Offshore Coordination project

Stakeholder engagement Phase 1

December 2020

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Contents

Introduction

The ESO Offshore Coordination project was launched in May 2020 to assess the most beneficial approach, for consumers and coastal communities, to deliver the levels of offshore wind that will be required to meet the Government's commitment to net zero greenhouse gas emissions in the United Kingdom by 2050. As a first step, we have set out the costs and benefits of different integrated offshore conceptual network designs and determined the next steps to unblock barriers to achieving the recommended approaches.

During the twenty-nine weeks that we have worked on the project, we have done so in collaboration with a wide range of stakeholders who have challenged, shaped and worked in partnership with us to deliver Phase 1 of the project. This document sets out:

- what we set out to deliver at the start of the project;
- who we have engaged with in Phase 1; and
- your consultation feedback, including how we have acted upon the feedback received

Please note that:

- We have published all written responses that are non-confidential, and these can be found alongside this document online here.
- In addition to feedback published in this document, you will note that there were some areas of feedback that we could not address as it was not within our remit to do so. Where this is the case, the feedback has been highlighted to the appropriate organisations.

We understand that 2020 has been a challenging year and required different ways of working, so thank stakeholders for taking the time to collaborate with us to set the vision for what we can achieve over the coming years. This should help deliver the government's commitments to net zero and offshore wind targets in a way that minimises the impact on consumers, coastal communities and the environment.

We set out to deliver the four workstreams below in Phase 1 of the Offshore Coordination project. This work has concluded with the publication of our final documentation on 16 December 2020.

1) Technology readiness and cost for offshore integration

2) Offshore conceptual network design, impact on the onshore network and cost benefit analysis

3) A review of the offshore connections process to encourage more coordination

4) Gap analysis and review of existing work to inform a potential Phase 2 of work

Consultation feedback summary

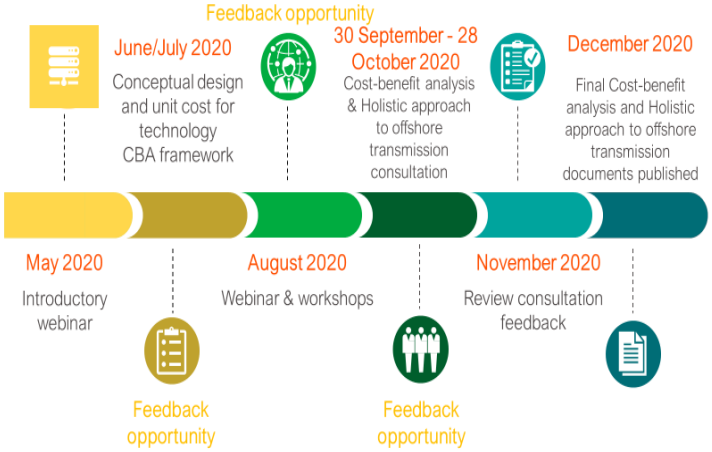
- There is widespread support for offshore coordination. Those representing coastal communities are keen to see progress as rapidly as possible. Other stakeholders cautioned against the difficulty in doing without negatively impacting the projects already in progress and the ability to meet the Government target of 40 GW of offshore wind by 2030.
- A strong message emerged on the need for regulatory and legislative regime changes to enable offshore coordination and a need to consider the practicalities onshore, offshore and with technology maturity.
- Stakeholders were generally positive about the approach we have taken and our findings, with information provided to help refine our analysis.

Who have we engaged with and how in Phase 1 of the project?

During Phase 1 of the Offshore Coordination project we took a collaborative, consultative approach to our engagement. We made a conscious decision at the start of the project in May that we would start the conversations on this with a blank sheet of paper and work together with our stakeholders to find the right solution to the question of whether there is a better approach to connecting offshore energy to the onshore transmission system. We engaged on a weekly basis to seek views, comments and to create together, with the wide range of impacted stakeholders, the vision that is outlined in our final Phase 1 documentation.

Our timelines below show the formal engagement touch points, in addition to these we held over **90** bilateral meetings with stakeholders.

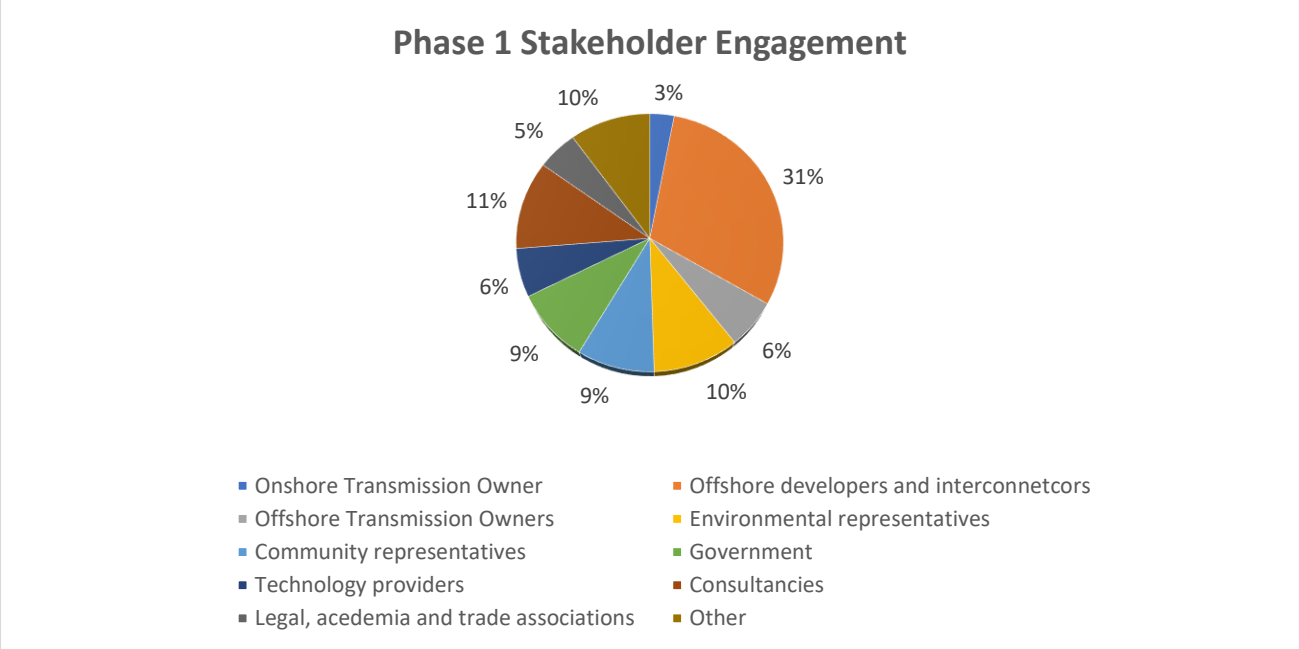
Timeline 1: Technical workstreams



Timeline 2: Commercial workstreams

At the outset of the project we recognised the wide range of stakeholders that could be impacted by the work we have undertaken. Within the challenging timescales of our first phase of work we collaborated with the stakeholder groups shown in **Figure 1**. Throughout Phase 1 we engaged with **99** companies, a full list of the companies can be found at the back of this document.

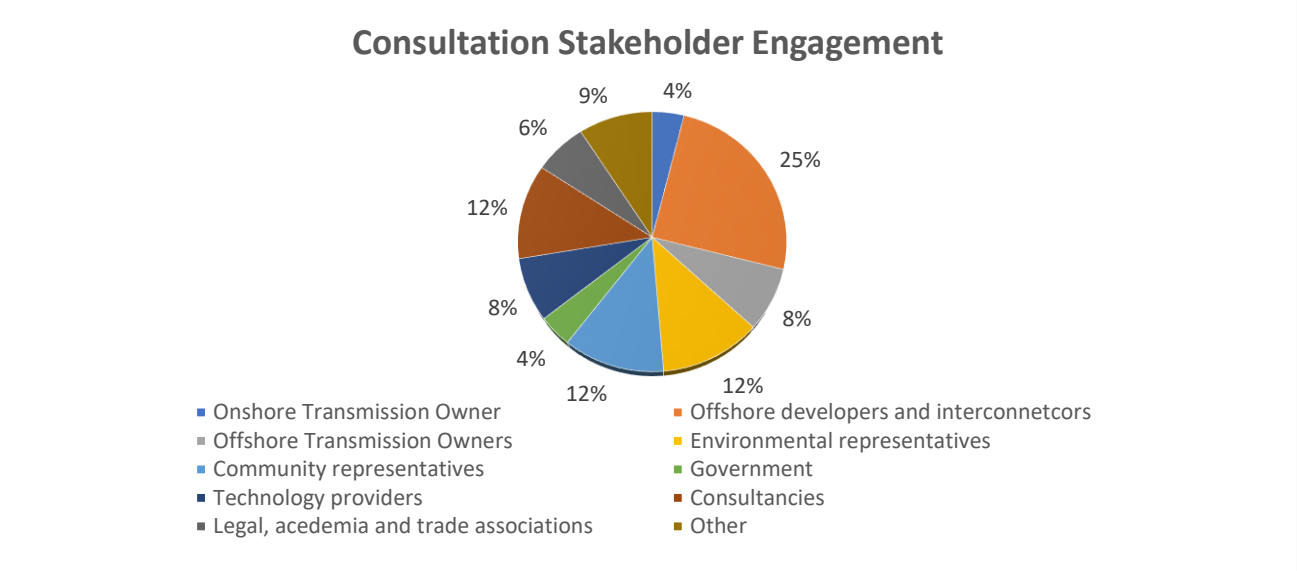
Figure 1



Consultation engagement

In October 2020, we consulted for a four-week period on the Phase 1 findings to date to shape our final documentation. We received **40** written responses, held **11** interactive workshops and engaged with **76** companies. Many thanks to all the stakeholders that took the time to engage in the consultation, this has shaped our final documentation.

Figure 2



Phase 2 engagement

As we finalise our plans for Phase 2 of the project, we recognise and understand that engagement, as we start to turn the vision in Phase 1 into robust delivery plans, is more important than ever. We will continue to build on the engagement to date and look forward to working in partnership with stakeholders as we move into Phase 2.

Cost-Benefit Analysis Report

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Our consultation: You said, we did

Cost-benefit analysis report

During our consultation we received lots of great feedback that has shaped our final documentation for Phase 1.

- **Table 1** sets out the responses to the consultation questions we asked, group by stakeholder type and how we have responded to that feedback. This includes feedback received in writing and in workshops.
- **Table 2** covers questions/areas of feedback received and our responses.

Some areas of the feedback have resulted in amendments or additional analysis. For example, analysis on the size of landing point infrastructure and the impact of moving to a more integrated approach in 2030 rather than 2025.

You will note that we have not been able to progress all pieces of work that could be completed to strengthen the cost-benefit analysis. This decision has been made after careful consideration as to what to focus our time, resource and consumers money on as we move into Phase 2. In particular whether the additional work would change the answer to the question we set out to address in Phase 1, which was to assess whether there is a better way to connect offshore transmission to the onshore network.

Table 1: Feedback provided in response to the questions we asked, grouped by stakeholder types

Question we asked you	Summary of responses received	How we have responded to your feedback
Q1. Do you agree with our assessment of the costs and benefits?	***Environmental*** **Environmental representatives' feedback** 1.Questioned whether the cost of protecting the environment in the status quo approach had been included in costings examples such as consenting and assessments that are carried out individually. 2.Asked whether the risk to marine environment had been taken into account in the integrated approach.	1-3 Whilst it has been put forward by some stakeholders that it would be of benefit to expand the CBA to include a deeper dive into environmental impacts, we will not be able to complete the extra analysis in time for publication in December 2020. We have added an additional paragraph including details of some of the environmental impacts highlighted.

	3.Stated that marine environmental impacts could be improved with an additional KPI. ***Costings used in the Cost-benefit Analysis*** **Offshore Transmission Owner (OFTO) feedback** 1.It is not clear to what degree the consequences in the differences in planned and forced outage rates have been included in the OPEX. 2.The scope of the assessment excludes differences in offshore wind farm array cables (or additional wind farm specific distribution Offshore Substation Platforms) and onshore wider works to accommodate the solutions being set out (Figure 2.6). However, section 2.7.3.6 (p.25) states that "The extra costs of onshore reinforcements are incorporated and reported within KPI CAPEX in section 2.7.2.1." It would be useful to check on consistency and if these differences are material and may influence the conclusions. 3.The discounted CAPEX assessment shows benefits of the Integrated option over the Counterfactual. The report (p.14) states that "the Integrated design has more anticipatory investments in the earlier years than the Counterfactual". This is not apparent from Figures 2-8 and 2-9 for the period 2025-2030 and it would be useful to see an undiscounted delta version.	1.Following this feedback we have added a caveat to the OPEX data to make it clear that it has not been included. 2.We have added clarity in the costs area of the CBA Report based on this feedback. 3. We have added non-discounted cashflow presented in the Appendix of the CBA Report.

