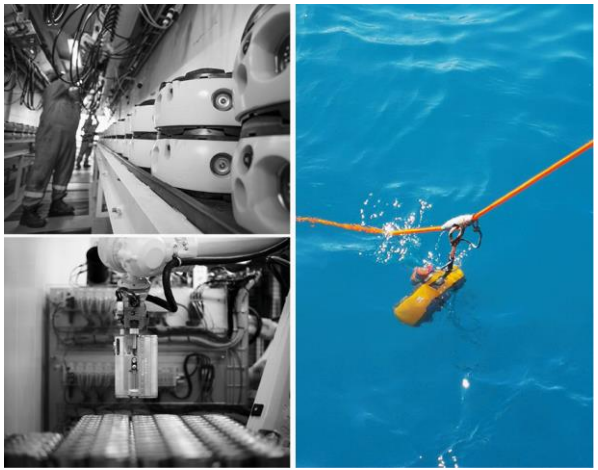
Example towed streamer vessel configuration and illustration of 3D image
Towed Streamer – ION [redacted]

Ocean Bottom Nodes (OBN) Introduction

- bp pioneered the use of OBN for industrial applications, carrying out the first major field trial in 2005
- Since then, bp has been at the forefront of increasing the efficiency and data quality of such surveys and has applied the technology to most of its major oil and gas fields
- OBN surveys typically involve 2 or more vessels to deploy and retrieve the nodes and produce the seismic sound source, and is typically applied at scale for deep oil and gas reservoirs
- OBN is not currently used for acquiring high resolution data over Endurance scale areas



Example ocean bottom node configuration and illustration of 3D image [GEO ExPro - Ocean Bottom Seismic: Robots on the Seabed]



Images showing nodes on vessel and where they are charged as well as an image showing the nodes being deployed by rope [GEO ExPro - Ocean Bottom Seismic: Robots on the Seabed]

bp OBN technology development

- bp are attempting to develop technologies that may improve OBN efficiency and help acquisition within windfarms
- This includes working on and funding Blue Ocean Seismic Services (BOSS) autonomous nodes, for which there are currently field trials in UK waters
- Feasibility studies have also been conducted investigating the use of uncrewed vessels (USVs) for node surveys
  - bp plan to test the source aspect in the Gulf of Mexico in 2022
- However, these technologies are still in early development, with no guarantee of improved data quality and commercial viability. The timing of any viable technological development for commercial use is uncertain.

Autonomous nodes

The **Blue Ocean Seismic Services** Limited product vision of using **Autonomous Underwater Vehicles for seismic acquisition** began in 2017 when Blue Ocean Monitoring Ltd and Woodside Energy Limited jointly funded a development project. bp ventures has now also joined us as a co-shareholder.

Note: Towed streamer (TS) may also benefit from USVs and self-simultaneous sources for TS could reduce TS costs in the future

