Title: Developing an enduring regime for offshore transmission Consultation Impact Assessment
IA No: BEIS036(C)-21-ESNM

RPC Reference No: N/A
Lead department or agency: BEIS
Other departments or agencies:

Impact Assessment (IA)

Date: 12/08/2021

Stage: Consultation

Source of intervention: Domestic

Type of measure: Primary legislation

Contact for enquiries:
offshore.coordination@beis.gov.uk

Summary: Intervention and Options

RPC Opinion: Not Applicable

Cost of Preferred (or more likely) Option (in 2020 prices)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
Up to £3bn	N/A	N/A	Non qualifying provision

What is the problem under consideration? Why is government action or intervention necessary?

Under the current offshore transmission regime, wind farms typically connect to the onshore grid through individually built point-to-point connections. This is no longer the most appropriate way of delivering offshore networks given government's increased offshore wind ambitions. It is inefficient because adjacent wind farms do not coordinate to share transmission networks to reduce costs, leading to a greater infrastructure footprint than required and avoidable negative environmental and community impacts. In addition, multipurpose interconnectors (MPIs) using less infrastructure also have not developed because of regulatory barriers. Government intervention is required to remove coordination barriers or change the regime to ensure coordination occurs.

What are the policy objectives of the action or intervention and the intended effects?

The objective of the Offshore Transmission Network Review ("the Review") is to ensure that the transmission connections for offshore wind generation are delivered in the most appropriate way, including finding an appropriate balance between environmental, social and economic costs. Focussing on projects expected to connect to the onshore network after 2030, the aims of the long-term enduring regime workstream are to minimise these costs. It is also intended that initiating the creation of a regulatory framework for MPIs will facilitate the development of these projects and encourage further investment, with potential to reduce the costs of interconnection with electricity systems in other countries.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

No preferred option is given for this consultation but there is an emerging consensus among the Review project partners and stakeholders for a higher degree of centralised design and delivery to meet the Review's objectives. The "do nothing" scenario has no measures to encourage coordination following the end of the short to medium term Review workstreams, reverting back to the current status quo. The overarching policy option is to increase coordination in offshore transmission and two broad categories of options are presented. Option 1 (Incremental change) approaches introduce market incentives for coordination and is closest to a non-regulatory option. Option 2 (Holistic network design and delivery) approaches are more centralised models involving a holistic network design and the potential for early delivery of transmission infrastructure. Separately, in parallel to these there is an Option 3 to make provisions for MPIs in legislation to clarify their legal framework; the "do nothing" alternative is facilitating MPIs within the existing regime which was not designed for these assets and some regulatory barriers remain without legislative change.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** N/A

Is this measure likely to impact on international trade and investment?	No			
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)	**Traded:** N/A	**Non-traded:** N/A		

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister: Date: 27 September 2021

Summary: Analysis & Evidence — Policy Option 2/2a plus 3

Description: Increase coordination in offshore transmission and make provisions for MPIs in legislation

FULL ECONOMIC ASSESSMENT

Price Base Year 2020	PV Base Year 2025	Time Period Years 26	Net Benefit (Present Value (PV)) (£m)		
			Low: Optional	**High:** Optional	**Best Estimate:** Up to 3,000

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate	N/A		N/A	**N/A**

Description and scale of key monetised costs by 'main affected groups'

Costs imposed on the Electricity System Operator and regulators have not been monetised at this stage because policy development is not sufficiently advanced. Similarly, admin costs and changes to costs of any competitive tendering to market participants have not been monetised at this stage. These costs under each of the high-level options will vary depending on the chosen delivery model but are expected to be small relative to the benefits of offshore transmission infrastructure coordination.

Other key non-monetised costs by 'main affected groups'

The emissions impact of multipurpose interconnectors (MPIs) is uncertain because competition between the transmission of renewables generation and interconnection capacity can increase curtailment, when compared to conventional interconnectors. Emissions decrease if MPIs deliver additional interconnection or renewables generation capacity or, depending on specific market arrangements on how flows are prioritised, provides an alternative route for power to avoid transmission network congestion and reduce curtailment.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate	N/A		110	**Up to 3,000**

Description and scale of key monetised benefits by 'main affected groups'

The monetised benefits from coordination are resource savings from reduced transmission capital and operating costs, estimated to be potentially worth up to £3bn (2020 prices) over the 2025-2050 timeframe. These savings reduce transmission costs for generators, but it is ultimately assumed end consumers will benefit in the form of lower energy bills.

Other key non-monetised benefits by 'main affected groups'

The key impacts from coordination are reductions in the negative environmental and social impacts of offshore transmission infrastructure. Habitat loss, disturbance, disamenity to local populations and other resultant impacts from the construction and placement of transmission infrastructure are estimated to be reduced by 30%. Separately, making provisions for MPIs in legislation is expected to increase regulatory certainty for investors.

Key assumptions/sensitivities/risks — **Discount rate** 3.5%

Published Phase 1 outputs from the National Grid Electricity System Operator's Offshore Coordination Project are the main evidence source. Estimates are based on differences between conceptual network maps created for the counterfactual and coordinated, 'integrated approach' scenarios including some MPIs. They assume 42GW of offshore wind is deployed by 2030 and over 80GW by 2050, based on the 'Leading the Way' scenario of their 2020 Future Energy Scenarios publication, meeting government ambitions to achieve 40 GW of offshore wind by 2030 but takes an accelerated pathway to support Net Zero before 2050. There is uncertainty around how well these maps represent future transmission networks under different delivery models of increasing offshore transmission coordination.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m:
Costs: N/A	**Benefits:** N/A	**Net:** N/A	N/A

Evidence Base

Problem under consideration

1. The UK has currently deployed around 10GW of offshore wind to supply the electricity system and Government has an ambition to increase this to 40GW by 2030. To achieve this will require a significant increase in the number of offshore wind farms and transmission infrastructure to transmit this energy back to shore. However, the current end-to-end process for developing a wind farm was designed when offshore wind was a nascent sector, and the focus was on de-risking the delivery of offshore wind.
2. At present, under the current Offshore Transmission Owner (OFTO) regime, offshore wind farms typically connect to grid connection points individually using self-built "radial" point-to-point connections. Offshore wind developers must first obtain a seabed lease and with a (onshore) grid connection point offer from National Grid based on the lowest network costs to accommodate the generation output. They then plan cable corridors, undertake surveys and start preparing for the planning and consenting processes. The generator constructs the connections and transfers ownership to an OFTO, appointed in an Ofgem-run competitive tender process, while continuing to fund their operation and maintenance for 20 years through annual charges.
3. This consultation IA covers proposed changes emerging from the long-term workstream of the Offshore Transmission Network Review ("the Review"), launched in 2020 to "ensure that the transmission connections for offshore wind generation are delivered in the most appropriate way, considering the increased ambition for offshore wind to achieve net zero." [1] Different models of delivering offshore transmission are considered and the 'Enduring Regime' focusses on projects expected to connect to the onshore network after 2030, due to the long development timeline of offshore wind farms and challenges influencing in-flight projects.
4. The role of multipurpose interconnectors (MPIs) is also being considered by the Review. These are hybrid assets combining the functionality of interconnectors with offshore transmission for directly connected generation. There are currently no operational projects involving GB. Potential projects would be expected to involve direct market-to-market connection of the GB grid with the electricity grids of neighbouring countries and combine this with directly connected offshore wind generation capacity, or vice versa. They may help the UK achieve its ambition of 40GW of offshore wind by 2030 and contribute to the 18GW ambition for interconnection capacity by 2030.