	Offshore developers' feedback 1.It would also be very helpful to understand where the cost benefits occur – is it in the wider network or in the offshore links to the projects? 2.In the counterfactual, there are often a number of offshore substation platforms, that can be located closer to the wind turbines, potentially reducing array costs and losses. With the integrated approach, has the increase in array costs been taken into account? Or the need for satellite HVAC platforms to enable interconnection? They may seem small but could have an impact on some of the cost benefits realised in your analysis. 3.The biggest cost benefits seem to be in the Eastern Regions and East Scotland: • As your work aims to consider an integrated approach only for projects that do not currently have a grid connection offer, how will existing projects in these areas be integrated into the whole? Will it now make it very difficult for projects in these areas to consider a radial approach even if it is the only available route to market for them, with the integrated approach dependant on regulatory changes and technological developments. • If the projects in Scotland choose to follow a Hydrogen production and transmission model, how will this impact on the benefits you have identified? • If some areas do not show a cost benefit following the integrated approach then will a radial approach be recommended?	1.We have updated the CBA Report to include a breakdown of the offshore and onshore split of asset CAPEX costs, based on their geographical location. 2. We have updated the CBA Report to add clarity on this assumption. 3.We have published an extra sensitivity study document identifying what the impact would be should we commence moving to an Integrated approach in 2030 rather than 2025. To clarify, the 2025 integration option includes some projects with connection agreements, an integrated approach was taken with projects that have not yet received consent. We recognise that delivering the extent of integration required in this timescale would be extremely challenging and potentially risk meeting the target of 40 GW of wind by 2030. There is therefore a need to deploy innovative and flexible approaches to the connection of offshore wind in the intervening period until a new enduring, integrated, approach is in place. This would be with the aim that, as much as possible, the benefits of an integrated approach can be captured for consumers and communities without placing the delivery of projects underway and the offshore wind target at undue risk.

	4.We believe that quantifying benefits around CAPEX and OPEX only is limiting the outcomes of the CBA. We would welcome the quantification of environmental and system security costs (related to changes in the SQSS and loss of infeed) KPIs where possible in order to give the CBA a wider picture of counterfactual vs integrated. 5.It is unclear how the CBA is considering supplementary costs for lengthy cables in the integrated approach. 6.We are doubtful about some of the outputs of the CBA, for example, the level of curtailments which is slightly higher for the integrated approach than the counterfactual, and the overall carbon intensity which is very similar for both approaches out to 2050. The integrated approach was supposed to support the onshore network to create new ways to take the energy across GB, reducing network constraints and therefore improving carbon intensity. We believe these benefits should be accounted for an integrated approach or, failing that, it should be explained why integration does not achieve wider benefits of boundary reinforcement. **Transmission Owner feedback** 1. Agree that an Integrated approach to offshore network design could result in a lower overall level	4-5. Many thanks for this feedback, we will not be adding any further granularity to the CBA Report, so we can start to progress Phase 2 of the project and starting to bring the vision into reality. 6.We have added clarity to this text on page 25 of the CBA Report. 1.We have updated the CBA Report to reflect the asset size comparison. We have also updated the text within the Report around availability of assets.

	of capital expenditure, but that any savings may not be as significant as indicated. They stated that it is not clear to what extent the CBA seeks to recognise the risk associated with each alternative, in particular the risks associated with HVDC subsea cable systems of higher voltage and/or capacity, and HVDC circuit breakers, as proposed in the conceptual Integrated design. While a material reduction in the volume of assets required onshore to facilitate offshore connections may result from an Integrated approach, a smaller volume of landing points may lead to larger onshore infrastructure developments (e.g. larger footprints/ building heights etc), therefore increasing localised impacts. 2. The CBA report makes reference on page 26 to consequential costs for additional MW behind a transmission boundary, but not the effect of those additional MW upon the interconnection allowance calculation within the SQSS.	2.We have reviewed the wording in this area and updated it following this feedback.
Q2. Do you have any other evidence to support or challenge the assessment made?	1.A Transmission Owner (TO) fed back that it would be beneficial for them to have visibility of a breakdown of the detail used in the 'background' when carrying out the CBA. They also suggested that a whole system (both on and offshore) assessment be worked on as we start to move into moving the vision outlined in the consultation into reality and detailed planning. 2.An Offshore Developer suggested that to build on the analysis, they would like to see additional	1. The network designs assume that all of the reinforcements recommended in the *Network Options Assessment* 2020 are built. In our analysis we have considered all of the options in the NOA, including those with hold and delay recommendations as well as those recommended to proceed. We have published an additional final report annex detailing this information. We plan to look in more detail at the interactions between the onshore and offshore networks in our next phase of work. 2. We do not talk in terms of projects as the idea is to build wind to accommodate wind growth in each offshore area. How this growth is represented by concrete project is outside of

	detail of the assumptions that were used to inform the CBA. They requested to see installed capacity of each wind farm as well as the assumptions to define CAPEX and OPEX associated with the offshore developments.	the objectives the analysis completed. We cannot reflect on the typical size of OWFs. The methodology for developing grid designs based on FES scenario is explained in the Holistic report in detail.
	3.The Crown Estate and NGV provided detailed information on work they have completed that can be found in their full response.	3.Many thanks for the detailed information provided. We have used the information to check our work and verify the results.
Q3. What do you see as the potential impact on the environment of these proposals, particularly the reduction in the number of assets and landing points?	**Environmental representatives' feedback** 1.The cost benefit analysis report continues to clearly highlight that an integrated approach to grid/cabling will reduce environmental impacts. However, that the report should also recognise that the scale of infrastructure required, even with the integrated approach, will have environmental impacts if not carefully planned and managed and;	1.We recognise that without careful planning and managing that there is likely to be an impact on the environment. We plan to work closely with environmental representatives as we progress into Phase 2. We have added wording to the CBA Report to reflect this point.
	2.That within the Cost Benefit Analysis Report the threats to the environment should be listed as has been done in the Social and Local Impacts section.	2.We have added additional text to paragraph 2.7.4.1 following this feedback, in the Comparison of impacts of Counterfactual and Integrated on 'sensitive' areas section.
	3.That a reduction in cabling infrastructure will reduce the risk of environmental impacts and consenting risk - although the impacts of the remaining infrastructure that is deployed may still result in significant environmental effects which will need to be assessed when the location and type of cabling infrastructure is known.	3.We have updated the text in 2.7.41 to add a caveat to this.

	Offshore Transmission Owner feedback 1.An Offshore Transmission Owner noted that in a number of places “number of assets” seems to be used as a proxy for environmental impact, stating that not enough is done in the report to emphasise that this is just a simple proxy.	1.We have updated the text within the Environmental impacts section to add a caveat around this.
	Transmission Owner feedback 1.A TO asked how the KPIs within the CBA are weighted and encourage the ESO to consider making use of the Whole System CBA being developed by ENA Workstream 4.	1.The KPIs are not weighted, we have added additional clarity on this within the Report.
	Offshore developer feedback 1.An Offshore developer questioned, in the broader environmental impact, that it should be possible to evaluate local disruption and the impact on shipping, fishing and tourism industry and capture the financial value of this in the analysis.	1.We have added some additional text following this feedback to the social area of the Report (2.7.4).
	2.Another Offshore developer stated that this has been a high-level study, so full detailing is not being discussed. On the environmental side, they would point out that concerns are not just on landings and onshore disruption, but the cable routes must also not cross any sensitive areas.	2. Many thanks for this feedback, it is acknowledged in 2.7.4.1 of the Report.
	3. The potential benefit from co-ordinated solutions varies over a huge range from area to area (in the report regional capex comparisons range from 0% to 30% capex saving). When co-ordinated offshore connections were last	3. This feedback discusses the potential challenges around implementation approaches. This is not part of the ESO’s scope in our report. We would expect these considerations to be covered as part of the wider OTNR work, being led by BEIS and Ofgem.

	considered (2012), Ofgem expressed concern that any analysis based on an implicit assumption of perfect foresight would almost certainly exaggerate the value of co-ordination. Based on this, it seems that there should be a minimum level of savings below which there is no sense in pursuing co-ordination. It would be useful if a such a minimum savings percentage could be published, so that developers in areas where co-ordination is not a sensible approach (e.g. English Channel and Irish Sea) are not needlessly delayed by having to consider it	
Q4. Do you have any further evidence on the potential social and community impacts of these proposals? We would particularly welcome responses from local authorities on this question	**Transmission Owner feedback** 1.A Transmission Owner feedback that the report seems to suggest that job and skills development have been considered with little description of the methodology applied for this assessment. **Offshore developer feedback** 1.An Offshore developer stated that they anticipate that shared connections will reduce environmental and social impacts. They went on to state that they note the impacts and subsequent views of stakeholders are likely to be dictated by location.	1.We have not used a methodology to actually assess the job and skills development. We compared the impact on jobs and skills based on the number of substations and lengths of lines and cables. 1.We have added additional text to section 2.7.4.1 based on this feedback.

Q5. Where do you see value for further work to build on and test these findings? Either from the proposed list or beyond?	**Environmental representatives' feedback** 1.Further assessment of landing point information, as well as more detail on environmental sensitivities could provide a more realistic picture of what the cost/benefits could potentially be. 2.It is highly likely that even after better grid coordination has been achieved, remaining connections are likely to be concentrated in coastal areas where existing grid connection has already been made. Grid connection on the north Wales coast seems likely to increase significantly under the current approach, but the integrated approach, whilst beneficial overall, is likely to result in additional connections in south-west Wales. These areas either host existing grid infrastructure or are likely to as and when other energy technologies are deployed, and numerous other activities also take place in these locations and that; 3.Greater integration can also result in benefits to the onshore grid network relative to the status quo. However, the reports do not present any analysis of the likely need for upgrades to the onshore network that will be needed to accommodate the large increase in overall power generation. Although this will be dictated by the location and scale of development that results in practice, it would be sensible to develop an understanding of the implications of onward transmission for onshore networks and for this to have an influence on the final designs and grid connection points of the integrated networks.	1. In our new landing points investigation we took a look at this in principle for the technology, but not site by site. This additional work clarifies the infrastructure size comparison. 2.No action has been taken in response to this statement. 3.We note that this statement is discussed within the Security of Supply, Security section of the CBA Report and is noted. The coordination of the onshore and offshore networks will also be explored further in our second phase of work.

	Community representatives' feedback 1.Recommended further detailed work to be carried out by the ESO assessing: • The economic opportunities for coastal communities resulting from an alternative approach. • The wider environmental implications of any new transmission network.	1.Many thanks for this feedback, as noted in the introduction to the CBA Report section we will not be completing any further analysis on the CBA in Phase 2 to best utilise resources and consumers' money.
	Offshore developer feedback 1.An Offshore developer suggested that an assessment on how offshore coordination would work if committed projects up to 2030 proceed as single radial connections would be of benefit. A sensitivity analysis which considers a scenario with radial committed projects up to 2030 would help to highlight the risk (if any) it may present to achieving net zero targets.	1.Following this feedback we have completed this piece of work and the sensitivity analysis can be found here.
	2.Another Offshore developed stated that the CBA is not clear on how it has assessed the cost of the onshore reinforcement needed to transmit the offshore power (ref 3.6.3 of CBA) to the load centres within GB.	2. This has now been clarified in the CBA Report following this feedback.
	Crown Estate feedback 1.The Crown Estate recommend we; (i) place greater emphasis on the environmental, societal and spatial considerations of future	1.We will consider the factors highlighted to a greater extent as we develop more detailed network designs.

	offshore transmission infrastructure in any further analysis, and (ii) considers the costs and benefits of designing offshore transmission infrastructure over a much longer design life, and up to 60 years.	