The role of 4D seismic in the monitoring plan

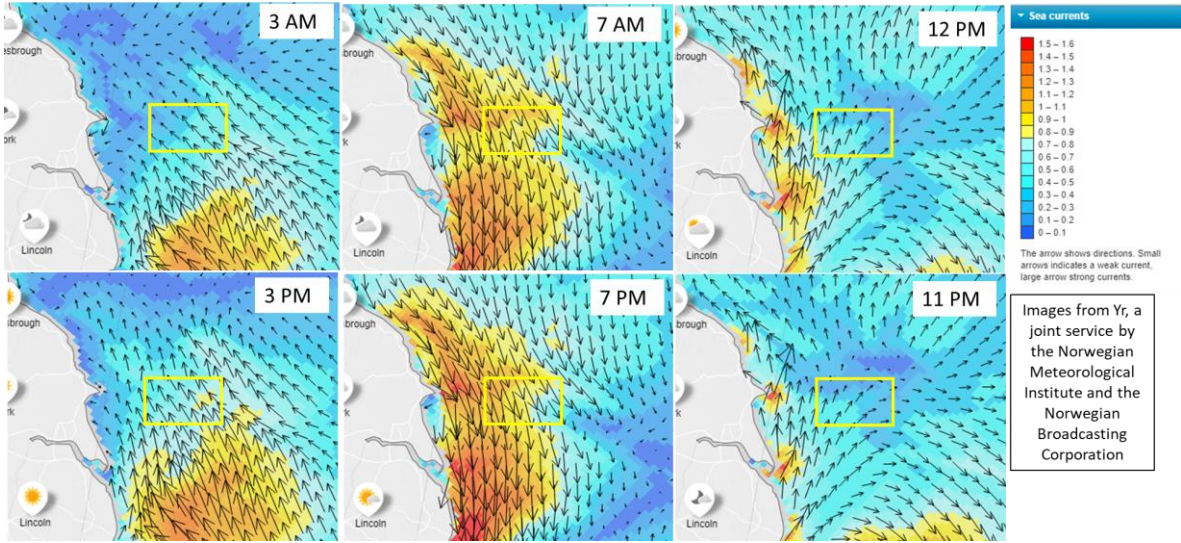
- A monitoring plan (the Monitoring, Measurement and Verification (MMV) plan) requires agreement between the project and the OGA, and outlines how we will ensure conformance and containment of CO_2 throughout injection and after closure
- 4D seismic is the key plume monitoring tool in the MMV plan, nothing else provides a **full 3D image** of the subsurface that indicates where CO_2 is present
- 4D differencing is key to being able to detect the CO_2, imaging alone without differencing will not be able to provide the required information. For 4D differencing to work, the acquisition and processing of the baseline and repeat surveys must be the same.
- Reservoir models are calibrated to 4D seismic results to demonstrate expected CO_2 behaviour and build up prediction of pressures, plume extent and capacity
- As seismic is very sensitive to low concentrations of CO_2, it will show where even small amounts of CO_2 are present outside of the main plume, but high resolution seismic is required to image this at the scale of geological variations

Acquisition Challenges

The windfarm is dense and the currents are strong and highly changeable.

Nodes are deployable but the challenge is the source boat, which will have limited ability to approach to turbines and in strong currents, this will result in:

- Significantly increased time for a survey (possibly stretching over 2 or more seasons), impacting both the fundamental ability to monitor CO_2 and the operational risk profile
- Inability to position source-receiver pairs in the same location over multiple surveys, which will cause poor 4D results
- The mobile sand waves on the seabed have caused significant problems for previous ocean-bottom acquisition in the area