Rationale for intervention

5. The current approach to developing transmission networks may not lead to economically efficient outcomes and leads to more transmission infrastructure being installed than is necessary. Commercial incentives to build individual radial connections at lowest cost optimises transmission infrastructure to connect individual projects to shore only and reduces the potential for extensions to the network to accommodate further offshore capacity. [2] This uncoordinated approach means future projects in an adjacent area could potentially require new radial connections to follow a similar corridor on the seabed with associated onshore infrastructure needs.
6. Limited coordination of radial connections increases total transmission costs from developing offshore wind capacity. Installing multiple transmission cables along a similar route on the seabed to radially connect multiple adjacent wind farms prevents benefits from economies of scale being realised. Some fixed costs elements of offshore cable installation such as surveying works may be duplicated while the marginal cost of installing higher capacity cables (or multiple cables at the same time) can be lower than if different offshore wind farms in adjacent areas installed transmission cables at different times.
7. There are also wider impacts of building new infrastructure. While planning and consenting processes exist to mitigate potential negative environmental and community impacts from individual offshore developments, such as marine habitat disturbance and disruptions to localities during the construction process, the full extent of negative externalities may not be fully accounted for if

[1] https://www.gov.uk/government/publications/offshore-transmission-network-review/offshore-transmission-network-review-terms-of-reference
[2] https://www.ofgem.gov.uk/ofgem-publications/161477

cumulative impacts are exacerbated by interactive effects. Substations and other infrastructure accumulated in areas with little coordination have raised concerns from local stakeholders.[2]

8. The existing regulatory regime makes it difficult to coordinate the development of offshore networks and limits opportunities to share transmission infrastructure. Differences in the timing of seabed lease allocations for adjacent locations creates barriers to pursuing more economic approaches to constructing offshore transmission infrastructure. Developers are not incentivised to oversize offshore transmission infrastructure for other future wind farms to connect because current charging arrangements do not reimburse the costs for building larger, shared transmission assets. Infrastructure sharing is therefore unlikely to take place unless opportunistic scenarios arise where wind farms near each other follow similar development timeframes because it is costly to make changes in the later stages of wind farm development.
9. The lack of coordination in offshore transmission may be a barrier to future offshore wind deployment due to planning concerns. Planning and consents for constructing subsea cables and associated onshore infrastructure for offshore wind typically takes several years to obtain and could be delayed if challenged. With increased scale of deployment, we are seeing increased local opposition to an uncoordinated approach, with one recent planning approval overturned by the High Court citing a failure to assess the cumulative impacts of transmission infrastructure in the area. A coordinated approach would support the building of a network which allows future projects to connect and reduces cumulative impacts compared to individual radial connections.
10. The current regulatory framework for electricity may also contain barriers to MPIs potentially playing a role in coordinating offshore transmission infrastructure and prevent any associated benefits from deploying this type of asset from being realised. Industry engagement conducted by BEIS and FCDO between November 2020 and February 2021 suggested that a barrier to investment in MPIs included regulatory uncertainty and the lack of regulatory framework for these assets. Licensable activities currently defined by the Electricity Act 1989 (as amended) include offshore wind generator, offshore transmission, and interconnectors,[3] but these are not intended for MPIs and restrictions on holding more than one type of license may preclude the realisation of MPIs' dual functionality.

Policy objectives

11. The overarching objective of the Review is to "ensure that the transmission connections for offshore wind generation are delivered in the most appropriate way, considering the increased ambition for offshore wind to achieve net zero […] with a view to finding the appropriate balance between environmental, social and economic costs."[1] The full assessment criteria are listed below:

Table 1: The Review Assessment Criteria

Criteria	Sub-criteria
Deliverability of the Review policy and Net Zero	• Deliverability • Decarbonisation
Economics and commercials	• Deployment impact • Renewable generation competition impact • Transmission competition impacts • Risk allocation
Environmental and societal impact	• Environmental (non-carbon) impact • Local communities impact
Consumer and system impact	• End-consumer net benefit

[3] https://www.legislation.gov.uk/ukpga/1989/29/contents

12. To ensure offshore transmission is delivered in the most appropriate way, the objective of changes to the regulatory framework are to improve coordination and cooperation in how the infrastructure is built. This spans the beginning to end processes of planning, developing, and delivering offshore transmission connections. These changes will mainly affect transmission infrastructure for connecting offshore wind to the onshore electricity grid, considering government ambitions to deploy significantly more capacity by 2030, but would be applicable to offshore transmission connections in general.

13. The ambition of increased coordination and cooperation is to improve the balance between environmental, social and economic costs from offshore wind deployment. While planning and consenting processes would continue, the new regime would aim to reduce the negative environmental and community impacts from offshore transmission infrastructure. It may result in less offshore transmission infrastructure, such as subsea cables and onshore landing points, being installed, and lead to further benefits such as lower capital expenditure on electricity transmission.

14. As part of coordination to deliver offshore transmission appropriately, changes are also proposed with the objective of creating a legal and regulatory framework around MPIs, which may help to deliver these novel assets and their associated benefits.

Outline of policy options

15. Two broad categories of policy approaches for offshore transmission delivery models to replace the current offshore transmission regime and encourage coordination are summarised below. These broad categories are based on seven high-level policy options with different combinations of features and development timelines, grouped into approaches with varying degrees of centralisation. Option 1 (Incremental change) has a lower degree of centralisation and Option 2 (Holistic network design and delivery) has a higher degree of centralisation.

16. No non-regulatory options are included because the existing regulatory regime for offshore transmission presents significant commercial barriers to coordination in the development of offshore networks. Incentives to encourage coordination would need to be introduced to make progress on meeting the Review's objectives, but to do so would require changes to existing regulatory processes. Option 1 (Incremental change) is closest to a non-regulatory option, but minor accommodating changes would still be required.

17. The consultation document discusses in detail a variant of Option 2 which requires significant changes to the renewables support framework and is summarised here as Option 2a (Combined seabed lease and CfD award). See Annex 2 of the consultation document for a full list of high-level policy options considered.

Option 0: Status quo ("do nothing" counterfactual)

18. The impacts of different delivery models considered as part of this consultation are compared to a do nothing counterfactual. In this scenario there is no change to the current OFTO regime. Transmission infrastructure for offshore wind continues to connect to shore using individual radial connections. Any coordinated network infrastructure facilitated by the short to medium-term workstreams of the Review would remain in place, but offshore transmission connections after 2030 would return to being uncoordinated because the long-term enduring regime would be unchanged by the review.

Option 1: Incremental change

19. This option is the closest to current OFTO regime and would continue to have a developer-led approach to designing and building offshore transmission. Incentives to encourage coordination amongst offshore wind developers would be introduced within existing flexibilities in legislation so this option can be seen as the closest to a non-regulatory option, however minor accommodating changes to existing processes would be required. Ways of introducing incentives include changes to the approach to anticipatory investment to allow developers to be reimbursed for oversizing infrastructure to accommodate shared connections or changing future offshore wind support to allow developers to benefit directly from any reduced costs from sharing transmission infrastructure.

20. This option could be implemented alongside a strategic plan to set out areas for wind farm development and lay out a schedule for leasing the seabed and renewables support. Focussed offshore development by region could mean developments in a similar geographical area follow similar development time frames to increase opportunities for cooperation between developers.

Option 2: Holistic network design and delivery

21. This option consolidates the approach of the short to medium-term workstreams ONTR workstream into the long-term enduring regime by continuing to implement a holistic network design beyond 2030. Under this centralised approach, a high-level network design is produced by considering future transmission needs, taking into account the expected location and timing of future offshore wind development as well as onshore transmission requirements. It could be delivered in a coordinated way by designing in a similar way for onshore transmission and could involve the cooperation between the electricity system operator (ESO), transmission owners (TOs), and offshore wind developers or independent transmission operators (analogous to current OFTOs). This approach has multiple possible delivery models with different parties adopting different responsibilities for different design and delivery stages.

22. While this approach does not necessitate the design of a strategic plan, implementing it with a strategic plan would increase confidence in generation being forthcoming in the areas expected at the expected time. This plan would equally apply to the onshore transmission network and would help ensure that capacity on the onshore network does not delay deployment of offshore generation.

23. This option could also be implemented with detailed design and delivery of offshore transmission infrastructure taking place earlier (or later) than currently. The current developer-led approach favours the design and delivery of transmission taking place in parallel with the generation asset, but a more centralised approach allows the design and delivery of transmission carried out at a different time from generation.

Option 2a: Combined seabed lease and CfD award

24. This variant of Option 2 (Holistic network design and delivery) aims to address challenges from adopting a more anticipatory approach to transmission caused by the timing of renewables support. It combines the current seabed lease auction with the Contracts for Difference (CfD) auction for renewables support into a single competitive process to avoid challenges associated with having two sequential competitive processes. This would enable transmission to be designed with greater certainty around the siting and timing of generation.

25. Significant changes to the current framework for renewables are required to pursue this option. Presently developers secure planning permission before they can pre-qualify for the CfD auction, but this work is difficult to complete without first knowing the location of the offshore wind farm from the seabed lease auction. Possible implementation approaches include changing the CfD framework to accommodate developers making changes to the CfD to adjust for any conditions placed on planning approvals obtained or, alternatively, for the seabed lease to come with planning permission already granted so developers no longer need to separately secure planning approvals.

Multi-purpose interconnectors

26. In parallel to the enduring regime options for offshore wind transmission, additional options are being considered for creating a legal and regulatory framework to facilitate the development of MPIs.