Table 2: Grouping of comments and questions

Group of questions	Answer
Q1. There is a need to progress from here to ensure regulatory and framework changes required happen in a timely manner.	We understand that some stakeholders wish to see change as soon as possible, whilst others have raised questions around how quickly changes can realistically be made to the regulatory regime and frameworks. Much of the regulatory and legislative change required goes beyond the remit of the ESO, and sits with the Department for Business, Energy and Industrial Strategy (BEIS) and Ofgem. We will be working as a partner within the Government's Offshore Transmission Network Review[1] (OTNR) to complete the areas of work that we are responsible for. We have set out our high level workstreams for Phase 2 of our project within our final documentation and will be publishing further information on this at the start of 2021.
Q2. We note that the vision set out in your consultation is what can be achieved if integration commenced from 2025. This has risks around what can be achieved and impacts live connections.	Delivering the extent of integration required in this timescale would be extremely challenging and potentially risk meeting the target of 40 GW of wind by 2030. We will continue to work with the relevant Transmission Owners (TOs) and offshore developers to deliver and honour connection agreements as per our obligations. Following stakeholder feedback, we have also completed further analysis around what would happen to the benefits case of moving to an integrated approach should this start to happen in 2030.This can be found in our final documentation. There is a need to deploy innovative and flexible approaches to the connection of offshore wind in the intervening period until a new enduring, integrated, approach is in place. Ofgem and BEIS have begun work on pathfinder projects and we will work with them on this. This is with the aim that, as much as possible, the benefits of an integrated approach can be captured for

[1] https://www.gov.uk/government/publications/offshore-transmission-network-review

	consumers and communities without placing the delivery of projects underway and the offshore wind target at undue risk.
Q3. The Cost-benefit Analysis Report provides a high-level benefit case for the move to an integrated approach. We would welcome more work being done on the local supply chain and local benefit calculation.	We appreciate that some stakeholders have put forward that they would welcome more work being completed within the cost-benefit analysis (CBA). After consideration of whether to complete additional analysis, including engagement through the OTNR and the Electricity Networks Stakeholder Group (ENSG) meetings, it has been decided that the ESO will not be completing further analysis as part of the CBA at this point. The objective of Phase 1 of this project was out to answer the question as to whether there is a more efficient way to connect offshore energy to the onshore network. As this has been answered through Phase 1, the focus through Phase 2 of our work will shift into the implementation of how to make the vision a reality.
Q4. We are interested in reviewing more granular commercial information for example on the offshore/onshore split of asset costs.	Following this feedback, we have carried out this disaggregation and the breakdown can be found in our final documentation. You can find it in our final documentation for Phase 1 here.
Q5. We note that an integrated approach will reduce the amount of landing points but would welcome information on the landing point asset size.	We have provided this information in our final documentation for Phase 1.
Q6. It would be beneficial to be clearer with the caveats that apply to analysis and be clearer on the scope as the ESO moves into Phase 2.	We have added caveats and been clearer on our proposals for Phase 2 in several places through the document.
Q7. We note that you havent weighted the Key Performance Indictors (KPIs)	We have not weighted the KPIs. Each KPI within the CBA stands alone as a separate measure. We did not feel it was appropriate for us to weight the KPIs as the ESO.
Q8. It would be beneficial to have used project-specific information within the CBA.	We have not used project specific information within the CBA.

Holistic approach to Offshore Transmission Planning Report

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Holistic Approach to Offshore Planning Report

During our consultation engagement we received lots of great feedback.

During our consultation we received lots of great feedback that has shaped our final documentation for Phase 1.

- **Table 1** sets out the responses to the consultation questions we asked, group by stakeholder type and how we have responded to that feedback. This includes feedback received in writing and in workshops.
- **Table 2** covers questions/areas of feedback received and our responses.

Table 1: Feedback provided in response to the questions we asked, grouped by stakeholder types

Question we asked you	Summary of responses received	How we have responded to your feedback
Q1. Do you agree with our assessment of the key technology and system risk barriers coming from the Holistic Approach to Offshore Transmission Planning Report?	**Environmental representative** 1.The report must recognise the environmental barriers which both cable/grid operators and offshore wind farm developers will face without a change in approach in planning and placement of infrastructure. **Citizens advice** 1.A consumer representative organisation stated that a coordinated approach to offshore wind offers potential efficiency savings but also, due to greater overall forecast uncertainty, greater risk that asset utilisation could be cumulatively less efficient. They expand that the ESO will need to be alert to the array of top-down and bottom-up system development risks the ESO can directly or indirectly influence but may also be outside of its scope. They also highlighted that: • The anticipated efficiencies will be achieved above a threshold of generation delivery, below this level consumers will be overpaying. • The system risk in realising the benefits of the coordination approach will include political and policy impacts beyond the control of the ESO.	1.It is recognised that there will be and are environmental barriers in planning and placing of infrastructure. 1.We recognise and note the feedback provided in response to the consultation. This has been taken into account when developing our Phase 2 scope.

	• A coordination approach will also require close monitoring of how energy demand impacting policies development will impact energy generation requirements of the system • A coordination approach will also require close monitoring of how energy demand impacting policies development will impact energy generation requirements of the system. As a result, there is a key ESO role in working closely with DNOs to understand DSO development and forecasting. • They support the ESO's consumer risk minimisation approach by encouraging a targeted innovation strategy to help progress HVDC circuit breakers. This is a good example of system signalling upwards to policy and governance - as well as downwards to innovators the required role in minimising consumer risk to deliver coordination **Offshore developers' feedback** 1.Can we avoid delays caused by connections being dependent on building new overhead lines? Can co-ordinated solutions help to avoid overhead lines? 2.Can the "bootstrap" HVDC links being developed by the onshore TOs be accelerated? Should there be less emphasis on cost-reduction and advanced technology for these projects, and more on rapid development and construction? 3.HVDC circuit breaker technology may be seen as a barrier by some, their size is tremendous, and the ancillary equipment required is much greater compared to its HVAC equivalent. But in practice, systems so far have managed using converter technology alone with built in redundancy. 4.When an assessment is made to the SQSS that radial connections are also considered as well as integrated as this will also impact costs and will ensure a suitable comparison. 5.Only one of the FES scenarios has been considered for this review and so as we have a very market led approach to the development of energy infrastructure in the UK, it is just as likely that other scenarios are more dominant. A least-worst regret analysis considering different FES scenarios and build-out timelines would be beneficial.	1-2 We will be working closely with onshore Transmission Owners as we move into Phase 2 to coordinate the onshore and offshore networks as we work to make the vision outlined turn into robust plans. 3. We note the view provided and will consider the relative benefits and challenges as we develop more detailed designs. 4. We will take this feedback into consideration as part of the Phase 2 SQSS review. 5.We note that one FES Scenario has been used. We plan, as part of the Phase 2 to use other scenarios as part of the technical work which will be the input Least Worst Regret analysis.

	6.Hydrogen was not considered in the evaluations it may be a substantial energy vector for Offshore Wind in the medium term, particularly where there is existing offshore infrastructure.	6. The Future Energy Scenario considered, Leading the Way, includes an additional 24 GW of offshore wind used directly for hydrogen production and therefore not connected to the electricity network or included in our designs.
	7.Standardisation needs to be considered carefully. 8.One stated that they support the conclusion that the predominant form of offshore transmission will be HVDC based given the technology readiness level of alternatives and the benefits HVDC offers in terms of flexibility of landing points. 9.The HVDC technology to achieve the capacity goals of 2030 is already available, with the barriers to implementation of shared infrastructure being more related to the regulatory framework that prevents anticipatory investment.	7-9 Thank you for your feedback, these views have been noted and we will bring into our next phase of work where relevant.
	10.Beyond 2030, incorporating higher volumes of offshore capacity is likely to require a move to multi-terminal systems. The report focuses on HVDC circuit breakers as a critical technology, but future work should look at interoperability challenges of multiple vendors on the same HVDC system, particularly the ability to have a mix of different vendors' technology within the same HVDC system, and so allow for future expansion without being restricted to a single HVDC vendor. Consideration should be given to the development of common European standards to assist this.	10. We will be considering this area of operability as part of Phase 2.
	11.Agree with the high-level findings of the assessment. It is imperative to maintain a clear pathway and continue momentum to deliver full decarbonisation of the power sector. Supportive of the modular buildout approach, outlined by NGESO, to develop and deploy new concepts. This will enable the future offshore transmission system to develop and evolve in a stepwise manner that maintains investor confidence and reduces the risk of stranded assets. 12. The size and costs of assets will be significant and that this risk is properly acknowledged by decision makers and authorities when deciding the future offshore transmission regime.	11-13 Thank you for your feedback, these views have been noted.

	13.Agreement that HVDC breakers and cabling will be very important technologies for the development of an integrated offshore grid, as offshore wind projects are developed further offshore and capacity requirements increase.	
	14.Prompt action is needed to ensure that necessary amendments to codes and standards are made to enable design and delivery of integrated solutions and that the codes and standards continue to evolve in a nimble way as new best practice develops.	14. We recognise that there is likely to be change required across all of the frameworks highlighted within this response and that there is a high volume of change currently progressing through the modification process. As part of Phase 2 we will be considering the most efficient model to deliver the code change required.
	15. In terms of timing, the cost savings assume that “full integration” starts from 2025. Most projects that will be commissioning in the mid-2020s already have connection agreements and are preparing for the next CfD auction round and are unlikely to be able to deliver integrated connections.	15.We have now completed a sensitivity analysis on starting integration in 2030. This can be found within our documentation here.
	16.Developers have all opted for developer build offshore transmission assets to date. This is driven by the desire to manage risk of designing and building offshore assets to time and spending. Moving to coordinated and shared assets necessarily means that some developers will be exposed to the third-party risk of non-delivery or cost over runs, which could delay the delivery of large offshore wind volume.	16.We recognise that the current regulatory frameworks need to be reviewed in light of the vision we have outlined and that this work will be carried out by BEIS and Ofgem as part of the OTNR.
	17.While there was a desire expressed to not delay projects that are already “in flight”, this seemed to be focussed on Round 3 projects that have been under development for many years. We are aware of newer projects that have already done considerable work on designing their grid connections. These should also be considered “in flight”.	17.We consider all wind farms with a connection agreement to be ‘in-flight’.
	18.Has NGSEO considered whether existing or new technology is available to enhance HVAC export connection capabilities (MW/export cable length) compared to 'current practice' on UK offshore projects thereby optimising landing points and, in some instances, avoiding the need for a HVDC solution?"	18.In the work we considered the existing HVAC technologies and maximised the use of that technology in the existing designs. However, if in the Phase 2 the HVAC export connection capabilities (MW/export cable length) prove to be the best solution, we will be considering that as alternative to HVDC.

	Transmission Owners feedback	
	1.Broadly, yes. However, we would also like to emphasise the need for the corresponding coordination of onshore network development in the coordination and development of the offshore network.	1.We agree that this is required and will be working closely with onshore Transmission Owners as we transition into Phase 2.
	2.Welcomes the work done by NGESO on this assessment, but we believe that without an OFTNO that could lead the coordination and construction of this integrated approach, the timelines outlined may be challenging to meet.	2. Since the consultation we have carried out a sensitivity analysis to consider integration starting from 2030.
	3 Difficult to understand the significance of the cost reductions outlined in the report without visibility of unit cost data and believe that sharing the unit costs and data behind these cost reductions could be a good transparency exercise.	3.Many thanks for this feedback, we are not in a position to publish the confidential cost data. We were transparent during our webinars that we will not be able to share details technology costs, due to the sensitive commercial information that were developed by the consultancy team via their projects. However, the technology costs were verified by Ofgem and Imperial College London as project official project reviewer. We also have Ofgem agreement that we will not be able to share details technology costs publicly.
	4. We are concerned about the expectations that these reports might raise, and how critical stakeholders might react based on the assumptions.	4.Many thanks for this piece of feedback, we have considered carefully the wording and caveats within our final report to manage expectations.
	5.It is important to recognise that HVAC will still have a role to play going forward, as many of the projects already in development for the 2020s are based on that technology, and there will be projects in future where radial connections continue to be the most cost effective.	5. The designs were developed with what we considered was the most appropriate technology. In some cases, this is HVDC and in others HVAC. This will be considered further as we progress into the development of more detailed designs.
	6. Given the current SQSS limitations around offshore connections to 1.32 GW normal loss of power infeed risk, and the fact that a review of the standard would be deemed necessary as soon as possible to investigate the costs and benefits for better alignment of the limits that apply to onshore and offshore networks, we	6. We propose we begin this piece of work at the start Phase 2.