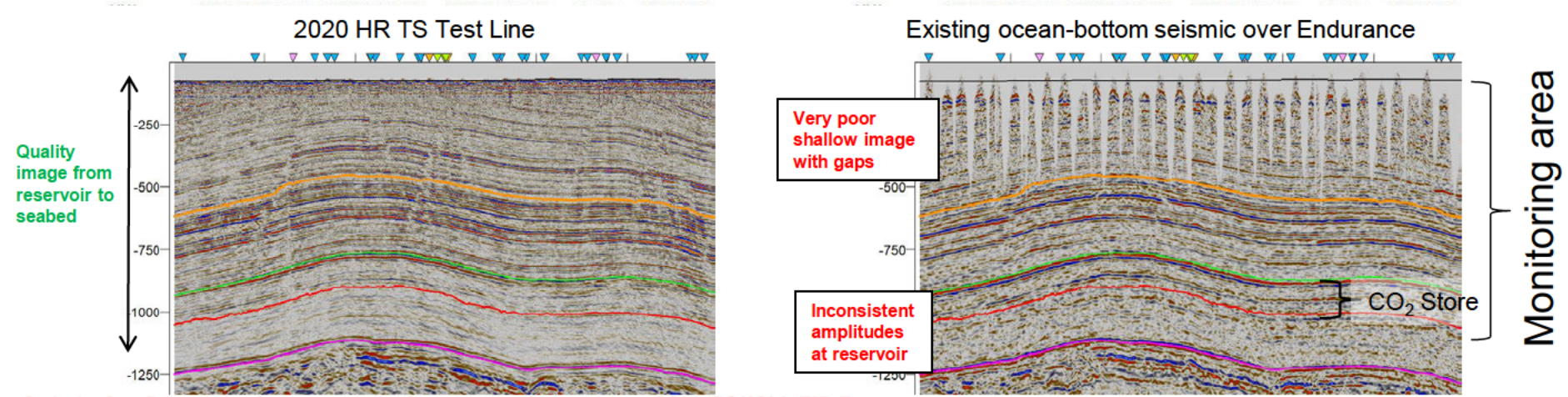


Example of variation in current direction and strength in the area (yellow box) over a 24 hour period (22/09/21)

- Greatly increased risk to crew and equipment (e.g. loss of power or unexpected weather conditions would present high collision risk)

Data Quality Feasibility

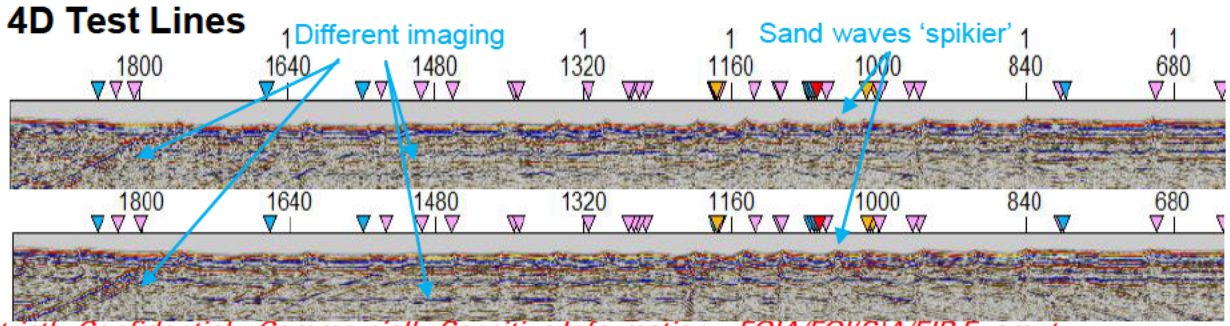
- Standard OBN data performs poorly relative to towed streamer at shallower depth ranges (as at Endurance) due to its lack of near offsets, which are critical for shallow imaging
- The defined monitoring area is seabed to base reservoir
- With irregularly spaced obstacles across the survey area, such as turbines, the imaging will be further impacted due to gaps in sampling – this is additional to the data quality impact from standard OBN on shallow imaging

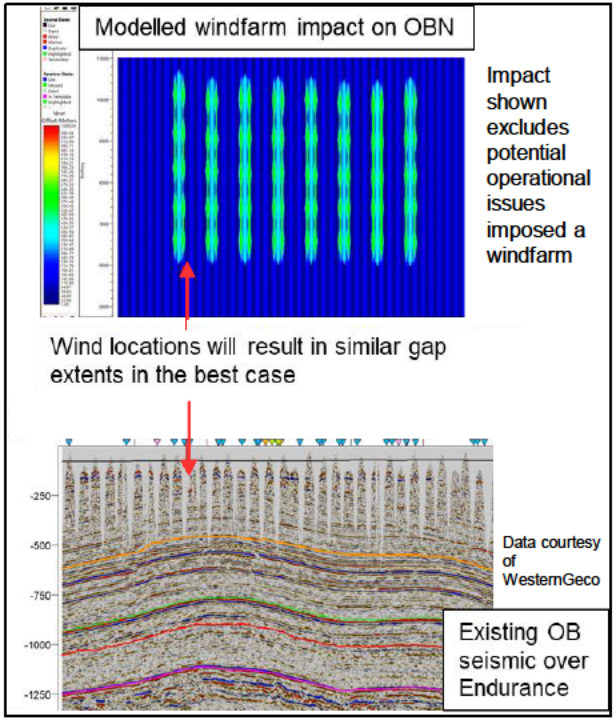


4D Feasibility

The power of 4D is in the difference between the baseline and the monitor. If acquisition cannot be matched exactly, or the data coverage is poor, this 4D differencing will be inaccurate:

- Unable to prove conformance and containment of the CO_2
- False positive 4D signal may wrongly indicate leaking CO_2 and stop the whole project
- Infill drilling of injectors and brine producers cannot be planned safely and efficiently
- No 4D in the shallower sections

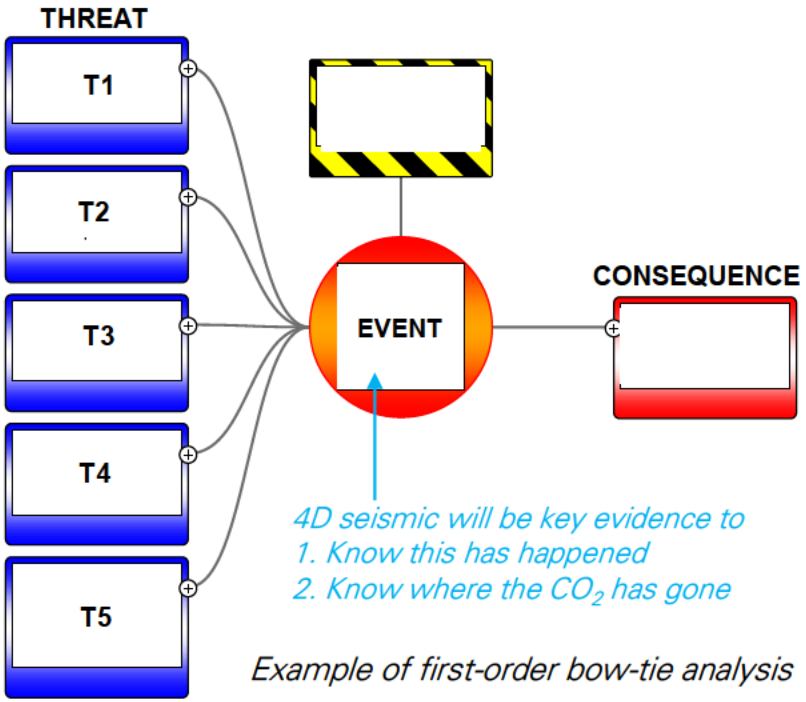




2D/4D repeat lines over Endurance: They should be identical but note the differences in seabed shape and reflectors caused by strong currents

Risk Management

- Risk assessment and management is an integral part of the planning process for a CCUS project
- Our risk management relies strongly on 4D seismic to provide information on the position of the CO_2
- If CO_2 starts to leave the store in small quantities it is likely that only 4D seismic will be able to detect this
- The risk of not being able to acquire 4D seismic, or of the quality of it being poor (e.g. low resolution, variable density impacting amplitudes, poor 4D differencing, noise, problems with processing caused by lack of near offsets), impacts a large portion of the risk management plan
- As a responsible operator, we are obliged to use best available technology. To change this, the operator will have to be instructed by the regulator(s) and reduced data quality for MMV activity explicitly deemed acceptable in the TRI business model



Example of first-order bow-tie analysis

Comparison of Seismic Acquisition Methods

Risk Element	HR Towed Streamer (2km streamers)	HR Towed Streamer in windfarm	Dense OBN (100m x 50m) in windfarm (using current technology)	Dense OBN in windfarm (using autonomous technology)
Safety	Low risk	Not possible	High Risk	Unknown
Technology	Proven		Never done in industry	Not developed yet. Data quality, timing and commercial application unknown
Data Quality	High		Poor shallow imaging, lower resolution reservoir imaging and obstructed by wind turbines	Unknown
Timing Risk	No impact (assuming area is free of turbines)		Significant timing risk around acquisition due to simultaneous operations	Unknown
Chance of Success	High		Moderate/Low	Unknown
Cost of x1 baseline + x5 repeats	~£17M*		Estimated at between £260M - £315M* *(extra time and complexity likely to increase base OBN costs by ~25%)*	Unknown