Option 0: Status quo (do nothing counterfactual)

27. The counterfactual option in relation to MPIs is the same as the status quo for the offshore transmission regime. No legislative changes are made to accommodate MPIs so it is assumed this class of assets would continue to lack a specific legal framework to operate; MPIs would have to work within the current legislative framework, which was not designed with these assets in mind and presents some regulatory challenges which cannot be avoided without legislative change.

Option 3: Make provisions for multipurpose interconnectors in legislation

28. This option would make provisions for MPIs in legislation to clarify their legal framework and definition for their operation. It provides clarity on the nature of assets classed as MPIs, though subsequent secondary legislation setting up the full regulatory regime for MPIs may be required to enable MPI deployment and realise their impacts on the GB energy system.

Summary and preferred option

29. The purpose of the consultation is to gather stakeholder views on the fundamental questions on which to base policy development so no preferred option is put forward. Responses will inform further development of policy proposals on which we might consult on at a later stage. There is an emerging consensus among the Review's project partners and stakeholders that a more coordinated approach to delivering offshore transmission networks is required to achieve government ambitions of offshore wind deployment, and it is expected legislative changes would be required to implement a more centralised approach towards coordinating network design and delivery.[4]

30. Increasing coordination using more centralised approaches could have an indicative positive social net present value of up to £3bn (2020 prices) resource cost savings from transmission capital and operating costs reductions over the 2025-2050 timeframe, based on National Grid ESO estimates for adopting an integrated approach to offshore transmission from 2030. Other system impacts are expected to be negligible with minimal impacts on carbon emissions and generation costs based on NG ESO modelling for adopting an integrated approach from 2025. However, there are potentially significant non-monetised environmental and social benefits, driven by reductions in physical infrastructure placement.

31. Costs imposed on the Electricity System Operator and regulators to develop the future offshore transmission regime – such as obligations to conduct planning activities and to run competitive tenders – have not been estimated at this stage because detailed proposals have not been developed, but they are expected to be small relative to the potential savings. Similarly, changes to competitive pressures will depend on how the chosen approach to coordination is delivered so have not yet been assessed.

[4] Identified through the Review's engagement events such as public webinars and responses to open letters, as well as discussions within the Review's governance. For more information on the Review's activities and publications, see: https://www.gov.uk/government/groups/offshore-transmission-network-review

Analytical approach

32. The main evidence source for potential impacts from coordination in transmission networks are Phase 1 outputs from the Offshore Coordination Project set up by National Grid Electricity System Operator (NG ESO) for the Review.[5] Use of outputs from the Offshore Coordination Project is proportionate since the ESO is well placed to complete analysis relating to transmission networks given their current role in the electricity system. The analysis uses conceptual network designs produced through a region-by-region assessment of offshore transmission network requirements:

    - Under the NG ESO counterfactual scenario, only 'radial' point-to-point network offshore connections are used and are built according to a year-on-year assessment of transmission needs. Each connection is optimised to the individual offshore wind project being connected, including the choice between adopting high voltage alternating current (HVAC) or high voltage direct current (HVDC) technology for transmission, and the onshore grid is designed separately from the offshore grid. There are no MPIs, and interconnectors are designed and connected separately as they are currently.
    - Under the NG ESO policy ('integrated design') scenarios, coordination in offshore networks is achieved through a whole system optimisation and infrastructure may be delivered early in anticipation of future requirements. Multi-terminal/meshed HVDC and HVDV connection options allowing the sharing of infrastructure are available in addition to radial connections. Further, MPIs may be built using a 'bootstrap' method where offshore wind farms connect directly to interconnectors to share transmission capacity.

33. Sensitivity results to the NG ESO analysis are used in preference to results in their Final Cost-benefit Analysis (CBA) Report where available.[6] [7] The CBA Report uses a policy scenario where an integrated network design is implemented from 2025 while the sensitivity results consider the impacts of implementing an integrated network design from 2030. The later implementation date better aligns with the longer-term timeframe covered by the accompanying enduring regime consultation. Although there are other Review workstreams focussing on offshore wind deployment prior to 2030, their impacts are not sufficiently certain to be incorporated into the counterfactual scenario.

34. Consistent with Green Book appraisal guidance, the CBA Report and Sensitivity Report calculate present discounted values discounted at a 3.5% social time preference rate. Monetary values are expressed in 2020 prices and the appraisal period is from 2025 to 2050 unless otherwise indicated.

35. Only one core scenario is presented to illustrate the potential impacts from adopting a new enduring regime for offshore transmission and is based on the NG ESO analysis. Although multiple variations for high-level options for an enduring regime are considered in the consultation, it is not proportionate to produce tailored estimates for the impacts of each of these because separate network designs would need to be produced, and it is uncertain how the network will develop over several decades. As explained under Risks and assumptions, this core policy scenario is assumed to best represent options with a higher degree of centralisation – which are the broad categories of approaches under Option 2 (Holistic network design and delivery) – in combination with Option 3 (Make provisions for multipurpose interconnectors in legislation).

36. Supplementary analysis on the potential wider impacts of offshore transmission coordination draws on a range of sources. Defra's Enabling a Natural Capital Approach guidance provides suggested evidence sources on the impacts of offshore development on the environment,[8] and official statistics on coastal communities provide context around the local impacts of any changes. However, due to uncertainty around how and which specific geographic areas would see material changes under the options considered as the future offshore transmission infrastructure develops over several decades and would be subject to separate planning and consenting processes, wider impacts are largely discussed qualitatively.

37. Further evidence around MPIs is also presented from a range of evidence sources. While the integrated design scenario modelled by NG ESO does include a few MPIs, it is appropriate to separately discuss implications from facilitating the deployment of these assets which are not currently operational in GB. Analysis commissioned by the European Commission, interconnector

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[5] https://www.nationalgrideso.com/future-energy/projects/offshore-coordination-project

[6] Cost Benefit Analysis Report: https://www.nationalgrideso.com/document/182936/download

[7] Sensitivity Analysis Report: https://www.nationalgrideso.com/document/182926/download

[8] https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca

developers and The Crown Estate have been used, and BEIS is considering developing MPI functionality to incorporate into BEIS's power market model for future analysis.

Monetised and non-monetised costs and benefits

38. Reductions in resource costs are the main monetised benefit from the policy options. Transmission capital expenditure (capex) and operating expenditure (opex) of offshore connections and onshore reinforcements under an integrated approach to offshore transmission network design from 2030 are estimated by NG ESO in the Sensitivity Study. The main CBA Report also estimates reductions in system costs, consisting mainly of reductions in boundary costs associated with fewer network constraints between regions, from an integrated offshore transmission design from 2025; these were not re-estimated for the 2030 sensitivity scenario because they were small.
39. The main non-monetised impacts associated with a reduction in transmission infrastructure is a reduction in land use, which has wider impacts on the environment and local communities. While land use was estimated by the NG ESO analysis, this IA discusses the environmental and spatial benefits from the policy options in more detail in the wider impacts section. Non-monetised benefits include the impact on marine habitats and natural capital more generally, while spatial impacts include amenity benefits from a reduction in visible infrastructure. The uncertain impacts on local economies and potential labour market impacts from a reduction in offshore transmission infrastructure building are also discussed under spatial impacts.
40. In the NG ESO analysis, implications on carbon emissions (through electricity grid emissions) and impacts on renewable electricity generation are excluded from the Headline impacts. While higher renewables generation is beneficial for reducing greenhouse emissions from the power sector, the modelled changes were negligible in scale so can be seen as broadly neutral impacts. However, potential benefits from reduced disturbance of blue carbon sinks and protecting their ability to abate carbon is added to the discussion alongside environmental benefits.
41. Admin costs and changes to costs of competitive tendering are not monetised at this stage but are expected to be small relative to the capital cost savings from offshore transmission infrastructure coordination. It is not possible to estimate these impacts given the high-level options and delivery models to implement them have not yet been developed in detail, and there are many potential permutations because different parties could be made responsible for the same part of the transmission infrastructure delivery process even under the same option. This consultation focusses on the high-level framework for coordinating network design so it is more appropriate to consider the costs associated with changes in obligations to operators at a later stage when delivery model design can be tailored to the preferred high-level framework.