	believe that any outcomes from such an assessment should also inform the CBA at a later stage. **Community representatives' feedback** 1.Do not believe that you can assess technology and system risk barriers coming from the report in isolation of detailed discussion with local community groups. 2. Based on our limited understanding of these issues the problems identified seem to be reasonable. However, we note that the appropriate financial and legal frameworks required, for a meshed offshore grid, also need to be identified and developed, in addition to the technological system operation and system security issues identified in the report. In addition, a coordinated approach raises further issues that will need to be addressed in phase two of the work (all areas listed in full response) 3.Clearly it is the national interest for transmission technology to enable as much of the electricity generated out at sea to be transmitted at distance for use by consumers without significant loss and without resulting in significant environment impact in doing so. The UK has an opportunity to be at the forefront of delivering class leading HVDC transmission technology and the knowledge and expertise gained can be used to support green growth. **Technology providers feedback** 1.Welcome this entire initiative and believes that the method of comparing the available grid technologies to be reasonable. Section 3 shows a good overview where the level of information is good and offers a broad overview of available HVAC, HVDC, and Low Frequency HVAC, however, there is no mention of other technologies which have been proven in an onshore environment and are under development for the offshore environment. **Other** 1.Barriers to Net Zero 2050' should be more fully listed at a high level to define the review starting point. Technology assessment is excellent but fails to address	1.We appreciate this feedback provided. We have engaged extensively with local authorities and MPs within the east coast areas of GB to date. 2.Many thanks for this feedback, this is all noted as we progress into Phase 2 and have passed this onto the OTNR. 3. Thank you for your feedback, these views have been noted. 1.Thank you for your feedback. If you would be happy to provide further details we will consider further as we develop more detailed designs in Phase 2 of the project. 1.This was not considered within the scope of Phase 1 but will be included as we move into Phase 2 of the project.

	land-based OFTO considerations such as likely cable Landing, Cable Trench and Converter Station environmental impacts, and options for mitigating these.	
Q2. Do you have any proposals on how to most effectively bring the technology to market for when needed?	**Stakeholders suggested the following proposals to help bring the technology needed to market:** **Innovation strategy** • An innovative 'learning by doing' approach for bringing this technology to market. This would be most effective in the form of an Offshore Coordination Innovation Strategy with incentives for developers to actively use new technologies, with initial demonstration projects to provide outcomes and lessons learned, feeding into a successful roll-out. Given the limited operational experience, such an Innovation Strategy would help mitigate the risks to developers associated with integrating new technology in the design. • The ESO should work with the industry to identify specific requirements for the UK's offshore grid and establish funding needs for innovation via BEIS and Innovate UK. • Conversations between NGESO, Ofgem and BEIS to develop an Offshore Coordination Innovation Strategy • The challenge for GB is how to incentivise development of the necessary HVDC technology whilst reducing its costs. As with other low carbon technologies, there is a need for upfront subsidy to reduce the costs of a technology which would have benefits globally. A coordinated European approach would be beneficial in sharing the initial costs to develop HVDC technology, with a balance to be struck between the cost and benefits to UK plc of early support from the UK Government. • Opportunity to create a financial framework that appropriately incentivises investment and manages risk for asset developers, for example, through a regulated rate of return as exists for onshore networks **Try and test approach and stakeholder experience including lessons learnt** • Utilising lessons learnt. • Early pathfinder projects, facilitated by flexible regulation, appear likely to be effective in supporting this. • Technology development and market readiness is an area where the onshore (and offshore) TOs are strongly placed to work with the ESO and the ESO should utilise this existing expertise and experience. • There are already good examples in GB of industry stakeholder collaboration to accelerate technology developments and bring down costs and would support demonstrations. • Stakeholders also highlighted the challenges that have been faced to date in the construction of HVDC to date, noting that voltages have remained static for some time. • Offshore wind generators will play a key role in bringing together any coordinated approach that embraces new technologies **Standardisation and clarity on design standards** • Clarity on the design standards would create the right signals and need to be harmonised with Europe to ensure consistency for manufacturers in order to be able to connect to multiple TSOs.	

	• One of the most important considerations during this process is to choose the most effective and efficient grid design without locking in/out a specific technology now. Designing tomorrow's grid using today's technology with an incremental approach is likely to result in a grid that is not fit for purpose in addressing the challenge. • Having a clear target of the amount of HVDC infrastructure that needs to be procured, within the UK or collaboratively across north west Europe, would give HVDC vendors a firm indication of the size of the market which would encourage them to invest in the R&D required to develop the technology. • A future framework needs to continue to have a generator-build option for offshore transmission assets. This would help to overcome some of the counterparty and coordination risks, as well as reduce first-mover risk for new transmission concepts. **Economies of scale** • The cost of offshore wind has been reduced by repeated competitive tendering rounds, and this approach could prove a basis for developing the necessary HVDC technologies for offshore applications, reducing risks for technology developers of a long-term market for their products. • Economies of scale can be utilised to bring down capex costs. ***Many thanks to all that provided ideas and feedback in this area. We are currently assessing what our role should be in bringing technology to commercial use in Great Britain within the OTNR project.***
Q3. Do you have any additional evidence to inform the assessment we have made?	**Evidence supplied by stakeholders (please note this is from all stakeholders and not grouped). We have removed any feedback that has been addressed in other areas of this document and is not in direct response to the Holistic approach to Offshore Transmission Planning area of work.** 1.On technology availability, the study assumes that individual cables with a capacity of 1.8 GW are available by 2040, stating that the current highest individual HVDC cable capacity that is widely available is 1.4 GW. The 1st and 2nd Eastern HVDC link proposals from the SHET area are 2 GW total in a bi-pole configuration (therefore two 1GW cables) for delivery in 2029 and 2031. 2.The UK has a clear target to take advantage of the vast offshore resource available in the North Sea. The development of 32 GW of offshore wind off the east coast (figure 4- 20) highlights the vast opportunity. However, this opportunity should be viewed in a more opportunistic and integrated manner. The report does discuss interconnection with neighbouring grids (27 GW by 2050) but the opportunity to truly take advantage of the offshore resource and deliver this power in an effective and efficient manner has been overlooked. 3.Europe has a target of 450 GW by 2050. This is a target that will not be reached in a nationalistic way. The development of a meshed offshore grid is vital to achieving this target and presents an opportunity for the UK to partake as a net exporter of power. The PROMOTioN project (PROgress on Meshed HVDC Offshore Transmission Networks[2]), which recently ended, pointed to the deployment of a meshed grid in the North Seas. This type of development requires strategic long-term planning and cooperation between all nations involved.

[2] https://www.promotion-offshore.net/

	4.The UK has a vast offshore resource which with the appropriate grid design and implementation, can be exploited in the most efficient manner with deeper interconnection to neighbouring grids. 5.Even without consideration of a larger grid development in the North Sea, higher levels of interconnection with neighbouring grids should be considered in the scenarios. The 30 GW of interconnection envisaged for 2050 is a conservative target which only increases interconnector capacity by 8 GW vs 2030. 6.NGESO should consider all outputs from the recently concluded PROMOTioN project. 7.Multi-Purpose Interconnectors (MPIs) can provide the first step in understanding the multi-terminal HVDC technology challenges. 8.From a cable point of view the ESO should consider conducting its own trial similar to TenneT, with UK installation constraints. 9.Maintaining the current radial HVAC approach may still be more efficient for some project areas as not all developments will necessarily benefit from the holistic approach, particularly where there is no cost and environmental advantages in doing so. Retaining an option on the current OFTO, or similar process, will undoubtedly be a consideration for some developers. 10.We believe that forecasting progress on developments for technology and readiness levels (TRLs), and its associated costs to 30 years ahead is a useful exercise but should always be considered as merely indicative. Technology costs and developments are subject to global signals that are influenced in part by the UK market but never entirely. This highlights the importance of moving across different spectrums of integration between Counterfactual and best case of integrated approach. in order to future proof the coordination approach without overestimate it. ***Documentation put forward:*** • A White Paper titled, ""Promising Outlook for Lithium-ion Battery Technology - Once Risks are Addressed"", • The final report from a two-year study conducted by DNV GL regarding lithium Ion battery safety for the maritime industry. • SuperNode have supplied information in the following three areas below that can be read in more detail in their full response that can be found published alongside this document here *(Superconducting Transmission Schemes, DC schemes & Grid benefit assessment)* ***Many thanks for the evidence and statements provided as part of the consultation. These documents and statements will be taken forward into Phase 2 of the project.***	
Q4. Do you have any further feedback on the report?	**Stakeholders fed back a range of feedback within the answers to this question, this is summarised below per stakeholder group.** **Environmental representatives' feedback**	

	They highlighted that they agree that an integrated approach to an offshore grid network is the way forward but expressed that: 1.There will still be a substantial amount of infrastructure required and that this needs to be carefully planned holistically ensure minimum environmental impact. 2.The technology used, including installation technology, requires careful planning to ensure that the right technology is place in the right location to avoid environmental damage. 3.It is important to spatially allocate where a coordinated offshore network should be placed within this timeframe to reduce the risk to the marine environment and consenting risk. 4.That the approach taken to date has not been successful from an environmental point of view. The poor planning to date has impacted the marine environment. 5.Integration from 2025 should not be discounted and that conversations around what can happen should occur. 6.The environmental implications of any decommissioning or repowering of grid infrastructure must be considered in future studies. **Community representatives' feedback** 1.That the changes proposed need to happen sooner rather than later and that the current approach, given the amount of infrastructure required by 2050, is not sustainable. 2.There needs to be more Research and Development into technology enablement. 3.Consider the impacts on regional infrastructure development when evaluating technical solutions and how a region could become an exemplar and enable a repeatable model to be developed.	1-6. We acknowledge the areas put forward for careful consideration as we move into Phase 2 of the Project. We will be working closely with stakeholders on the planning required. We will be working with Ofgem and BEIS as part of the OTNR on early opportunities to coordinate in the 2025-2030 window. 1-6. We appreciate the need to work at pace to start to take the vision outlined in our Phase 1 Report and bring it to reality and will be working as part of the OTNR to deliver/feed into the workstreams we are responsible for. We recognise the need for an Innovation Strategy and are considering our role in this as part of the OTNR work. We additionally appreciate the amount of offshore wind power that is to be connected in the Eastern Region and recognise the challenge that this will bring.

	4.Consider the future growth of electricity production such as hydrogen alongside technical solutions and potential reuse of existing brownfield infrastructure in any technical solutions. 5.Consider Hybrid grid models, linking market to market interconnectors with offshore wind. 6. The challenge of the installed capacity offshore wind power in the Eastern Regions by 2050 and that it exceeding the ambition set within the remaining five regions identified and what this will be practically in terms of where the connections will be onshore and the impact this will have. **Transmission Owners feedback** 1.Designs only based on one Future Energy Scenario and should be assessed against all scenarios along with a Least Worst Regrets analysis to make the CBA more robust. 2.Highlighted that the 'current individual, radial approach' is not a fair comparison as it is not like that in reality. They noted that any transmission infrastructure already needs to be efficient, coordinated and integrated and that the current investment planning approach does not generally allow for shared use transmission infrastructure to be developed based on only one generator connections. 3. That the counterfactual assumption limitations mean that the savings indicated in the CBA may not be correct and asked whether there is still benefit if the assets used are larger. Another TO stated that the benefits of an integrated solution are likely to be dependent on the specific projects brought forward, their location, capacity and timing. 4.Asked which reinforcements are used within the analysis and highlighted that a TO could deliver the proposals in the integrated approach. In addition, that multi-purpose interconnectors are used in the report and that this may require additional onshore reinforcements.	• 1-7. We will be using a number of different scenarios in Phase 2 for Least Worst Regret analysis • We have used the radial approach as our counterfactual case. Shared network infrastructure will be applied in Phase 2 of the project. • The network designs assume that all of the reinforcements recommended in the 2020 *Network Options Assessment* are built. In our analysis we have considered all of the options in the NOA, including those with hold and delay recommendations as well as those recommended to proceed. We have published an additional final report annex detailing this information.