** present day costs using £1:$1.4 exchange rate*

Commercial / Regulatory / External Stakeholders

- Government Support Package (GSP) from HMG proposes to take on the long-term CO_2 leakage liability from the T&SCo once conformance and containment of CO_2 has been proved and signed off by the technical regular.
  - technical regulator will need to instruct operator **not** to use best available technology
  - T&SCo is not equipped to hold long-term leakage liability

- TRI business model states clearly that all costs have to be efficient and economic and will be under regulatory scrutiny.
  - economic regulator has not yet been appointed and discussions on whether increased costs for reduced certainty of monitoring outputs cannot be undertaken

- Public stakeholders concern on CO2 storage safety was identified in BEIS's CCUS public dialogue (July 2021) and CCUS industry will need to demonstrate the highest standards in safety and risk management

ANNEX 7
NOVEMBER 2021 Q&A IN RESPONSE TO OCTOBER 2021 WORKSHOP

Seismic Monitoring : Ocean Bottom Node (OBN) Workshop - Questions and Answers (Q&A):

Note: Following the OBN workshop the team have endeavoured to provide a more thorough set of replies to the questions asked during the session. This is in addition to the answers provided on the day and should provide further clarity and detail where possible.

Q1: Ronnie Parr
What prevents OBN from delivering high temporal resolution?

A1:
There is theoretically no reason why OBN could not give you similar temporal resolution. However, near offsets play a big role here both for shallow imaging and shallow water demultiplex during processing. To achieve this with an OBN survey, dense sources and receivers are required. Barriers to positioning the receivers and sources will erode near offsets and data density.

The water depth (60m) and shallow imaging requirements (full overburden and reservoir at only ~1000m) strongly point towards towed streamer being the best technological solution for seismic acquisition here. OBN has many strengths but high resolution shallow imaging over large areas is not where it excels.

Q2: Ronnie Parr
It looks like the current is mainly driven by tides. How often will a source vessel be able acquire within a windfarm corridor?

A2:
With respect to currents, we have no experience in acquiring through a windfarm, and to our knowledge this has only been done once in industry, for 2D site survey data through a small windfarm in the East Irish Sea.

Main considerations for safety are current direction compared to acquisition direction and weather/current conditions to ensure that there is no risk of collision if the boat loses power. Computer modelling of wind and tides along with operational tests of the vessel being used will be required to define safe operating limits.

Q3: Mike Branston
Slide 8. Can you comment on the cross line receiver separation of the data shown compared to your planned OBN receiver line interval? How does this compare to the inline image/sampling? Can you also comment on the use of downgoing OBN data for shallow hazard characterisation?

A3: The receiver line interval of the existing OB data at Endurance is 420 m. The expected required OBN line interval for CCUS monitoring purposes would be around 100 m, while going denser in the in-line (e.g. 50 m or 25 m). This incorporates potential usage of the downgoing / imaging with multiples which are still in their infancy with regard to 4D and shallow monitoring.

Q4: Mike Branston
Slide 9. Have you been able to quantify the impact on NRMS on TS v OBN? And how a miss-positioning in xy for the OBN compares to the change in seabed topography for the TS?
Question answered as understood from meeting. Please clarify if more detail is required.

A4
We don't have any 4D windfarm-acquired OBN to use for comparisons on NRMS (normalised root-mean squared, which is used to assess 4D repeatability between baseline and monitor surveys). Within a wind farm there are new noise sources, mis-positioning errors and gaps in coverage which will all impact repeatability.
Both TS and OBN would be impacted by changes in seabed topography, but as that impacts the Z position of the nodes, the impact would be higher for the OBN.