Risks and assumptions

42. As indicated above, only one policy scenario is presented to illustrate impacts from the different options for a new enduring regime for offshore transmission. The Sensitivity scenario from the NG ESO analysis is assumed to be a good representation of the broad category of options with a higher degree of centralisation because they all bring about coordination through a holistic network design and allow for a whole system optimised approach to offshore network coordination. The NG ESO policy scenario also includes the deployment of MPIs (or 'integrated interconnectors'), so can be viewed as representing Option 3 being pursued alongside Option 2. The Impacts appraisal section outlines why the Option 1 (Incremental change) approach is assumed to have more modest impacts.
43. There is a risk that the NG ESO conceptual network designs fail to accurately characterise the development of the offshore grid in timing, location and scale. The offshore wind capacity connected in both policy and counterfactual scenarios follow the 'Leading the Way' offshore wind deployment scenario from the ESO's Future Energy Scenarios (FES) 2020 and assumes 42GW is deployed by 2030 and over 80GW by 2050, meeting the government's ambition of 40GW by 2030 but takes an accelerated pathway to meet Net Zero before 2050.[9] However, there is inherent uncertainty around

[9] 'Leading the Way' is the fastest credible decarbonisation scenario characterised by NG ESO and is the only scenario where government's 2030 offshore wind deployment ambition is met. In addition to significant investment in renewable electricity generation, this scenario assumes the use of carbon capture and storage technology and network investments to support the electrification of heat. For full details see: https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

where and when offshore transmission infrastructure would be built under both the policy scenario and counterfactual as the network and generation capacity is developed over several decades.

44. The estimated reduction in transmission costs is derived by comparing the costs of continuing offshore grid development from 2030 onwards under the status quo versus adopting an integrated approach (representing the policy option). Under the status quo counterfactual it is assumed all offshore network connections are point-to-point radial connections connecting individually to offshore wind farms as required, while a whole system cost-optimised approach is taken under the coordinated integrated approach. This may overestimate potential infrastructure reductions for the policy options if it does not sufficiently account for mitigations such as taking less direct cabling routes to reduce community and environmental impacts.

45. While all options are assumed to deliver an offshore transmission network sufficient to accommodate the UK's offshore wind generation, they introduce coordination in different ways and could result in differing scales of impacts. The broad category of approaches with centralised holistic network design and delivery (Option 2) are expected to be more effective at ensuring coordination, and are well represented by the NG ESO analysis, but estimates on how different delivery models and methods of implementation affect coordination effectiveness are difficult to make and this underlines the reasoning as to why only one core policy scenario is presented.

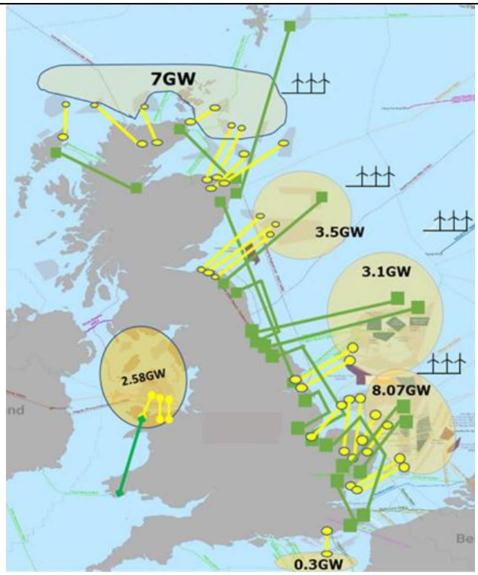
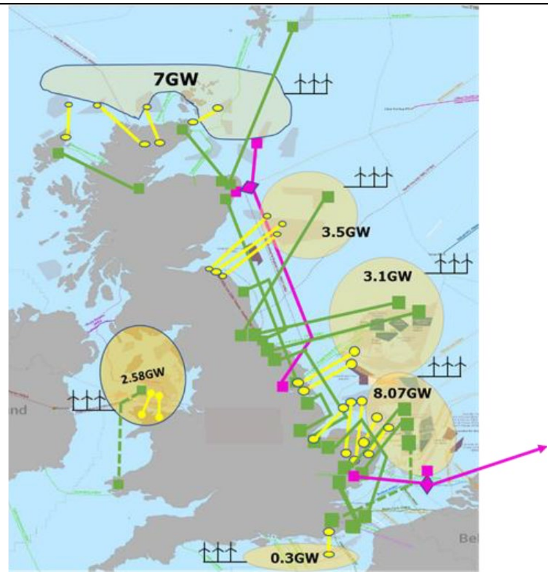
46. For MPIs specifically, there is significant uncertainty over future deployment numbers reflecting limited development activity at present as a result of barriers under the regulatory framework. These are deployed in the policy scenario, but further development of the regulatory regime will likely be required before such assets can deploy. The impacts of coordination under MPIs is also challenging to estimate as it is unclear the extent to which interconnection and offshore wind capacity of future MPIs would displace or provide additional capacity to the pipeline of projects in the counterfactual. In keeping with the NG ESO analysis, this analysis assumes no additional interconnection or offshore wind capacity occurs as a result of MPI deployment to avoid confounding the impacts of coordination with the impacts of additional interconnection of renewables capacity.

Impacts appraisal

47. Option 1 (Incremental change) approaches are unlikely to attain the full potential savings from coordination because it relies on opportunistic cooperation between developers. Under a variant without a Strategic Network Plan, offshore wind developers will continue to face time inconsistencies in development timelines preventing coordination from occurring so there is unlikely to be significant meaningful coordination even with the introduction of incentives to coordinate. Even with a Strategic Network Plan, coordination would not be possible because it still relies on opportunistic cooperation so savings would be expected to remain modest. It is expected that some element of centralised design is required to drive higher levels of coordination.

48. The following analysis therefore focusses on the broad category of policy options involving a centralised network design – Option 2 – which are well represented by the policy scenario of the Sensitivity Report and includes the use of MPIs which may be facilitated to develop with Option 3. The conceptual network designs under counterfactual and policy scenarios are shown in Figure 1. Coordination has the potential to significantly reduce the number of offshore cable corridors, as illustrated by the reduction in point-to-point links when moving to an integrated network. These diagrams show a higher level of coordination is more likely to be achievable with a centralised network design under Option 2 (Holistic network design and delivery) where offshore wind generation is connected to more optimal locations on the onshore grid instead of the nearest landfall point.

Figure 1: Conceptual network designs under counterfactual and coordination scenarios in 2030 and 2050

<table>
<tr><th>Year</th><th>Counterfactual</th><th>Integrated from 2030</th><th>Key</th></tr>
<tr><td>2030</td><td>
</td><td>
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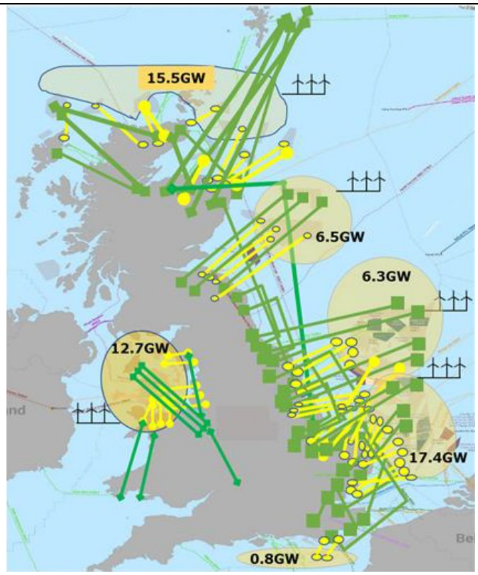
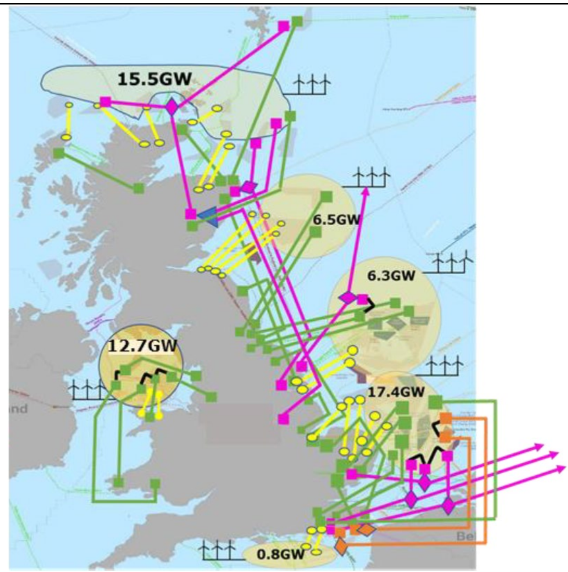
HVAC point to point Link
Multiple Windfarms
Multi-terminal Bipole
Meshed HVDC Substation
Offshore HVDC Switching Station
Integrated Interconnector
HVAC Interlink
Onshore HVDC Switching Station
Connection into existing HVDC Converter Station</td></tr>
<tr><td>2050</td><td>
</td><td>
</td></tr>
</table>

Source: Sensitivity Study and CBA Report

Headline impacts

49. The policy scenario (Option 2 plus Option 3) has total resource savings of up to £3bn over 2025-2050 (2020 prices), as estimated by NG ESO, representing an 8% reduction in lifetime transmission costs. This consists of around a £2bn reduction in capex costs, a reduction of 8%, and around a £0.7bn reduction in transmission opex costs, a reduction of 10%. There is uncertainty around these figures because the network will develop over several decades and the reduction in transmission infrastructure for the actual network may differ from ESO's conceptual network designs.