	5. That technology readiness needs to be explored further within the CBA e.g. cable failure rates and technology availability. 6. One Transmission Owner stated that they support this approach and would emphasise that the development of a more coordinated/ integrated approach to offshore infrastructure must not risk delays to vital reinforcement of the onshore system which is already in development. 7. The detailed report indicates that with the integrated design, the combined power transfer across all considered boundaries is reduced. The basis of this reduction should be made clear however. It is assumed that the relevant boundaries have not been extended offshore to reflect the additional infrastructure proposed (e.g. In Table 7.2). It is also noteworthy that the counterfactual approach is also likely to involve offshore HVDC systems. **Offshore developers and interconnectors feedback** 1.An offshore developer stated that onshore reinforcement can include many of the options included in the integrated approach and that onshore reinforcement is not limited to 'onshore' only today. In addition, that any boundary benefit associated with any integrated offshore network should be appropriately assessed. 2.Has the option been looked at where a National Offshore transmission operator is established rather than the OFTO model? Another noted that the development of an integrated offshore transmission system would be best operated by an integrated control centre rather than multiple control centres which would be costlier to run and that this could be done by way of extension by NGESO. 3.To what degree the impact offshore has been taken into account, noting that the demand grid infrastructure will be taken offshore. 4. It was noted that it's not clear whether the SQSS change highlighted in the Report is assumed in the results or not. It was also suggested that 1800 MW should also be considered in the review of the SQSS rather than the 1320 MW infeed loss. Additionally, it was stated that the SQSS review should look at	1.We will be working with the onshore Transmission Owners as we transition into Phase 2 of the project to coordinate as we start to bring the vision we have outlined in Phase 1 into robust delivery plans. 2. We note these thoughts and that this will be a question that BEIS consider as part of their role in the OTNR. 3.Detailed consideration of what would occur in specific areas offshore has not been considered in this Phase of our project. 4. No change to the SQSS has been assumed in the analysis. The analysis has been completed based on the current version of the SQSS. The review will be taken into account in Phase 2 of the project and this feedback will be considered as part of that.

	redundancy and mitigations planned in case of outages or faults that would affect multiple sites connected to one point of connection.	
	5. That it is likely that upon further scrutiny further significant updates to codes (in particular the GB Grid Code, CUSC, SQSS) are likely to be required to implement an offshore transmission system. The current code change governance procedures are unlikely to be capable of coherently managing the degree and volume of change that will be required given that they are struggling to keep up with the volume of many much smaller changes currently ongoing. Any changes being made to the Grid Code should align with changes the EU network codes to ensure that HVDC vendors are not required to manufacturer HVDC equipment specific for the GB market.	5. We recognise that there is likely to be change required across all of the frameworks highlighted within this response and that there is a high volume of change currently progressing through the modification process. As part of Phase 2 we will be considering the most efficient model to deliver the code change required.
	6. Whilst the holistic report makes mention of the first offshore windfarms to produce hydrogen post 2032, it assumes that such windfarms will not be electrically connected to the GB system. This may not develop in such a binary approach in the real-world, with clusters of offshore wind hubs potentially sharing both electricity and hydrogen onshore connections to increase the utilisation of the available infrastructure.	6.We recognise that when the vision we have outlined starts to move into plans and reality that things may not progress exactly as indicated but that it gives a broad indication of what could occur. We will be considering hydrogen as part of Phase 2 of the project.
	7.That a long term, whole system approach needs to be taken rather than investments being completed based on price signals and that it would also be of benefit to complete least regret analysis.	7.We agree with this statement and that a whole system approach needs to be considered as we progress.
	8. Noted that whilst the report rightly considers interconnection with Continental Europe, both directly and through offshore wind clusters, the next phase of the work should also consider greater interconnection with the Single Electricity Market (SEM) between Northern Ireland and Ireland.	8.We will be considering this as we progress into Phase 2 of the project.
	9. It was suggested that in order to enhance this approach examining the results of TCE Leasing Round 4 and Scotwind leasing results to better determine the geographical distribution of projects, the sizing of each project, and the number of projects in each zone would be of benefit.	9. This more detailed analysis will be considered in Phase 2 although these factors are considered in the development of the Future Energy Scenarios, on which our analysis is based.
	10.With regards to further work examining these findings in the context of an integrated system that also combines with power offtake solutions, for example hydrogen technologies or battery storage would be of benefit.	10. This will be considered as part of our Phase 2 work.

	Technology providers 1.Superconductivity offers the opportunity to have significantly higher capacities of power carried on a single line, which can then be ""split"" 3/4/5 ways meaning that the points of connection with the onshore grid could be smaller in capacity. 2. Welcome the recognition that redundancy in HVDC configuration has value and merits investigation in the same way that bootstraps are considered not to be largest single infeed. This points towards the merits of a meshed offshore arrangement that can handle larger amounts of electricity without compromise. **Other** 1.That the report makes absolutely no mention of a potential off-shore ring main (ORM) as a suitable route for bringing electrical energy ashore with the minimum of damage to the local natural and urban environments.	1.We agree with the statement provided but our analysis has not been completed to this level of detail. 2.Thank you for your views, which we have noted. 1.We have considered the right approach to be able to connect the amount of offshore wind required to meet the government's targets in the best way for consumers, communities and the environment whilst maintaining security of supply.

Table 2: Grouping of comments and questions

	Question	Answer
Q1.	TenneT in Netherlands has commissioned studies for higher voltage HVDC wind farm connections. However, the voltage they are pursuing is 525kV - much lower than the 640kV suggested in the report for UK projects completing in 2030. Furthermore, if a 640kV offshore converter was required for a UK project completing in 2030 it would need to be ordered before any 525kV offshore converters were in service anywhere in the world. Thus, lessons from 525kV could not be incorporated into the design.	In our technology report we do not attempt to fix an "ideal" DC voltage for the functional designs proposed, rather we note the range of voltages available via vendor products as available today and the maturity of these and technologies beyond that. We welcome lessons that may be attained from other parallel European activities as tailored to their own particular project requirements that are occurring in the same time period and would expect lessons learned from these to be taken on-board where possible/ relevant. The conceptual designs are constructed in such a manner that they can be implemented as +/- 525kV HVDC systems as well.
Q2.	Are the technologies proposed in the review (e.g. a +/-640kV HVDC substation at Peterhead) too advanced for projects that are supposed to be complete by 2030 – noting that this means placing orders for the new technologies by 2025 at the latest? We appreciate that the authors of the report were looking for	640KV represents a possible voltage within a range that could achieve the desired 2.64GW bipoles being proposed. We are not seeking to limit or constrain vendor innovation in delivering efficient project specific solutions within the available range. For information around the reasons for assessing these technologies available today as

	advanced technologies that could be applied across the 2030-2050 period, and therefore didn't want to limit themselves by worrying too much about the first few years, but we think that maybe these advanced technologies should only be required for projects that place their orders in and around 2030, and complete around 2035.	sufficiently mature for delivery more detail can be found in the full Holistic Approach to Offshore Transmission Report- We note a range of international precedents for such developments. For example, by 2025 there will have been over seven years of relevant operational service of onshore HVDC circuit breakers. Beyond the enabling activities of the PROMOTioN project we note in our recommendations other areas which may support delivery of this technology.
Q3.	One important risk that was highlighted for integrated networks was multi-vendor systems, particularly for initial projects where the report recommends a single vendor for the whole system. A similar risk is that of multiple meshed transmission network owners closely coupled within a small geographic region. Multiple interfaces between meshed transmission networks with power electronic interfaces increases the complexity of design and construction, and the operational risk of interaction, compared to a single owner model. This could be achieved by extending the licences of TOs to include offshore assets. The report suggests that two 1.8 GW cables together in a bi-pole configuration will allow connections of 3.6 GW, however in reality this isn't true. The ESO, when looking at an offshore connection in the SHE Transmission area that was greater than 1800 MW, did not consider a bi-pole configuration as a suitable option to adhere to the infrequent infeed loss risk of 1800 MW - stating that two fully separate monopole links (i.e. with no common point of electrical coupling and little to no risk of both cables being taken out by an anchor) would be required. Hence two separate monopole HVDC links of 1.8 GW capacity would be needed to connect 3.6 GW. Does the offshore integrated approach account for this and for the 'normal infeed loss risk'?	The integrated and counterfactual designs account for normal infeed loss risk of 1320 MW, respecting the requirements of the current SQSS in respect to securing offshore loss under certain contingency. As noted within the report, bipole configurations of 2.64 GW are adopted i.e. two monopoles of 1.32 GW as a maximum capacity solution for offshore connection. Within the integrated design in the early 2040s a single example of a bipole of 3.6 GW is proposed, supporting a route between an onshore HVDC substation near Kintore and a HVDC convertor connection near Cottam. This route does not lead to a greater than normal infeed risk offshore. The proposed review of the SQSS may allow further adoption of 3.6 bipoles for offshore connection, depending on the outcome This is not an assumption that is adopted for our integrated designs which are respecting the existing codes of standards.
Q4.	On technology availability, the study assumes that individual cables with a capacity of 1.8 GW are available by 2040, stating that the current highest individual HVDC cable capacity that is widely available is 1.4 GW. The 1st and 2nd Eastern HVDC link proposals from the SHET area are 2 GW total in a bi-pole configuration (therefore two 1 GW cables) for delivery in 2029 and 2031.	We note the two eastern projects are included in the base assumptions of this work, as are other Network Options Assessment (NOA), which the work in turn builds upon with its status quo and integrated offshore designs. When 1.8 GW is mentioned, it is this sort of more detailed analysis will be considered in Phase 2 although these factors are considered in the development of the Future Energy Scenarios, on which our analysis is based.in the context of 2 x 1.8 GW cables in a bipole arrangement with an aggregated capacity of 3.6 GW by 2040. This is assuming in the intervening years cable vendor capacity to deliver such arrangements broadens from the 2.64 GW bipoles deliverable by 2030. We are aware of the technologies being used on the Eastern HVDC projects. Our broader approach to 2030 is compatible with these earlier projects.

Q5.	The report states that less power will flow through the onshore network in the integrated option (15- 20% less in 2030, and 35-60% less depending on the region in 2050), however the base counterfactual assumption does not include the 1st and 2nd Eastern HVDC link proposal from the SHET area (as explained above). Further, onshore reinforcement can include many of the options delivered in the integrated offshore approach (also explained above). This is very crude analysis that assumes onshore reinforcement is limited to 'onshore' only, which is not the case today. In addition, any boundary benefit associated with any integrated offshore network should be appropriately assessed. If the offshore network connects to the mainland GB system north and south of the boundary, then the offshore network is determined as crossing the boundary and the associated planned/fault outage of the offshore assets would need to be considered as per the NETS SQSS criteria for design of the main interconnected transmission system or operation of the onshore transmission system.	The integrated and counterfactual designs include both 1st and 2nd Eastern links, together with all other projects in the last NOA assessment. Our analysis datasets start from that foundation of network reinforcement. The pace of offshore development and scale of growth within the Leading The Way scenario is higher than within the scenarios reviewed under the previous NOA. Within our integrated picture from 2025 onwards a different approach to implementing offshore connection occurs which results in a lower onshore boundary power flow. We may no assumptions on the ownership or instigation of the proposed activities within the integrated offshore solutions.
Q5.	Section 3.1.1: We would like to highlight that 275kV HVAC connections are already being offered.	Existing GB projects such as Hornsea (1200 MW, 130 km) use intermediate reactors on dedicated reactive compensation platforms. We have selected 220 KV to contain the cable capacitive charging to practical levels that can compensated by just one intermediate compensation platform. We would also highlight that harmonic instabilities can be worsened at 275 KV. It is also not clear what benefit there would be of a higher voltage substation as it would drive larger switchgear and only allow an increase up to 1320 MW. In a limited number of cases, 275 kV might allow the connection of OSWs without the use of intermediate reactive compensation due to the higher power rating, but this has to be evaluated as the capacitive charging increases in the meantime.
Q6.	Figure 3-1: It is extremely unlikely to place any kind of harmonic filtering offshore, given its considerable impact on the eventual footprint. The figure should be updated to highlight this.	Indeed, it is not usual to deploy harmonic filters offshore. The figure intends to show the possible components offshore even though those are not common practice.
Q7.	Section 5.4.4.2: Modular (lighter) structures that require lower crane lifting capacities are only really applicable to HVAC, which isn't clear in the report. HVDC platforms are significantly heavier than HVAC platforms and will always either need heavy lift vessels or other installation methods, as described in the report.	". We have not done detail analysis on the construction work for HVAC technology and we are expecting to consider those details in Phase 2.