Q5: Mike Branston
Slide 9 - is the 4D change shown in the section a result of the sand dune movement?

A5:
The example was to demonstrate what small changes in shot-receiver pairs can have on repeat imaging. In this example the 2 lines were shot on consecutive days (same sail line in the same direction), so the difference is due to the different feathering of the streamer, even in the shallowest section where the difference is smallest (as feathering increases along the streamer). This example was shown to demonstrate how even small changes in shot-receiver pairs can return different images, and how this would be a problem for 4D. For the OBN in a windfarm the difference would be in shot position (getting accurate repeated shot positions), whereas here, it is the receiver position.
Regarding sand waves - we have not done detailed modelling of what the impact is. Note that sand waves will create issues on 4D signals in general, also for Towed Streamer. However, for OBN you have the additional complication that the actual environment and positioning of your nodes will change which will have a compound impact on your ability to extract a 4D signal.

Q6: Ronnie Parr
Can you clarify the principal risks and uncertainties that you are using seismic monitoring to mitigate?

A6:
The principal uncertainty is the heterogeneity of the reservoir rock, particularly the presence of shale or cemented baffles and barriers (both vertical and horizontal), which will influence the movement of the CO2 in the subsurface.

The principal risk associated with this uncertainty is non-conformance of the injection strategy, i.e. the injected CO2 may not evenly fill the structural closure and could move outside of the spill-point to the south (the shallowest spill point), potentially reaching legacy wells which have no Bunter level containment.

Seismic monitoring helps to mitigate these uncertainties and risks by enabling a 3D image of where the CO2 is moving to within the subsurface. This determines the final planning of positions for new injector wells and brine producers where they will have the most impact on the CO2 distribution and pressure dissipation to ensure conformance of the

project. Seismic monitoring is also the key technology for long-term liability to be able to demonstrate that the CO2 remains safely stored within the storage complex.

Key knowledge documents along with workshop material have been provided to the OGA which outline the seismic requirements for imaging of the CO_2 and the risk management plan. For other parties, the White Rose key knowledge documents which also describe the risks and development of Endurance for CO_2 storage are referenced at the end of this document.

Q7: Graham Gillott
Regarding temporal resolution, it is maybe more accurate to talk about aperture. The basic aperture is indeed affected by offsets, but aperture can be extended significantly by using full wave field imaging. Mike mentions the downgoing and that is part of it.

A7:
If you would look exactly over an OBN line/OB cable and have a source line right over it, then for that location you would get the near offsets. For any layout using current equipment and generic OBN design, the way out of this is dense acquisition. However, in a windfarm, that is not physically possible at all locations. We have seen recent success in structural imaging of the seabed and shallow overburden with multiples/downgoing waves but this has not been tested in a 4D sense yet. None of our projects where we have used this have a 4D signal in this shallow area.

Q8: Mike Branston
Slide 11. can you confirm that the cost comparison is for the whole area (200 sqkm?) and not the area of overlap. Have you considered a hybrid approach at all?

A8:
The cost approximations are not just overlap, but for the required monitoring area, which corresponds to approx. 300 km2 receiver area.

The details of migrations apertures (>1km), safety margins (1km) and overlap between towed steamer and OBN surveys (probably also ~1km to allow for calibration) mean that the full fold TS survey would be limited to 2km+ north of the windfarm boundary. To achieve the full fold OBN/TS overlap plus the OBN migration aperture would then require OBN to start 4km north of the windfarm boundary. This would cover almost all potential injector locations.

Towed streamer is the best technological solution for monitoring Endurance and to use this we need the structure plus a 1km safety margin to be free of wind turbines (scenario 3).

Q9: Mike Branston
Gaps in subsurface coverage is key to the overlap area. Can you quantify the coverage as a function of depth and angle coverage and how this links into the delta amplitude as a function of angle? I've what % of the subsurface are we missing?