50. NG ESO's cost-optimising approach to coordination also brings forward spend as transmission is delivered earlier, and a different mix of transmission technologies are used. Anticipatory investment under coordination means a greater proportion of spend happens in earlier years to accommodate future connections at lower cost. Figure 2 shows capex savings by technology component between the counterfactual and coordinated scenario by year. There is likely to be a switch from HVAC to HVDC technology to transport higher loads more efficiently over longer distances, but higher spend on platforms to make more connections is more than offset by a net reduction in cable costs.

51. Unit cost data used by the NG ESO Offshore Coordination Project to estimate technology costs are based on historical information accounting for future costs reductions, however were not published for commercial confidentiality reasons. They include project costs from the initialisation stages to realisation, such as surveys and studies, materials procurement, installation costs and project overheads. Consenting costs included within overheads and the cost of environmental impacts mitigation are not included because these are highly uncertain and project specific andare expected to fall with increased coordination because the number of distinct projects will reduce.

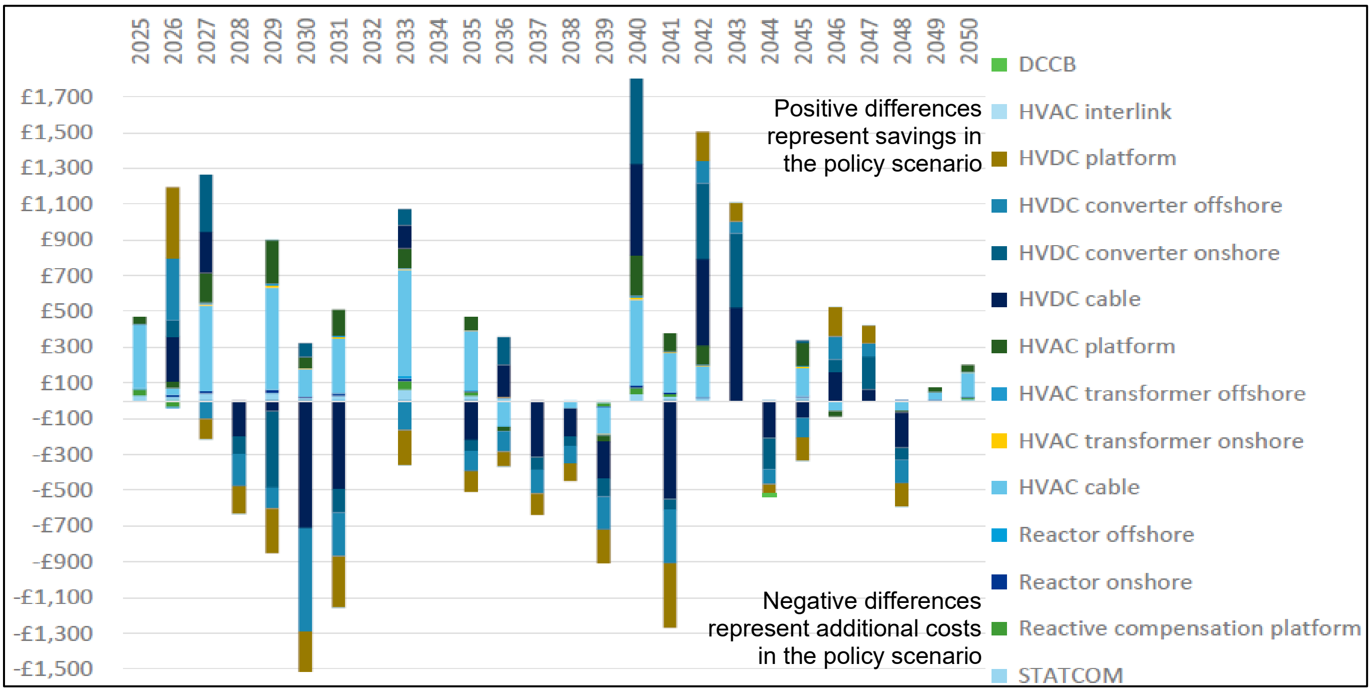
Table 2: Lifetime transmission costs under counterfactual and policy scenarios (2020 £m, discounted)

	Counterfactual	Integrated from 2030	Transmission savings
Capex	£ 29,000	£ 26,798	£ 2,202 (8%)
Opex	£ 7,113	£ 6,429	£ 684 (10%)
Total	**£ 36,113**	**£ 33,227**	**£ 2,886 (8%)**

Source: Sensitivity Study and BEIS calculations.

Note: Figures are presented to the nearest million as per the original report, but they should only be used to understand the broad magnitude of impacts due to uncertainty around future network development.

Figure 2: Annual capex changes by component: counterfactual less policy scenario (2020 £m, discounted)



Source: Sensitivity Study

52. The transmission savings identified may not distributed evenly across offshore wind regions. The NG ESO conceptual network design for an integrated approach from 2030 suggests minimal savings are possible in the South East due to low total wind capacity to connect. Meanwhile, savings in North Wales and the Irish Sea area may be limited because its geographical separation from the other offshore wind areas on the eastern side of the British Isles prevents inter-region coordination. Conversely, significant transmission capex savings may be possible around East Scotland with a lifetime reduction of 17% compared to the counterfactual, as offshore generation is directed to landfall points southwards instead of the nearest shore to avoid onshore grid network constraints and minimise network reinforcement spend, while other regions could benefit from capex savings of 6 to 8%.

53. All transmission cost savings are ultimately assumed to be passed on to end consumers. While organisations engaged in the delivery of transmission infrastructure, such as the transmission owner or offshore transmission owners, may initially benefit from reduced infrastructure spending, these savings would be expected to pass to generators and electricity suppliers through reduced transmission network use charges – who are expected to ultimately pass savings on to end-consumers in the form of lower bills. Note not all consumers may benefit equally because network charges are made up of location specific and shared elements.

Table 3: Lifetime capex costs by offshore wind region under counterfactual and policy scenarios (2020 £m, discounted)

	Counterfactual	Integrated from 2030	Capex saving	
North Scotland	£ 7,859	£ 7,241	£ 618	(8%)
East Scotland	£ 3,709	£ 3,077	£ 632	(17%)
Dogger Bank	£ 6,064	£ 5,675	£ 389	(6%)
Eastern Regions	£ 7,521	£ 7,016	£ 505	(7%)
South East	£ 126	£ 126	£ 0	(0%)
North Wales	£ 3,720	£ 3,663	£ 57	(2%)
Total	**£ 29,000**	**£ 26,798**	**£ 2,202**	**(8%)**

Source: Sensitivity Study and BEIS calculations

Note: Figures are presented to the nearest million as per the original report, but they should only be used to understand the broad magnitude of impacts due to uncertainty around future network development.

System impacts

54. The system impacts of increasing coordination are expected to be negligible so are not monetised, with minimal impacts on generation costs and the costs of system constraints (boundary costs). As mentioned above, the cost-benefit analysis produced by NG ESO found that adopting an integrated network design from 2025 did not have significant impacts on system costs so the modelling was not repeated for the sensitivity study which this IA uses where possible. It estimated total discounted lifetime system costs to be £78m lower under the integrated scenario, representing a change of around 0.1%.[10]

55. Table 4 shows a breakdown of system costs changes estimated by NG ESO. Total generation costs are nearly identical between the counterfactual and integrated network scenarios because they represent costs under an unconstrained system, whereas boundary costs refer to additional costs from congestion rent and/or redispatch costs when the system is constrained. The impact of offshore coordination on relieving system pressures is mixed and is likely to be broadly neutral overall; a more

[10] Calculated from the CBA Report. Discounted system costs excluding carbon capture and storage revenues totalled £64,581m in the counterfactual and £64,503m in the integrated scenario. The CBA Report presents an alternative set of system costs including these revenues where payments to CCS generators means, on net, total generation costs in 2040 and 2050 are negative. In this case total discounted lifetime system costs were £148m higher in the integrated scenario.

integrated network may reduce the need for generation to be relocated closer to demand in some years, while in other years the counterfactual may perform better.