Q8.	Section 5.4.4.2: HVDC ""ancillary assets"" such as filters can certainly be reduced but other assets such as smoothing reactors can't. These are always required in one configuration or another for a number of purposes.	We have considered the reduction of size / footprint of the ancillary assets, not necessarily the complete removal of such devices.
Q9.	Section 5.7.1.2: Going forward with greater coordination and information exchange, how can we ensure that company IP [intellectual property] is sufficiently protected?	This is definitely an important question to be addressed, but not within the scope of our planned work.
Q10.	Table 5-1: Regarding "Improve maturity of multi-vendor, multi-terminal solutions", Actions should be updated to include engagement with stakeholders at a European level, including pilot projects.	We agree that EU level engagement is important for this item, but this is already implied in the three actions listed, albeit in a more generic manner: 1. Engage with stakeholders 2. Identify and support potential pilot projects 3. Experience in operating and maintenance
Q11.	We agree with the findings that high voltage direct current (HVDC) technology will play a key role in achieving the net zero targets for offshore wind. We also note the value that offshore infrastructure would add to the security of the Great Britain (GB) transmission system through diversion of north-south power flows from the onshore infrastructure. While we agree with the key technology assessments, we are of the view that the risk of delays in deployment of DC circuit breakers (DCCBs) by 2030 has not been adequately addressed. DCCBs are a key HVDC technology to facilitate the significant deployment of offshore wind in an integrated approach. Although the report acknowledges the existing barriers for DCCBs on limited standards and specifications it lacks clear steps to address the barriers to meet 2030 targets and beyond. A sensitivity analysis which considers a scenario with limited deployment of DCCBs by 2030 would help to highlight the risk (if any) it may present to achieving net zero targets.	We believe that there is minimal risk that DCCBs will not be deployed by 2030. The European project, PROMOTioN, detailed specification and processes for DCCB for European development. They have also been tested and demonstrated in laboratory conditions. Between now and 2030 we would expect a number of trial installations to be adopted across Europe, potentially including within GB. Whilst we have outlined the reasoning for why we think there is not a high risk in this area we agree that more work needs to be done and is why we recommend further driving the maturity of DCCBs. Should DCCBs not be available, we are confident that an integrated approach could still be achieved whilst appreciating that this would be costlier.
Q12.	There is need to develop adequate technical capabilities in operation and maintenance of meshed offshore networks, including DCCBs, to match skills requirements for 2030 and 2050 targets. National Grid Electricity System Operator (ESO) may facilitate trial projects with transmission owners (TOs) and/or offshore project developers to support the deployment of novel grid technologies We would like to see ESO's leadership in	Other than the DCCB itself, the other components of a meshed DCCB system are in service today in Europe and from these GB and other European established maintenance approaches are available. Our approach has developed HVDC designs grown from that experience which similarly allows insight from the operation of these earlier projects to inform how these more integrated designs may be operated.

	facilitating offshore coordination even for projects contracted to connect by 2030 to an extent possible within the current offshore regime. A considerable number of contracted projects are being developed by the same developer or same group owning multiple developer entities, which would make offshore coordination easier than otherwise. that would enable extensive technology deployment from 2030 onwards for integrated offshore networks.	Workstream 3 of our proposed Phase 2 work covers "Early Opportunities", within this workstream we will be working closely with Ofgem and BEIS to develop Pathfinder schemes which will aim to enable integration as soon as possible.
Q13.	Speaking with manufacturers, we do not agree entirely. HVDC circuit breaker technology may be seen as a barrier by some, their size is tremendous, and the ancillary equipment required is much greater compared to its HVAC equivalent. But in practice, systems so far have managed using converter technology alone with built in redundancy. To reinforce the point, Subsea HVDC cable has excellent reliability performance, as such with the loss of a valve or any fault within the converter system itself, the HVDC equipment is capable of staying in service to a certain degree negating the real need for a breaker. Has NGSEO considered whether existing or new technology is available to enhance HVAC export connection capabilities (MW/export cable length) compared to 'current practice' on UK offshore projects thereby optimising landing points and, in some instances, avoiding the need for a HVDC solution?	Our technology report considers a variety of technology options for HVAC capacity/ distance enhancement (for example Low Frequency High Voltage Alternative Current (LFHVC), superconducting HVAC or Gas Insulated Lines (GIL) use instead of cable, but concludes these solutions are insufficiently mature, and has summarised the associated technical risks, including system risks relating to the stability of such solutions).
Q14.	The main consultation document and supporting detailed reports indicate in several places that the current approach to offshore connection planning and design involves onshore and offshore network designs being considered separately. We would note however that existing processes, and in particular the Connection and Infrastructure Optioneering Note (CION) process, do consider the effect on the onshore system as part of the offshore connection design process. It is also important to note that a coordinated approach is being taken in relation to the development of the Torness to Hawthorn Pit HVDC Link (E2DC) and associated offshore generation connections in the area.	The existing COIN process has delivered value within the context of project by project incremental connection approaches which occur today. We note within the report that further benefits can occur within a holistic review where the integration of projects within more interconnected offshore designs offers greater flexibility in how offshore connections are presented as impacts to the onshore systems, which enables further local and wider connection boundary optimisation to occur onshore. We are assuming that the Torness to Hawthorn Pit reinforcement (E2DC) has been delivered in both counterfactual and integrated illustrative development scenarios.
Q15.	The detail report (Section 7.2.2) states "The new power capacity between the years 2025-2030 in the counterfactual design is connected via HVDC to Cockenzie (Q6) and Torness (S6). In the Integrated design, all the wind capacity Is connected to Blyth (Q4) via HVDC." We do not recognise this counterfactual approach to	Within our Report we have described the process by which as yet un identified projects within the counterfactual are considered on a project by project basis. This involves treating the year on year step change in capacities in these areas not identified to a project in the backgrounds as a dummy project of that capacity.

	accommodate the 2.3GW assumed to connect in this timeframe in the 2020 Leading the Way Future Energy Scenario. Based on the outcome of the CION process, and in line with the contracted position, we anticipate this capacity will be delivered via HVAC connections. It may be appropriate to review what if any impact this may have on the CBA, so as to avoid any risk of adverse outcomes, including delays to the timely connection of offshore wind. We would also welcome further detail on the indication of Blyth as a preferred landing point in the north of England in the conceptual Integrated offshore design.	Should smaller scales of projects emerge it is recognised that different counterfactual solutions may be delivered. The scenario is an illustrative one making assumptions which would necessarily require review as further detail were to emerge.
Q16.	Our understanding is that HVDC converters are not tolerant of vibration, even in the installation phase and so we would ask that National Grid check how would they fare with the installation on a floating platform? Is this something that needs to be addressed for projects in Scotland and deeper water? This was not addressed in the report and research and development aimed at this aspect may be very beneficial to UK and International projects	Modern HVDC converter designs have been much improved, including the vibration tolerance. For example, the Dolwin Beta platform, built as a semi-submersible floating structure, was towed from Aibel's yard in Haugesund, Norway. Following a four-day tow by two tow ships, the platform arrived in the DolWin wind cluster in the German Bight. During such a trip, a certain level of vibration is expected. We believe that the design of valve supporting structure will be further improved to tolerate the constant vibration when installed as a floating platform.
Q17.	Can you confirm what assumptions you have made on the cost of Large Bipole HVDC converter platforms? Currently all offshore converters have been up to 900 MW and there are new projects planned with 1200 MW or 1320 MW but would very large Bipole converters be accommodated on a single platform or across a number of platforms and have you taken into account the additional costs for this? Is there a physical limit to the size of the platforms that can be assumed? We note that you have a recommendation to improve the maturity of technology offshore HVDC converters > 1000 MW but it does not seem to address the platform requirements.	We have not narrowed the most likely design into either of the two alternatives. But our baseline cost estimate assumes that the 2.6 GW will be built as two platforms, with the plus and minus pole placed on each of those, respectively. In such a manner, we can use the cost of two 1300 MW@±320kV platforms to establish the upper bound of the 2.6 GW platform(s). Furthermore, each of the two platforms will be cheaper than the 1300 MW@±320kV as the former has lower DC voltage insulation level, 525 kV as compared with 640 kV.
Q18.	The detailed report indicates that with Integrated design, the combined power transfer across all considered boundaries is reduced. The basis of this reduction should be made clear however. It is assumed that the relevant boundaries have not been extended offshore to reflect the additional infrastructure proposed (e.g. In Table 7.2). It is also noteworthy that the counterfactual approach is also likely to involve offshore HVDC systems.	The current SQSS does not at this time have a concept of an offshore connection boundary and we have not within this work sought modification of the SQSS in this direction. Offshore networks need to conform to connection and operation criteria in the SQSS, which relate to having capacity for exporting the generation to shore, and how outages are handled within the offshore connection infrastructure. In terms of how onshore power boundaries are addressed, with integration comes the flexibility to allocate power from the offshore generation to many landing points. Depending on how that is done, the onshore power boundary flows and the

		interconnection allowance that applies to securing that onshore boundary can be reduced. Any spare capacity within the integrated offshore network at given wind load factors may also be offered up to help meet the onshore boundary need.
Q19.	With regards to considerations on the TRL [Technology Readiness Level] of each technology, low frequency AC is considered, and detail provided on the TRL level even though it is at a relatively low level of TRL 3.	Indeed our assessment gives TRL 3 to LFAC, mainly due to the lack of industrial interest to develop, demonstrate and deploy the technology in the application of offshore wind, which so far stays at the “Experimental proof of concept”. There has been not clear move to the next level.
Q20.	With regards to HVDC circuit breakers (DCCB), the functionality required is to break DC fault currents. This can also be achieved by use of full bridge technology. Working closely with both our project partners and key supply chain partners (Siemens, Hitachi-ABB etc.) it has been concluded that there is no technical necessity to implement DCCBs for multi-purpose interconnectors. Using the same designs as NSL and Viking Link for point-to-point bipole interconnector configurations, any fault which causes a trip of any of the converters leads to a shutdown, reconfiguration and restart. This process happens in seconds and restart time is limited only by the ESO. A fault on proposed MPI projects can be effectively contained by tripping of the AC circuit breakers which connect the generation to the HVDC MPI system and onshore networks. The impact on the onshore transmission and energy supply is no different to that associated with a conventional interconnector or large windfarm connection today. This technical approach delivers the same resilience and reliability as existing interconnectors and does not increase the risk to GB security of supply i.e. is still within the maximum ESO in-feed loss parameters. By connecting windfarms does increase the number of points of potential failure on the MPI, and this could be reduced by adding DCCBs to the MPI but the cost is significant, and the additional benefit (in resilience & reliability) not justified. In a future world where offshore HVDC grids become increasingly interconnected, DC circuit breakers will be required to segregate the offshore grid to reduce the amount of transmission or generation lost as a result of a fault.	We agree that in a non-meshed HVDC systems, sufficient operational security can be achieved without the use of DCCB. The use of DCCB will need to be justified by the CBA (increased cost vs improved availability). In the case of MPI, it might be required as a precondition for the OWF to connect to a pre-existing interconnector.
Q21.	The development of the extruded polypropylene cable technology is limited to one manufacturer, so the statement ‘widening of the supply chain’ is incorrect.	Here we have highlighted the potential of this technology due to the reduced complexity in manufacturing, which has the potential to widen the supply chain.
Q22.	Section 3.1.2.3 states XLPE jointing takes a day. There could be more context to this, stating if this is in comparison to MIND.	To clarify, MIND jointing takes approximately a week, whereas XLPE jointing takes a day.

Q23.	Whilst the report recognises the need for HVDC circuit breakers and cabling, and MPIs are noted on figures 3 and 4, we would be keen to understand to what extent other technology has been considered, such as multipurpose HVDC (bootstraps) or wind farms connecting directly to electrolysers. Equally, to what extent other infrastructure competing for marine seabed space e.g. hydrogen, CCUS has been considered.	You will note within the status quo designs a number of additional complementary bootstrap reinforcements. These are above and beyond the reinforcements already assumed via the NOA reinforcements that are already included in the background. Hydrogen electrolysis is included in the Leading the Way scenario, but within that scenario the generation supporting hydrogen production is considered to be "off grid" and as such both the generation and demand involved is not considered. Our study has not included detailed seabed surveys
Q24.	The progress and developments necessary around technology readiness levels (TRLs), particularly HVDC cables and HVDC circuit breakers (CB), included in the report seem optimistic based on the network design that's being proposed by 2030 (page 13). Achieving this degree of integration will be conditional on reaching a significant level of maturity in regard to HVDC circuit breakers and HVDC cable sizing, that seems challenging for the end of the decade - judging by the TRLs depicted in the report. Clear market signals should be given to manufacturers in advance of integration, supported by an Innovation Strategy that incentivises developers and transmission owners into the live utilisation of key technologies.	Our rationale for TRL levels is consistent with the EU project PROMOTioN's recent assessment, which included TSOs, developers and manufacturers in that assessment process. With regard to HVDC circuit breakers, this is a technology already delivered onshore in three existing projects in China and which the aforementioned PROMOTioN project has advanced the TRL further for European implementation. As such use of these at a technology level is not in our view unreasonable. We agree that an innovation strategy is required and have highlighted this proposal to BEIS and Ofgem. We are considering whether the ESO has a role in this as we develop our proposals for the next phase. .
Q25.	On page 57 under 'Topology - T5' it is stated that "currently capacity is limited to 1.8 GW infrequent loss of infeed". Is that correct? 1.32 GW is referred to elsewhere as the limit.	The maximum onshore loss is 1800 MW, however in the context of offshore design chapter 7 of the SQSS require certain losses be contained to the normal infeed of 1320 MW. Accordingly, you see within the report offshore connections via a maximum monopole scale of 1320MW being used. You will also note that we are proposing to review this area of the SQSS within Phase 2 of the project. For more information on this please refer to the what happens next? section of our final document.