A9:
Modelling done to look at near offsets with the wind turbine restrictions on sources and receivers shows that along the line of turbines the closest near offset increase from 30m to over 500m. 500m offset is approximately 10 degrees at 1km depth. In reality we would expect overburden imaging in this scenario to be similar or slightly worse than the

overburden image to the existing legacy OBC data, which would mean shallowest useful imaging would start around the upper Triassic stratigraphy (essentially about half of the overburden would be missing because where there are significant gaps in coverage it will be challenging to pull through a 4D interpretation).

Q10: Mike Branston
There are some very interesting examples in SE Asia showing hybrid design mitigating undershoot in very shallow water. What is different and would need to be considered is depth of monitoring, the objective & coverage requirement.

A10 Charles Cooper
Undershoots where you combine OBN around a platform with a larger streamer survey has not been considered since towing streamers within a windfarm is not seen as practical.

==========

Follow-on Questions Received After the OBN Workshop:

FQ1:
As a follow on to Q6. Can you identify what physical properties and geophysical attributes you plan to monitor in order to mitigate the risks and uncertainties that you highlight in the answer to Q6?

FA1:
We plan to use amplitude from 4D differencing as the primary tool due to the large amplitude change with CO2 replacing brine. Time shifts can be used in the central plume once a large amount of CO2 has accumulated there.

FQ2:
How does the 4D seismic monitoring plan integrate into the wider monitoring plan. E.g. borehole seismic, micro-seismic, non-seismic, well based observations etc?

FA2:
4D seismic monitoring using towed streamers is the primary tool used in NEP's MMV plan. It provides the highest resolution 3D image of the position of the CO_2 in the subsurface and there is no equivalent alternative. Well-based pressure and saturations will aid with calibration.

FQ3:
Do the objectives identified in the answer to Q6 and answer FQ 2 apply across the full monitor area (i.e. seabed to base reservoir – slide 8) or are the monitoring objectives split into sub-zones (e.g. reservoir, seal, near overburden and shallow overburden)?

FA3:
The monitoring area extends beyond the geographical area of the storage complex and from the base of the store up to seabed. Please see definition in the K43 report referenced. Overburden monitoring is required to prove containment and also to provide data in the event of unusual seabed monitoring results. Seabed monitoring will be looking for bubbles, seabed disturbance and changes to water composition. Monitoring data needs to be able to prove or disprove any claims of leakage from the store that could significantly damage the operability of the project. Hence the whole overburden is an important monitoring area.

FQ4:
Can you clarify the assumptions in the estimate of the OBN survey duration and what needs to occur for the acquisition to stretch over two seasons? What is the expected survey duration without these potential delays?

FA4:
2 node vessels, 300 km2, 50 m x 100 m node grid, assuming no windfarms. This results in acquisition of several months, pushing a whole season. Introducing windfarms will add a significant but uncertain amount of time to the duration, hence, acquisition within a single season is not guaranteed.

FQ5:
Can you clarify the definition of HR Towed Streamer. i.e. cable configuration and source output.

FA5:
There is no single set up for HR TS but as a technical checklist we require inline bin size <=6.25m, crossline bin size <=12.5m, 30% of CMP (common mid-point) lines to have near offsets of 30m or less. Water depths are ~60m over Endurance.

FQ6: Can you elaborate on the technical justification of a 100m x 50m receiver deployment and quantify the level of geophysical compromise incurred by relaxing the receiver sampling?

FA6:
The dense OBN deployment is required to obtain good near offsets to facilitate shallow overburden imaging (as water depth is only 60m) and mitigate against the gaps in both receiver and sources due to the wind turbines as described above. When a first survey is acquired, we will be able to assess the results to understand the necessary density for future surveys. If an alternative receiver deployment is being suggested, we would welcome further information and the basis of why the alternative would be practical and economically viable against the characteristics of the Endurance reservoir.