56. There is also expected to be minimal impact on renewable electricity generation and grid emissions. Based on results in the NG ESO CBA report, there was no notable increase in the need to reduce offshore wind generation (curtailment) under the integrated approach compared to the counterfactual over the period 2025 to 2050. The small increase in curtailment of 56 TWh over 2025 to 2050 is expected to be an overestimate because the power markets of neighbouring countries connected through multi-purpose interconnectors have not been modelled, and excess generation could have been exported instead. Despite the increase in renewables curtailment, total carbon emissions over the period 2025 to 2050 are modelled to be 0.13 $MtCO_2$ lower than the counterfactual scenario (a reduction of less than 0.1%).

Table 4: Lifetime system cost breakdown under counterfactual and earlier policy scenarios (2020 £m, discounted)

	Counterfactual			Integrated from 2025			System cost savings		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050
Generation costs	3,980	5,780	6,469	3,980	5,783	6,469	32 (0.8%)	0 (0.0%)	−38 (−0.6%)
Boundary costs	35	68	242	3	65	279			
Total	**4,015**	**5,848**	**6,711**	**3,983**	**5,848**	**6,749**			

Source: CBA Report and BEIS calculations

Note: Figures are presented to the nearest million as per the original report, but they should only be used to understand the broad magnitude of impacts due to uncertainty around future network development.

Multi-purpose interconnectors

57. The enduring regime consultation includes an option to make provisions for MPIs in legislation to clarify the legal framework for these assets to operate in. Extensive industry engagement has indicated uncertainty around offshore grid planning and regulatory uncertainty is a barrier to making investments to develop these projects. Pursuing Option 3 to make provisions for MPIs in legislation is expected to make investment in MPIs more likely. Although several pathfinder projects have been proposed by GB and European TSOs, the amount of additional investment is uncertain and is demand driven by investors and developers and face further barriers around coordination, funding and appropriate risk allocation.

58. MPIs offer significant benefits compared to conventional interconnection in the form of capex and opex reductions through the shared utilisation of infrastructure. The NG ESO scenarios model 4 assumes interconnectors deploying in the counterfactual to become MPIs as offshore network development becomes more coordinated, facilitating the connection of offshore wind capacity. Savings from these projects are already included in the transmission savings under headline results. Transmission costs are in essence reduced by connecting offshore wind generation to an interconnector, meaning transmission cables are shorter than if connections were directly to shore. However, alternative connection models exist. For example, case studies by the European Union on potential hybrid projects between the UK and Netherlands instead use shortened interconnector cable lengths by connecting them to offshore wind farms and kept transmission cables largely unchanged.[11] The benefits associated with reduced transmission infrastructure are discussed under Wider impacts.

59. The dual interconnection and offshore transmission functionality associated with MPIs increases asset utilisation, helping to a achieve a more efficient use of infrastructure. When offshore wind is generating below full capacity, and especially during times of low wind speeds, radially connected transmission infrastructure is underutilised because there is not enough power to transmit. Asset utilisation is higher with an MPI because when wind generation is low, the spare transmission

[11] How to reduce costs and space of offshore development: North Seas offshore energy clusters study (https://op.europa.eu/en/publication-detail/-/publication/59165f6d-802e-11e9-9f05-01aa75ed71a1)

capacity can be used for interconnection purposes. An unpublished study on connections between GB and the Netherlands conducted for The Crown Estate and TenneT (the Dutch TSO) suggests under half of the total flow potential of offshore wind transmission assets are used in the counterfactual, but utilisation can be one fifth higher for hybrid technologies. An increase in capacity utilisation may increase revenues for investors and encourage more projects to be developed.

60. Evidence around the impact of MPIs on the wider energy system can be mixed and is often confounded with the impacts of additional interconnection capacity. While a study commissioned by BEIS found that an increase in interconnector capacity between GB and EU would likely lead to a reduction in carbon emissions in both GB and the EU,[12] the case studies by the European Union highlight a conflict exists between available interconnector capacity and offshore wind generation. The competition for capacity between transmission of renewable generation and interconnection on MPIs has the potential to increase grid emissions compared to a counterfactual where capacity for both functions were separate if curtailment increases, but overall impacts are unclear and are likely dependent on specific market arrangements on how flows are prioritised. When compared to standalone interconnector capacity, the increase in emissions caused by MPIs was generally very small. The configuration of MPIs is also important, renewables curtailment caused by onshore congestion may be avoided where MPIs provide alternative routings for electricity. Further, emissions could be lowered if total offshore wind and/or interconnector capacity increases or is brought forward due to investment in MPIs.

Wider impacts

61. Infrastructure reductions in the core policy scenario reduces the number of landfall sites and area of land used by transmission networks which has wider impacts that are not monetised. The primary impacts are benefits in the form of reduced negative impacts caused by the development of offshore infrastructure to the natural environment and local communities. Other impacts from the policy options being consulted include potential competitive effects, but assessments of the impacts at this stage based on high-level options for an enduring regime alone are challenging to make in the absence of delivery models being developed in greater detail.

62. Offshore network coordination is expected to reduce negative environmental impacts and social and local impacts by around 30%, according to the NG ESO Sensitivity study. Compared to a counterfactual with radially connected offshore wind farms, adopting an integrated approach to network design from 2030 can reduce the number of onshore landing point for cables by 40% though, due to increases in the size of the transmission technologies required, the area of land used for landing points is reduced by a more modest 20%. Reductions in transmission cable length varies depending on location, with the total length of offshore cable trenches reducing by 10% and onshore cables by 27%.

Table 5: Transmission infrastructure placements in 2050 under counterfactual and coordinated scenarios

	Counterfactual	Integrated from 2030	Infrastructure reduction	
Length of offshore cable trenches (km)	8225	7385	840	(10%)
Length of onshore cables (km)	3360	2465	895	(27%)
Number of onshore landing points	105	63	42	(40%)
Area of land used for landing points (ha)	386	310	76	(20%)

Source: Sensitivity Study and BEIS calculations

[12] The impact of interconnectors on decarbonisation (https://www.gov.uk/government/publications/impact-of-interconnectors-on-decarbonisation)

63. The wider benefits are distributed unevenly across regions because of differences in offshore wind capacity and deployment timelines. The conceptual network design produced by NG ESO estimates the greatest reduction in onshore substation asset counts under a coordinated scenario in North Wales, East Scotland and the Eastern Region, reducing by roughly one half, while the South East sees more onshore infrastructure as offshore generation in the Eastern Regions is landed more closely to where demand is located as part of an integrated network. The number of onshore cable corridors closely follows the number of onshore substations. As part of a holistic network design, total transmission costs may be minimised by redirecting landing points for offshore wind to avoid network constraints on the onshore grid. However, these changes represent the outcome of one modelling scenario by NG ESO and there is uncertainty around how the network would develop over several decades.

Table 6: Onshore substation asset counts in 2050 by offshore wind region under counterfactual and coordinated scenarios

	Counterfactual	Integrated from 2030	Infrastructure reduction	
North Scotland	25	18	7	(28%)
East Scotland	9	5	4	(44%)
Dogger Bank	18	13	5	(28%)
Eastern Regions	27	13	14	(52%)
South East	7	11	−4	(−57%)
North Wales	20	7	13	(65%)
Total	106	67	39	(37%)

Source: Sensitivity Study and BEIS calculations

Environmental impacts

64. Offshore developments can have negative impacts on marine and coastal environments so reductions in the amount of offshore infrastructure can mitigate some of the harmful effects. Coordination is expected to have a positive effect on natural capital by reducing the number and area of installations in marine and coastal ecosystems and associated reductions in disruptions during the construction process. However, the extent of these benefits are uncertain because it would depend on the actual location of infrastructure location in the planning and consenting process in the counterfactual and policy scenarios as they develop over several decades, the construction methods used, and other factors such as the effectiveness of any environmental risk mitigations.

65. Reducing the placement of substations and cable corridors on the seabed is expected to reduce habitat destruction and disruption to surrounding ecosystems, and coordination is expected to better account for cumulative impacts. Preparatory works for installing foundations of structures such as substations may require material to be dredged or excavated from the seabed, and habitats can also be changed by materials deposited for the external protection of cables, such as concrete mattresses or rock bags.[13] While individual projects currently already undertake environmental impact assessments and adopt mitigations where appropriate, especially within designated Marine Protected Areas, coordination could allow a more holistic examination of the total cumulative impacts offshore developments have on the natural environment.