Offshore Connections Review Report

nationalgridESO

Offshore Connections Review Report

During our consultation we received lots of great feedback that has shaped our final documentation for Phase 1.

- **Table 1** sets out the responses to the consultation questions we asked, group by stakeholder type and how we have responded to that feedback. This includes feedback received in writing and in workshops.
- **Table 2** covers questions/areas of feedback received and our responses.

Some feedback touched on pathfinder projects and current connection agreements. We will continue with all connection agreements as per our licence and code obligations unless we are directed otherwise.

Table 1: Feedback provided in response to the questions we asked, grouped by stakeholder types

Question we asked you	***Responses received are below. We will take this feedback into our Phase 2 work as part of the OTNR. Comments indicate that stakeholders agree that work needs to be done on the CION and that assessment of what could be improved needs to be done carefully. We will be communicating more information on our plans in this area in January 2021. Our final Offshore Connections Review Report can be found here.***
Q1. Do you think that if the areas we are highlighting were improved, that the ability to coordinate projects would be significantly increased?	**Environmental representatives' feedback** 1.Review the Connections and Infrastructure Options Note (CION) process to implement improvements that drive and encourage coordination: The Wildlife Trusts (TWT) support this as a short-term action. The CION process requires a greater amount of transparency and there is very little engagement with Statutory Nature Conservation Bodies (SNCBs) and Environmental Non-Governmental Organisations (eNGOs) on the selection of a grid connection that has the least environmental impact. They highlighted the Cable Route Protocol, which The Crown Estate has developed as mitigation for cabling impacts on European Sites, which has resulted in improved dialogue by some developers on grid connection and cabling options. There is an opportunity to build upon this and create a best practice model. This may be in the form of a code. TWT is happy to offer expertise in the review of the CION process and we also encourage engagement with SNCBs and the RSPB. **Offshore developers' feedback** 1. Agree with the concept of regional CIONs as they believe it would support offshore integration. However, for the concept to be effective it needs to address issues around anticipatory investment for shared use offshore assets, including associated regulatory framework. It would also be helpful to learn lessons from the current framework on why coordination has not been done and what can be done to remove those barriers. They also support the proposals to package connection application offers with other processes like seabed leasing and codification of the CION into the Connection and Use of

	System Code (CUSC). This would help to minimise uncertainty for offshore project development. For each area of improvement identified, they would like to see the degree of socialisation and associated benefits. 2. A coordinated approach with the seabed leasing rounds and a review of the CION process would be appreciated. It is important to bear in mind that anything that increases risk for developers on cost or timelines will have an adverse effect on overall system costs. As the CION can be seen as a way to amend connection offers, reducing certainty and stopping developers from having foresight then any adjustments will need to be undertaken very carefully. 3. It says in the report that "The mechanism for how these changes could be implemented is currently being explored, with any proposed changes to the CION only taking place with full consultation with industry and other interested stakeholders". However, we have already seen some changes being made to the CION process without consultation and this is of some concern. 4. Agree that the areas highlighted are a sensible approach, especially in regard to the regional Connections and Infrastructure Options Note (CION), the formalisation of the developer roles and the codification of the CION. However, they believe the proposed areas of improvement should be flexible enough for maintaining the pace of existing project developments while progressing with changes in favour of a wider coordination. Furthermore, it is not entirely clear to them how a regional CION process would work with connection offers. For example, would multiple developers be offered the same coordinated connection agreement? For this case, they believe the second phase of this project will need to work in conjunction with these highlighted areas of improvement in phase 1 in order to provide clarity around regulatory considerations such as liabilities and securities, CMP192 (Arrangements for Enduring Generation User Commitment), and Transmission Use of System Charges. They note that opportunities highlighted for immediate and short-term grid connections may be linked to progress in areas that are going to be progressed in phase 2 of the coordination project, compromising the ability of industry stakeholders to access quick wins for coordination. For example, reopening the CION process without understanding the implications for securities and liabilities, and their impact on projects may be challenging, bringing uncertainty to projects. Reopening the CION also presents significant risks to developers. This needs to be tackled by engaging with developers in the early stages and providing them with transparency regarding the plans, timescales and actions to follow. 5. The BEIS-Ofgem open letter of July 2020 called for interested developers to come forward with co-ordination ideas, some of which might deliver in this timeframe. These pathfinder projects are a positive step but remain challenging. Renewable UK understands that there are developers who would be interested in coming forward are concerned that they may lose the "baseline" of existing grid connection agreements. For the pathfinders to be successful in the medium term, they need to be a "no regrets" option to be explored on an opt-in basis, rather than running the risk of losing all connection agreements. As well as a new grid connection agreement, there will also be planning reviews, impacts on CfD, etc, that will also need to be considered and will make a redesign of connections challenging. To avoid a risk that pathfinders are unsuccessful, but

	existing agreements are cancelled, a “twin track” approach of maintaining existing project development and reforming the process needs to be pursued to minimise project risk and maximise developer engagement. 6. It is not entirely clear how a regional CION process would work with connection offers. For example, would multiple developers be offered the same coordinated connection agreement? They assume that this will build on the existing “coordinated/ integrated offers” process, but it is not clear how the commercial risk and connection development would be managed needs to be understood. 7. We agree that there will therefore be a much greater role for a shadow “offshore TO”, most likely led by one of the developers to plan and deliver, but this requires further work, and is unlikely to deliver solutions before 2030.The ESO should assess whether, or the extent to which the developer, as “shadow TO” would be party to the System Operator Transmission Owner Code (STC), and the impacts that may have on deliverability and risk that parties take on. To maintain confidence of all developers, it will need to be open and transparent system, balancing the commercial interests of all developers and transmission network users. **Offshore Transmission Owner’s feedback** 1. State that it is not clear how the coordinated CION would interact with connection applications from other types of application (e.g. onshore generation, interconnection) and we would welcome further assessment of this. **Consultancies feedback** 1. They believe that steps should be taken to remove or mitigate any new risks, and that no project seeking to connect in the medium-term timescales set out in the consultation should be worse off than it would be under the current regime. Clearly this is a topic for subsequent phases of the project but, for example, this could be achieved in part through amending the eligibility criteria for CfD allocation rounds to allow projects to bid where their commissioning date would fall out with the relevant delivery years if this was due to a change in connection date by NG ESO. **Other feedback** 1. Replacing Generator Build OFTO with an alternative more coordinated approach should be a high priority. A regional approach to Crown Estate releases and CIONs would make sense but the market led approach seems to make it hard to plan efficiently. A solution has to be found to investment in the required infrastructure and clearer leadership and guidance may be needed to achieve this.

Q2. Do you think we have missed anything in our offshore connections review that would add value and increase coordination?	**Environmental representatives' feedback** 1.Natural England welcomes the proposed review of the CION process and the concept of regional CIONs. It would be helpful to provide the proposed 'enhanced visibility to developers of pre-defined areas of connection and capacity, enabling easier access' to other stakeholders too such as Natural England to enable us to provide upfront advice and consideration of the potential environmental impacts in relation to proposed connection points. From their perspective it is important that the CION process does not just allow 'economic and efficient approach to connections' but also sufficiently takes into account potential environmental impacts in order to also arrive at proposed connections and routes which are most beneficial to society in being both economic, efficient and least environmentally damaging. Natural England would value more transparency in the CION process. They would like to see more information on what checks and balances there on the environmental information provided into process by developers and what weight this information is given. They advise that this could be achieved by altering the process to include the need for statutory consultation with relevant stakeholders, such as ourselves. 2.There is an opportunity for the CION process to do more to encourage least environmentally damaging route and landfall, not just most cost effective. Is this where strategic consideration can be given to best landfall/ grid connection points from an environmental as well as cost perspective? **Transmission Owner's feedback** 1.They appreciate the proposals here are in their infancy. In due course, they would like to better understand the ESO's vision and how some of the suggestions to improve analysis cannot be addressed in an improved, expanded CION (which looks at multiple offshore connections) and the NOA. Options from the OFTO, ESO, TO and any 3rd party can be submitted in the current NOA process with further scenario sensitivities considered. The Offshore Connections Review Report outlines a series of improvements to the CION process which would enable coordination of multiple offshore connection projects. The suggestions are that previous CIONs can be reopened, or regional CIONs created (to look at a group of connections), to encourage coordination, and for developers to take an active role in the CION process (through formalising their roles in the STC). This overhaul of the CION would lead to a CBA which considers TO and OFTO solutions (and solutions which are a combination). 2.These improvements to the CION along with the associated consideration of offshore wind in FES and NOA, where the associated CION options (plus further alternative options) can continually be assessed on an annual basis, should lead to an efficient coordinated solution (comprising of TO or OFTO solutions) for connecting offshore wind. The resulting overall solution across the GB system might be a mixture of the so-called 'current radial approach' and 'integrated approach' in this report - an overall solution which is not considered in this analysis.

	Offshore Transmission Owner's feedback 1.A key issue of the connections process is the degree to which the NGESO counterparty has legal certainty over the timescales and costs associated with the connection. The recommendations are to review the CION process for the Short-Term Opportunities, but this review should also include the application, offer, acceptance process too. The review does not seem to have adequately identified the shortcomings in the existing process and these should also be assessed as barriers to the potentially more complex arrangements required for coordination. A non-exhaustive list of aspects to be considered are: lack of legal certainty of application fee outturn cost due to CION costs being allocated to this and no clarity on the timeframe or complexity of this process; ii. lack of legal certainty of connection point or timescales to connect for offers or contracted positions pre-CION; iii. lack of legal certainty (or visibility) of security requirements as they are estimates only and subject to amendment every six months, particularly for the wider works tariff which is announced annually a few weeks before the next six-monthly security level is due. **Technology provider feedback** 1.Coordination across several projects is challenging, as the CION process only considers the most economic and efficient way to connect sole applications, without consideration of coordination with other applications, or the potential for further generation in the future. The above is listed under "concerns and issues with current approach," but there does not seem to be a mention of how potential for further future generation from a site will be considered in the review of the process. **Consultancies feedback** 1. It is maybe too early in the process to develop meaningful estimates, but it would be useful to understand that potential impacts that the proposals could have on the costs of offshore connection for developers. 2. Understanding how the grid connection point-to-point links will evolve over time compared to the development of the coordinated approach will certainly be of interest to developers. The sizing of offshore hubs to cater for future increased capacity and the resulting financial mechanism will have an impact on the planning of projects in development. 3. Additional details on the increased efficiencies and benefits of the direct connection of offshore wind to interconnectors, given that it would be re-exported without having to be routed onshore, would also be of further interest. **Offshore developers' feedback** 1.They believe most of the significant issues/topics are included in this review although, as per previous questions, these are closely linked to workstreams that are included in phase 2 of the Offshore Coordination Project. They encourage

	NGESO to produce a matrix of interactions between different workstreams to support stakeholders' understanding of how/when the different milestones of the Offshore Coordination Project can be facilitated within a defined timescale. This matrix of interactions should also be integrated into a wider roadmap which includes other project milestones, beyond and above regulatory, such as a potential innovation strategy.
Other Offshore Connection Review Report feedback	**Transmission Owner's feedback** 1.Agrees that the current industry framework for connecting offshore windfarms is not fit for purpose and that significant policy change is necessary if we are to achieve Net Zero ambitions by2050. They agree with the efforts to embed greater efficiency, co-ordination, collaboration, clarification and joined-up policy making within the offshore connections space in order to facilitate our common decarbonisation ambitions. They agree that the ESO should focus on a review of the CION process and believe such a review is overdue. 2.They acknowledge that the proposal around regional CIONs could be beneficial in providing visibility to developers of pre-defined areas of connection and capacity. However, they envisage there would be challenges in implementing this and look forward to working closely with the ESO to fully consider the risks and benefits of any such change. 3.Separate individual CIONs always choose the best connection options for each subsequent connection, but the sum of these connections may be less economic that an overall solution. For example, taking two separate offshore windfarms, the most economically efficient connection solution from individual CION CBA's may be at points A and C. However, the overall best solution may be to connect at point B. Therefore, it would seem sensible to aggregate the CBAs during the CION process as part of a regional approach. The current CION approach did foresee the benefits of studying projects together within the CION Guidance Note). 4.The ESO has suggested codification of the CION process. To be able to provide more detailed feedback, they would welcome clarification around the ESOs vision as to what provisions within the STC would need to be changed to accommodate proposed amendments to the CUSC. 5.To assist the ESO's thinking in this regard, they have set out the challenges we are faced with in our BAU operations: • Multiple parties seeking connection for same seabed leasing site where, under industry codes, they are obliged to treat each as a separate and distinct development and, hence, create a 'queue'. Given that only one party can ever be awarded the lease option, this might result in misleading connection offers for the parties that are not first to apply. • The CION can take in excess of a year to produce an offer and considers each application in isolation from others. Industry codes oblige an offer to be made within three calendar months resulting in an initial offer constrained by those obligations and typically significantly modified following the CION.