FQ7:
Can you clarify what close pass exclusion zone you have used in the assessment of missing coverage? In the past, a schematic diagram shows a total gap of 100m (diameter) in the source coverage around each turbine. Has this evolved or does this assumption still stand?

FA7:
There is no industry standard for close pass exclusion zones, a risk assessment is required in each case. Internally in bp 100m is standard. Considering the doors/barovanes this means that the missing source coverage will be greater than 100m in diameter, hence for the coverage calculation a diameter gap of 200m was used. This distance may be reduced to approx. 150m, however the strong currents would need to be considered. This would all be subject to a joint risk assessment with a selected seismic acquisition contractor - a 200 m source coverage gap is a reasonable assumption for planning purposes at this stage.

References:

K42 Report:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/531047/K42_Storage_risk_assessment__monitoring_and_corrective_measures_reports.pdf

K43 Report:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/531187/K43_Field_Development_Report.pdf

ANNEX 8
DECISION-MAKING FLOW CHART

NEP/HP4 INTERFACE
SUMMARY DECISION TREE FOR ExA / SoS

(1) TECHNICAL CASE
Does the ExA / SoS consider co-location feasible in the Exclusion Area?

If accepting Orsted's submissions, **YES**

= NEP would not develop the Endurance Store in the Exclusion Area, if wind turbines also located there

If accepting bp's submissions, **NO**

See bp's technical case – e.g.:
REP1-057: 147 – 207
REP3-047: 6 – 36
REP5a-027: 3 – 16
Annex 4 of D6 submission

Outcomes:
- c.70% reduction in storage capacity of the Endurance Store
- ECC Plan rendered unviable
- Loss of 10-11MTPA of CO_2 injection capacity, greater than 50% of the Government's minimum CCUS capacity target for 2030

(2) PUBLIC POLICY QUESTION
Should the NEP project be prioritised in the Exclusion Area, in pursuit of the Government's CCUS targets and wider net zero ambitions?

NO

HP4 prioritised in the Exclusion Area

YES
See e.g.:REP1-057: 122 – 124 (ss. 3-4)

HP4 could still go ahead across the rest of its site with a 2.5% reduction in annual energy production
See: REP1-057: 16 (para. 5.11)

= Exclusion Area necessary

Orsted's approach

Orsted's protective provisions do not provide for the imposition of an Exclusion Area by the SoS or any arbitrator

See e.g. REP5a-027: 12 (paras. 7.7 – 7.8)
35 (paras. 5.10 – 5.14)

bp's approach

bp's protective provisions clearly provide for the Exclusion Area, allowing both the NEP project and HP4 to proceed

(3) INTERFACE AGREEMENT
Should there be a provision addressing the IA's risk of significant compensation as a result of the Exclusion Area?

For information on the risk, see e.g.:
REP1-057: 140 – 142 (s. 15)
REP2-062: 16 – 19
REP5-091: 1 – 4 (s. 3)

YES, remove liability under the IA (new approach)

See REP5a-027: 35 – 36 (s. 6)
Annex 4 of D6 submission

YES, disapply the IA (original approach)

See REP2-062: 16 – 25
PPs at REP4-059: 8 – 11

NO
Risk of compensation unaddressed

See e.g. REP5-091: 3 – 4

- Risk of compensation under the IA removed
- No other rights/obligations under the IA affected
- Compensation payment from bp to Orsted determined by the SoS, factoring in the viability of the NEP project
- **Further input from the SoS required**

= NEP Project + HP4 proceed

- Risk of compensation under the IA removed
- This is a lawful and appropriate action – see REP5a-027: 27 – 36
- **No further input from the SoS required**

= NEP Project + HP4 proceed

= NEP would in all likelihood not elect to utilise the Endurance Store in the Exclusion Area

All submission references are in the format "Examination Library Reference: electronic page numbers (specific section/paragraph, if relevant)"