66. The wider evidence on natural capital impacts from offshore developments is mixed or unclear, with evidence constantly developing and often highly location or species specific. Some areas such as benthic habitats seem resilient to disruption while the research on the impact on marine mammals is inconclusive. Artificial reef effects are potentially beneficial for commercial species, but there is also

[13] Marine Pressures-Activities Database (PAD) v1.4 | JNCC Resource Hub

concern over the role of developments in assisting with the spread of invasive species.[14] This emphasises difficulties in estimating an overall environmental impact from the high-level policy options and conservations issues may be more appropriately addressed at a local level. Biodiversity impacts aside, a reduction in construction activity would be expected to reduce environmental risks associated with construction of offshore infrastructure such as the release of pollutants into natural ecosystems and collisions with ships causing injury or death to marine animals.

Greenhouse gas sequestration

67. Protecting natural habitats can have positive impact on greenhouse gas abatement because they act as carbon stores and sequester carbon. 'Blue carbon' refers to atmospheric CO2 sequestered by vegetated coastal and marine habitats, storing carbon in soils and sediments,[15] and the Office for National Statistics estimate UK saltmarshes, sublittoral (sub-tidal) sands and sublittoral muds alone sequestered between 10.5 and 60.1 MtCO2e in 2018.[16] While coordination is not expected to have a significant impact on carbon emissions from the electricity system, reducing habitat loss would help maintain the size of the carbon sinks.
68. Reductions in onshore landing sites would be expected to reduce the disturbance of coastal and marine habitats to prevent the re-release of emissions and maintain their ongoing ability to sequester carbon dioxide. Sand dunes, saltmarshes and machair dune grassland make up around 93% of UK coastal margin habitats, and saltmarsh and seagrass represent the largest sedimentary carbon store. However, the most recent estimates indicate saltmarshes sequester 2.35 to 8.04 tCO2e per hectare per year.[17] Despite the clear value from protecting natural habitats and carbon stores, emissions savings under the policy scenario are modest when given the policy scenario only uses 76 ha less land area for landing points by 2050.

Spatial impacts

69. Increasing coordination in offshore transmission can have nuanced effects on local communities. Reduced infrastructure building would be expected to reduce construction disruption and alleviate concerns amongst the local population around offshore cables and onshore landing points near coastal locations, however, may have an uncertain impact on local economies and jobs. Overall, coordination may better enable local communities to have their views represented in planning processes by reducing the individual number of applications to respond to, and better enables cumulative impacts to be considered.
70. Coastal communities in England and Wales could benefit more from reduced disruptions from infrastructure building than the wider economy because they have a different sectorial composition which may make their local economy more vulnerable. Coastal communities are more orientated towards providing leisure and hospitality services and may be more adversely impacted by the visual impact of transmission infrastructure development. In 2018, the accommodation and food services sector had the highest share of employment amongst in small seaside towns, with 19%, compared to just 7% for this sector in non-coastal small towns. A relatively low proportion of employment are in high productivity sectors. Coastal towns are more likely to be deprived than non-coastal towns and resident populations less likely to have degree-level qualifications.[18]
71. Reduced opposition to offshore wind development during planning can accelerate the delivery of offshore wind capacity and bring forward additional high value jobs. The offshore wind sector directly

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[14] Understanding the Impacts of Offshore Wind Farms on Well-Being, The Crown Estate (2015) (https://www.offshorewindindustry.com/sites/default/files/ei-understanding-the-impacts-of-offshore-wind-farms-on-well-being.pdf)

[15] Carbon Storage and Sequestration by Habitat, Natural England (2021) (http://publications.naturalengland.org.uk/publication/5419124441481216)

[16] Marine accounts, natural capital, UK: 2021, ONS (https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/marineaccountsnaturalcapitaluk/2021)

[17] NatureScot Commissioned Report 957 (2017) (https://www.nature.scot/naturescot-commissioned-report-957-assessment-blue-carbon-resources-scotlands-inshore-marine)

[18] Coastal towns in England and Wales: October 2020, ONS (2020) (https://www.ons.gov.uk/businessindustryandtrade/tourismindustry/articles/coastaltownsinenglandandwales/2020-10-06)

employed approximately 7,200 full-time equivalent employees in 2019,[19] and some local areas are supporting offshore wind development as part of their local economic strategies. While reductions in capital spending resulting from increased coordination may reduce the numbers of jobs directly involved in delivering transmission infrastructure, any reduction in total jobs is likely to be small and could be offset by increased delivery rates. Offshore cable installation typically represents 6% of total offshore wind costs, while cables represent 5%.[20]

72. Less infrastructure placement may be beneficial for employment in other sectors. Increased coordination can help to deliver fewer, larger developments instead of more, smaller developments, which may be beneficial from a tourism perspective.[21] However, while concerns over tourism impacts are often reasons cited for objections to offshore wind developments, the evidence on local impacts is mixed. It is unclear whether these issues would have materialised had they not been considered as part of planning and consenting processes. The Tourism Impact Review for East Anglia ONE North and East Anglia TWO offshore windfarms suggests different areas along the same coastline may be affected differently.[22] Further, a Welsh study found no evidence to support businesses claims of disruptions from construction causing a fall in visitor numbers.[23] Some areas' hospitality sectors may be relatively unaffected by reductions in tourist visitors because there is additional custom from workers moving into the area to deliver offshore wind projects.

73. The need for fewer landing points and onshore substations reduces disamenity on local populations, who would also benefit from experiencing less noise and traffic caused by construction processes. The placement of supporting onshore infrastructure for radially connected offshore wind farms reduces the space available for recreation and can have negative visible impacts further afield. While increased coordination of offshore transmission networks may have negligible visible offshore impacts, expected reductions in onshore infrastructure would reduce the cumulative localised impacts on communities most impacted by developments.

Competition and innovation impacts

74. The high-level policy options may require changes to the OFTO regime and could impact on competitive pressures, though these are uncertain until the policy details are developed further. Under the current offshore transmission regime, following the introduction of the generator build option in 2015, offshore transmission is typically built by offshore wind developers with the assets transferred to OFTOs at construction completion. Alternatively, OFTOs can manage the process from the beginning and be responsible for the design and build too.

75. Currently Ofgem run the competitive process for allocating offshore transmission licences to ensure generators are partnered with the most efficient and competitive players in the market to lower costs or generators and, ultimately, consumers. The policy options maintain competitive processes for delivering offshore transmission networks. Depending on choice of counterfactual, an evaluation for Ofgem indicated cost savings from holding these competitions were in the range of 19 to 23%.[24]

76. Option 1 (Incremental change) approaches appear similar to the counterfactual so there may be no initial difference in competition but encouraging cooperation between developers potentially weakens competitive pressures. Policy options with a greater central design element (Option 2) could require a reallocation of responsibilities between offshore transmission stakeholders and thus change the competitive nature of its delivery. The extent to which competitive pressures are maintained will depend on the specific delivery models adopted to achieve the high-level policy design.

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[19] Low carbon and renewable energy economy estimates, ONS (2021) (https://www.ons.gov.uk/economy/environmentalaccounts/datasets/lowcarbonandrenewableenergyeconomyfirstestimatesdataset)

[20] https://guidetoanoffshorewindfarm.com/wind-farm-costs

[21] Economic impacts of wind farms on Scottish tourism: research findings (2008) (https://www.gov.scot/publications/economic-research-findings-economic-impacts-wind-farms-scottish-tourism)

[22] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010077/EN010077-002667-ExAWQ1A13D1V1EA1NEA2Applicants%E2%84%A2ResponsestoWQ1Appendix13TourismImpactReview_378285_1.pdf

[23] Study into the Potential Economic Impact of Wind Farms and Associated Grid Infrastructure on the Welsh Tourism Sector (2014) (https://gov.wales/sites/default/files/publications/2019-06/potential-economic-impact-of-wind-farms-on-welsh-tourism_0.pdf)

[24] Evaluation of OFTO Tender Round 2 and 3 Benefits, Ofgem (2016) (https://www.ofgem.gov.uk/sites/default/files/docs/2016/03/ofgem_tr2_tr3_evaluation_final_report.pdf)

77. Competition in delivering offshore transmission delivery may increase or decrease with increased coordination. More integrated networks are larger and more complex than radially connected offshore transmission so could raise barriers to entry to infrastructure delivery and reduce competition, but since there are fewer projects to bid for and work on, competitive pressures between firms may increase if the number of bidders per project increases. Higher levels of competition would be expected to increase the level of innovation as competing firms seek to deliver infrastructure more efficiently at lower cost.
78. Pursuing Option 3 to make provisions for MPIs in legislation to clarify their legal framework is expected to increase innovation. There are currently no operational MPI projects so the expected increase in investment in these projects will require innovation in design and delivery to make such projects operational. In addition, alongside increasing coordination in offshore transmission to create more integrated networks, is likely to increase the demand for more transmission control technologies where innovation can improve asset performance.