	• Application fees, charges (see later section on charging in north of Scotland) and securities requirements in the north of Scotland are all high and a potential barrier to entry, particularly for new technologies. • The focus is currently on the making of offers, however to achieve the timeline for connection there is a growing urgent need to progress the associated design and pre-consenting works for both onshore and offshore grid infrastructure. Co-ordination and collaboration will be critical to optimise the available cable corridors and landing points, taking account of the views of local stakeholders. • When there are multiple parties looking for a connection for the same site and they join the queue SHET will treat them as being 'interactive'. Ultimately, only one of those projects will successfully secure the connection for that particular site. Their system planners then need to assess reinforcement options for the next project(s) in the queue which are seeking a connection. In the process of developing these new reinforcement options, connection dates are pushed further and further back. 6.There are significant onshore planning and consenting challenges to delivering the onshore electricity network infrastructure required to accommodate the growth in offshore wind. They therefore welcome any early reduction of this infrastructure, as it will both help to alleviate some of these challenges and help to bring the impacted communities with us. However, it will be critical to develop clarity around exactly what will be required in terms of changes to achieve the ambition outlined. 7.They note this area appears light on detail and implementation plans currently and we look forward to working closely with the ESO and industry on developing the practical aspect of this and what specific projects an evolving and improving Connection process applies to in the next phase of work and beyond. **Offshore developers and interconnectors feedback** 1.With regard to the Connections Review: apart from the CION process, they think that the ESO and host TOs can undertake more anticipatory preparatory work to identify strategic grid connection locations to enable future offshore projects – rather than being reactive to developer-led activity. An enhanced, public domain, NOA process could deliver this information to identify strategic grid locations for offshore projects and their grid reinforcement dependencies. In this way, it should be possible to signal at a regional level information such as the economic capacity potential of different grid connection locations over time. They do not expect the ESO to design offshore transmission solutions but to provide the framework for TOs and other developers to do so. To be able to deliver innovative alternatives more quickly, ensuring flexibility and responsiveness regarding connection arrangements for projects is also very important. 2.In the immediate term RWE recommends that NGESO's Network Options Assessment (NOA) is expanded offshore. Whilst the NOA process does not anticipate offshore connection locations, capacities and likely timings ahead of a connection application being received the process produces a flawed assessment of likely grid infrastructure requirements.

	The RIIO-2 price control should include funding and remit for NGESO to begin this as soon as possible. Indeed, delivery of the government's 40GW by 2030 at best value to the GB consumer depends upon it. 3.Given the delays offshore wind projects have experienced due to ESO and TO's reactive planning of infrastructure upgrades in relation to offshore wind capacity it is necessary for Ofgem to urgently update the frameworks for TO investment in grid infrastructure onshore to transmit offshore generation to demand centres once it has made landfall. There is a significant risk that lack of foresight by Onshore TOs and the ESO to appropriately plan and deliver grid capacity will lead to delays and more expensive infrastructure costs to the consumer than are necessary. Therefore, the RIIO-T2 funding and net zero reopener processes should be designed with the intention of enabling anticipatory investment in grid infrastructure onshore to enable and support the delivery of the government target of 40GW by 2030 at best value to the GB consumer. 4.In practice when applying for a grid connection offer the current process of TOs waiting until the output of a forthcoming NOA report before decisions about connection offers can be made means that discussions during a CION process can be delayed as TOs do not want to pre-judge the NOA report recommendations. Adopting the process described here would prevent this. 5. They fully agree that the existing Connections and Infrastructure Options Note (CION) process is outdated and requires reform. They also agree that the concept of regional CIONs should be developed further. They note that this is already an option within the framework, although there are no processes set out for how this would work in practice. Where NGESO have proposed this before (in Eastern England, for example) the developer community felt it was too risky an option for NGESO to pursue, as it would potentially result in the delay of some projects. How do NGESO plan to address those concerns as part of developing the process? 6.There are a great many fundamental issues to be addressed where such an important, yet uncodified process is to be amended: what would the output of such a regional CION look like? Would projects be issued "coordinated" connection offers as a result? Such offers may require commercial agreements to be in place ahead of acceptance. What would happen if a project chose not to proceed pre or post signature? How much involvement would developers have in such a CION process? 7.Another key issue to address is that of timing of the CION process. Currently ESO separate the two highly interdependent processes of issuing offshore generation customers with a connection offer within 3 months and the completion of the CION process. This is not how the STC designed the processes to work, largely because it never anticipated large volumes of offshore wind capacity. This has resulted in ESO adopting the undefined and vague terms "pre-CION" and "post-CION" connection offers, out of context from the current guidance note, and in a way, which can be used to give ESO and the relevant TO more than 3 months in reality to issue a comprehensive connection offer. The "pre-CION" offer could be used as a placeholder whilst the CION process is done, but one which ESO would still require the connecting customer to sign as

	per the terms in the CUSC and in doing so agree to take on financial securities and liabilities. Following this ESO and the relevant TO have scope to undertake a CION process with little to no codified timescales governing its completion and there is therefore risk that this lag could cause change connection agreements to be changed quite considerably even once they have been signed. 8.They agree with NGESO's acknowledgement there is a need to better formalise the role of the offshore developer as a "Shadow TO" for the time period over which they have responsibility for designing and constructing offshore transmission assets. This could be done via formalising their role in the STC, which NGESO place firmly in the "Medium to Long term". RWE considers that a key element missing today which prevents the "Shadow TO" role being formalised is the nervousness of NGESO and the Onshore TOs to discussing certain information with developers. This will need to be overcome in the short term in order to discuss coordination as part of any pathfinder projects and using a revised regional CION process. 9.Any changes to the CION process guidance should be open to consultation. RWE remains of the view that the CION process being in the form of guidance rather than a codified process is not appropriate. It allows the process to operate non-transparently and outside the specific timescales set out in the CUSC for NGESO to issue coherent, complete and meaningful connection offers to customers. This results in delays to project programmes and financial implications for which developers have no control or recourse. 10.NGESO also suggests that they should exercise their existing ability to fully or partially reopen CIONs to encourage coordination of geographical groupings of projects. It is extremely important that the process by which this could come about is transparent and involves the active agreement of the Developer(s) involved. RWE considers that this could be pursued, subject to the next paragraph where a project identifies that it wishes to participate in a no-regrets pathfinder process to consider potential opportunities to coordination before 2030. 11.Developers and project shareholders need confirmation and comfort that their commercial interests will be protected as pathfinder projects. In particular that their existing connection agreement would be guaranteed and ringfenced as a baseline, and associated works would not be put on hold, whilst collectively NGESO, Ofgem, BEIS and Developers explore what coordination could be possible in a cluster/region, including what regulatory framework changes might be necessary to enable coordination opportunities. Any subsequent decisions to amend the baseline connection agreements should only be possible with the explicit agreement of the Developer(s) and shareholder(s) involved, as they need to fully take into account the sunk costs of their projects, often many millions of pounds. They suggest that NGESO confirm this in an open letter, along with a commitment that this process will not create delays to existing connection dates, to enable suitable developers and shareholders to commit to the no-regrets pathfinder process once it is set out by Ofgem and BEIS. 12.We welcome what's proposed in the connections review, but they believe the short-term opportunities cannot be accessed without progressing in parallel with the phase 2 workstreams of the Offshore coordination project. They would

	encourage NG ESO to consider how aspects of the Phase 2 workstreams could be brought forward, particularly as regards Securities and Liabilities, and User Commitment. 13.The coordination of the ESO's planning work with The Crown Estate and Crown Estate Scotland leasing rounds should be a priority. Maximising the benefits of shared connections is inextricably linked to the location of the wind farms themselves, and therefore leasing locations and plans need to be coordinated with the NOA and ETYS processes. With this in mind, the NOA process should be extended offshore. **Community representatives** 1.The proposed modifications of the CION, in both the short and long term, are likely to offer significant benefits for coordination. However, they still consider that other modifications to the process are required to ensure the natural environment impacts of individual or bundled connection offers, are reasonably assessed at the plan level, as they currently are for offshore development and cable leases. Given the focus on fewer larger sites, and therefore the consequent environmental impact of a smaller number of large connection points, both on an offshore, the effective plan level assessment of environmental effects, is likely to be essential. 2.Changes to the CION process must be supported by wider regulatory change, in both the short and long term, to maximise the extent and benefits of offshore coordination.

Table 2: Grouping of comments and questions

Question we asked you	Answers and comments
Q1. How quickly and in what way can changes in this area happen?	The short-term work outlined within our Offshore Connections Review Report has already begun and is being carried out by our business as usual team aligned to the Offshore Coordination Project within the ESO. We are working through a detailed plan for Phase 2 of the project which will be available in early 2021. We will be working at a pace to ensure that we deliver what is required to enable the vision in our final Phase 1 documentation to become a reality. An initial indication of timings is provided in our supplementary RIIO-2 Business Plan delivery schedule on this topic[3].

[3] Final Determinations: Technical Annex part one, https://www.ofgem.gov.uk/publications-and-updates/riio-2-final-determinations-transmission-and-gas-distribution-network-companies-and-electricity-system-operator

Q2. How will you be working with those with 'live connections'?	We will be working closely with BEIS and Ofgem through the Offshore Transmission Network Review (OTNR) on their pathfinder projects.

Next steps

We will now be refining our Phase 2 deliverables and the timeline for these as we head into 2021. We will be publishing more detail on this at the start of 2021, which will position our work within the workstreams being progressed by the Offshore Transmission Network Review (OTNR).

We will be continuing to work closely with stakeholders over the coming months as we start to implement the changes required to make the vision set out in our final Phase 1 documentation. The high-level scope for Phase 2 of the ESO offshore coordination project can be found in our final Phase 1 report.

Annex 1 of companies that have engaged with the Offshore Coordination project In Phase 1

- ABB Limited
- Addleshaw Goddard
- AECOM
- Atkins
- Aviva Investors
- Balfour Beatty
- Barford and Wramplingham Parish Council
- BEIS
- BritNed
- Carbon Trust
- Catapult
- Citizens Advice
- C&I And Technology
- CmY Consultants
- Country, Land & Business Association (East) - CLA
- CPRE Norfolk
- Crown Estate Scotland
- DAERA
- Defra
- DF Energy Consulting
- EDP Renewables
- East of England Energy Group (EEEGR)
- EirGrid
- Energy Equals Ltd
- Engie
- Equinor
- Equitix Limited
- ESB
- Etchea Energy
- Frontier Power Ltd
- GE
- GE Renewable Energy
- Generating Better
- Green Investment Group
- Greenlink
- Hitachi
- Hutcheson Associates
- Iberdrola
- iCON Infrastructure
- Innogy
- ITP Energised
- Members of the public
- Members of Parliament
- National Grid Electricity Transmission (NGET)
- National Grid Ventures
- Natural England
- Natural Resources Wales
- NatureScot
- NeuConnect
- New Anglia Local Enterprise Partnership All Energy Industry Council
- Nexceris, LLC
- National Farmers' Union (NFU)
- NnG Offshore Wind
- Norfolk County Council
- North Norfolk District Council
- NorthConnect
- Offshore Wind Consultants Limited
- Ofgem
- Orsted
- Planning Inspectorate
- Scottish Renewables
- Sembcorp
- Scottish Government
- Shell
- Siemens Energy
- Scottish Power Energy Networks
- SSE Renewables
- SSEN Transmission
- Statkraft
- Suffolk County Council
- Suffolk Energy Action Solutions
- Supernode Energy
- TenneT
- The Crown Estate
- The Grid Cooperative
- TNEI Group
- Transmission Excellence Ltd
- Transmission Investment
- UK Power Networks
- Vattenfall
- Welsh Government
- The Wildlife Trust

• Diamond Transmission Corporation Limited • EON • East Suffolk Council • EDF Energy • EDF Renewables	• Institute of Electrical and Electronics Engineers (IEEE) • Imperial College London • JNCC • Mainstream Renewable Power • Marine Management Organisation	• Red Rock Power Limited Renewable UK • RSPB • Royal Town Planning Institute (RTPI) • RWE	• WindEurope • WSP

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