Security of supply

79. More integrated transmission networks because of coordination has the potential to improve security of electricity supply overall, but further investigation is needed when designing the networks in detail. Like System impacts, this is based on an assessment made in the NG ESO CBA Report for an integrated approach to network design from 2025 where the conceptual network designs used for both policy and counterfactual scenarios were designed to meet the same minimum Security and Quality of Supply Standard and Grid Codes.
80. Network adequacy and resilience can improve despite coordination increasing the size of connected capacity capable of causing losses when disrupted. This is because an integrated network is better able to re-route power in the event of a circuit outage, and more diversified connections provide alternative paths to reduce the loss risk of individual faults. The greater use of HVDC is also typically associated with shorter outages than HVAC technology. Further, integration of the offshore network with the onshore network is expected to improve system stability compared to multiple radial connections injecting offshore wind power into the onshore network.

Direct costs and benefits to business

81. The enduring regime workstream of the Review focusses on offshore wind deploying after 2030. These are projects which do not currently exist. Depending on the option pursued and specific decisions on delivery models and allocations of responsibilities, costs may be imposed on the Electricity System Operator and regulators to develop the future offshore transmission regime – such as obligations to conduct planning activities and running competitive tenders. It is not possible to estimate costs at this stage given detailed proposals have not been developed but they are expected to be small relative to the potential savings.
82. The up to £3bn reduction in transmission costs will directly benefit electricity generators and suppliers from whom the costs of installing and maintaining the transmission system are recovered. Under the current Transmission Network Use of System (‘TNUoS’) charging system, users of transmission networks are charged tariffs based on which geographical zone they are connected to. Generators, including offshore wind farms, are charged tariffs based on their entry capacity to the grid and electricity suppliers are charged based on their actual demand. However, these savings are ultimately assumed to be passed on to end consumers.
83. MPI developers would also directly benefit from regulatory certainty created by legislative change to set up a regulatory regime to facilitate their deployment. Again, the Electricity System Operator and regulators may incur costs in establishing that regulatory regime.

Small and micro business assessment

84. There are currently no small or microbusinesses directly operating in the transmission sector, and neither the Electricity System Operator nor regulators are small businesses. The current incumbent transmission owners are large businesses and operators of offshore transmission assets, which

consist of consortia of large businesses, including construction companies and institutional investors. The value of offshore transmission assets being owned and operated are typically valued in excess of hundreds of millions of pounds.

85. More widely, increasing offshore transmission network coordination is expected to have a positive indirect impact on small and micro businesses through reductions in energy bills. Transmission cost savings under the core policy scenarios are ultimately assumed to benefit consumers. Smaller businesses in coastal locations are also expected to face lower burdens in responding to planning applications for offshore transmission as these are managed in a more coordinated way.

Equalities assessment

86. Increasing coordination in offshore transmission may have a small net positive impact on those with protected characteristics. Disruptions to local communities from developing transmission infrastructure may have a disproportionate impact on individuals with mobility challenges, who may be overrepresented within certain protected groups, by impeding road access and use of clear footpaths. Reductions to transmission infrastructure development from coordination is expected to reduce disruptions and therefore have an overall positive impact on local communities and members of local communities with protected characteristics. While changes to offshore transmission landfall points and the location of onshore infrastructure placement could cause disruptions to previously unaffected areas, any disproportionate impacts would be expected to be mitigated through local planning and consenting processes.

Monitoring and Evaluation

87. The current offshore transmission regime has evolved over time in response to stakeholder feedback and learning. For example, an extensive consultation was held to support the development of the generator build option for offshore transmission delivery.[25] In the context of increasing ambitions for offshore wind, it was recognised that continuing to construct radial connections for offshore wind may not be most appropriate. The Review was established with a wide range of partners to ensure a more coordinated approach in the short, medium and long term.[26]

88. At present it is premature to develop detailed monitoring and evaluation plans for a new long-term enduring regime because policy proposals have not undergone detailed development yet. The consultation is on a high-level framework to increase coordination in offshore transmission, and it is expected that further consultations will be needed to develop the new enduring regime in full. Monitoring and evaluation arrangements will be planned at appropriate stages as the policy development progresses.

89. It is envisaged that any changes will be reviewed on an ongoing basis due to the extended time over which the new regime will be introduced. A single formal review point for changes to the offshore transmission regime is unlikely to be appropriate due to the extended period over which the changes will be introduced and significant time lags before impacts can be seen due to the long lead times of offshore wind deployment. An ongoing review supported by stakeholder engagement and, where necessary, more formal consultations and data collection, would provide insights as to whether the offshore transmission regime remains appropriate for delivering transmission connections for offshore wind, and to provide learning should improvements be required.

[25] https://www.ofgem.gov.uk/publications-and-updates/offshore-electricity-transmission-updated-proposals-under-enduring-regime

[26] https://www.gov.uk/government/groups/offshore-transmission-network-review

Annex 1 – Summary of NG ESO Holistic approach to offshore transmission

National Grid ESO's Offshore Coordination Project Phase 1 outputs are the main evidence source for this IA. Estimates on transmission cost savings and reductions in the negative environmental and community impacts associated with transmission infrastructure are taken from the Cost Benefit Analysis Report and Sensitivity study. Estimated impacts are based on conceptual network maps created for the Offshore Coordination Project and the Holistic Approach report illustrates a method for identifying and assessing a coordinated transmission network design for the policy scenario.

The NG ESO cost benefit analysis was performed based on the 'Leading the Way' scenario of the 2020 Future Electricity Scenarios Report. It is the most ambitious of the scenarios in FES 2020, and is the only one to meet government's offshore wind ambitions by installing 42 GW of offshore wind by 2030. In addition to significant investment in renewable electricity generation, this scenario assumes the use of carbon capture and storage technology and network investments to support the electrification of heat. By 2050, it assumes there will be over 80 GW of transmission connected offshore wind and over 20 GW of non-networked offshore wind for hydrogen production.

Conceptual network maps following the offshore wind deployment trajectory from FES were created to illustrate the potential impact from offshore transmission coordination. The following table summarises the high-level principles for how offshore networks for the counterfactual and policy scenarios were designed. Existing infrastructure and, for the sensitivity study used as the policy scenario, new projects that are planned to connect prior to 2030 are unaffected. Both approaches use technologies which are available today.

Counterfactual (Project specific design)	Policy (Integrated offshore network design)
Requirements for each project considered separately	Takes account of possible future requirements
Only considers point to point offshore network connections	Considers a range of connection options including multi-terminal/ meshed HVDC and HVAC options
Individual project optimisation and transmission (HVAC or HVDC) decision	Considers whole system optimisation and transmission technology decisions
Onshore and offshore network designs are considered separately	Considers effect on onshore system optimisation as part of offshore design development
Interconnectors are designed and connected separately	Possibility that interconnector/bootstrap capacity can be shared by an offshore wind farm
Local community impacts are managed on a project-by-project basis	Local community impacts considered on an overall impact basis

Source: Holistic Approach report

Under the counterfactual scenario, offshore wind farms connect to the transmission system by project specific radial connections. Transmission networks for offshore wind projects are optimised individually and only point to point network connections are used. The offshore network design makes no consideration to the onshore transmission network.

Under the integrated approach of the policy scenario, onshore transmission network design processes are extended to include the offshore network. A more holistic approach to network planning is taken, set out in National Grid's Electricity Ten Year Statement ('ETYS') and Network Options Assessment ('NOA') publications. A longer-term view of offshore networks is taken with future requirements taken into account and transmission is optimised on a whole system level instead of the current project by project approach. Implications for the onshore network, such as impacts on boundary constraints and network reinforcement costs, are considered when designing the conceptual network map for the policy scenario.

An integrated offshore network design enables offshore transmission assets to share infrastructure, leading to design efficiencies and avoids excess substations and transformers. The most appropriate technological designs were selected from a range of modularised conceptual building blocks, leading to increases in the use of high voltage direct current (HVDC) technology. In addition to minimising costs, the approach considers offshore grid evolution in a holistic way to provide wider system benefits. Transmission infrastructure development is restricted to areas where amenity impacts could be better managed for local communities, and the location of connections may be varied to improve the integration of offshore wind with the wider transmission network.

However, the conceptual network maps produced represent just two credible points on a wider spectrum of possible development approaches for the connection of new offshore projects. Detailed project development work will still need to be conducted and the actual amount of infrastructure required may differ from the designs illustrated. Further, the progression of offshore wind development could differ from the trajectory provided by FES and thus impact on the level of effective coordination achievable under the counterfactual and policy scenarios.