OFFSHORE GRID COORDINATION

Delivering the shared offshore network

OWIC recommendations for enabling offshore grid coordination

Offshore Wind Industry Council

Foreword

"As the offshore wind sector moves from an innovator to incumbent in the energy market, playing a key role in UK energy security, the way we approach offshore grid delivery has to change."

The UK has been a global leader in offshore wind generation for over 20 years.

There are currently 15 GW of offshore wind operating in UK waters. The Government is committed to radically increasing offshore wind deployment by 2030 to support the Government's 2030 clean power mission. Further to this, The Crown Estate plans to lease a further 20-30GW by 2030 to realise a pipeline out 2040.

The rapid expansion of offshore wind is a huge success story, bringing value to the UK economy as well as well-paid, high-quality jobs to coastal communities. This success has been driven in part by an offshore grid delivery model that has allowed offshore wind farm developers to build their own grid assets in a radial (point-to-point) configuration, prior to financial and operational divestment, through a regulated process, to an Offshore Transmission Owner (OFTO).

However, as the offshore wind sector moves from an innovator to incumbent in the energy market, playing a key role in UK energy security, the way we approach offshore grid delivery has to change. The Government's Offshore Transmission Network Review (OTNR), published in 2020, highlighted a need to consider the UK's offshore wind pipeline as a whole and plan the network accordingly. The OTNR highlighted a need to account for the increasing number of landing points, constraints on the electricity system, and the environmental and community impact of new infrastructure. This resulted in a number of processes which required National Grid ESO to take a whole-system approach to planning the network, including the Holistic Network Design (HND), Follow-up Exercise (HNDFUE) and now the Centralised Strategic Network Plan (CSNP).

The work to date from Government, the regulator and the system operator to deliver these network plans in partnership with industry should not be underestimated and provides a strong foundation from which to build. However, more work is needed for the regulatory frameworks for offshore grid delivery to keep pace with the ambition of offshore wind and network designs. We have seen stagnated coordination of offshore grid development. Complexity of coordination, misaligned incentives between parties, ineffective coordination mechanisms, and financial, regulatory and policy uncertainty have combined to make the current approach to offshore coordination non-viable.

In response to the barriers identified, OWIC commissioned this report provide recommendations on how they can be overcome. The 25 recommendations in this report are aimed at addressing the challenges in three clear areas:

- Removing barriers to coordination in the existing regime.
- Adopting a new 'third party build' model for offshore grid delivery in future leasing rounds.
- Opportunities for better coordination in the offshore regime, in bothradial and non-radial projects.

We believe the recommendations in this report offer a workable, financeable and cost-effective pathway to delivering offshore grid coordination. Their adoption will benefit and accelerate current offshore grid delivery, paving the way for an enduring regime that is ready for delivery of a large-scale meshed offshore grid.

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Glossary of Terms

AI - Anticipatory Investment

ASTI - Accelerated Strategic Transmission Investment CBA - Cost-Benefit Analysis

CfD - Contracts for Difference

CSNP - Centralised Strategic Network Plan

CUSC - Connection and Use of System Code

DCO - Development Consent Order

DND - Detailed Network Design

DESNZ - Department for Energy Security and Net Zero ESA - Early Stage Assessment

ESO - Electricity System Operator

ETV - Estimated Transfer Value

EU – European Union

FID - Final Investment Decision

FTV - Final Transfer Value

GCC - Generator Commissioning Clause

HND - Holistic Network Design

HNDFUE - Holistic Network Design Follow Up Exercise HVAC - High Voltage Alternating Current

HVDC - High Voltage Direct Current

IAE - Income Adjustment Event

ITT - Invitation to Tender

LCOE - Levelised Cost of Electricity

MEA - Marine Environmental Assessment

MITS - Main Interconnected Transmission System NESO - National Energy System Operator

OFTO - Offshore Transmission Owner

OTNR - Offshore Transmission Network Review OWF - Offshore Wind Farm

PB - Preferred Bidder

POC - Point of Connection

SQSS - Security and Quality of Supply Standard SSEP - Strategic Spatial Energy Plan

TO - Transmission Owner

TNUoS - Transmission Network Use of System

TRS - Tender Revenue Stream

TSO - Transmission System Operator

UK – United Kingdom

General Context

OWIC

The Offshore Wind Industry Council (OWIC) was established in May 2013 to drive the development of the offshore wind sector in the UK.

Building on the outputs of the 2019 Offshore Wind Sector Deal and Seizing our Opportunities: Independent report of the Offshore Wind Champion, published in 2023, OWIC brings together industry and government to realise the UK's ambition of radically increasing offshore wind deployment by 2030.

Co-Chaired by the Secretary of State for Energy Security and Net-Zero and a government-appointed industry co-Chair, OWIC actively drives progress towards offshore wind delivery, supported by an industry-funded work programme and dedicated team within RenewableUK.

1 EXECUTIVE SUMMARY

The Offshore Transmission Network Review (OTNR) was launched in 2020 with the aim of ensuring that the transmission connections for offshore wind generation are delivered in the most appropriate way, and to strike an appropriate balance between environmental, social and economic costs. In July 2022, under the framework of the OTNR, National Grid ESO published the Pathway to 2030 Holistic Network Design (HND) which presented its recommended network design for the connection of 23 GW of offshore wind by 2030. The recommended design included radial and, for the first time, several non-radial connections, with wind farms exporting power via shared transmission infrastructure, in a move towards a more efficient, coordinated network topology.

However, there is broad consensus among key stakeholders that the current approach to coordination has not been successful and fundamental change is required to deliver an offshore grid which can unlock the UK's offshore wind potential and meet ambitious 2030 targets.

Network planning processes in GB are currently in a state of transition, with the National Energy System Operator

(NESO) developing the processes and capabilities to perform holistic planning for the onshore and offshore networks, publishing a 12-year ahead view in the form of an annual Centralised Strategic Network Plan (CSNP) publication. The HND and subsequent HND Follow Up Exercise formed the basis of the transitional CSNP (tCSNP) or "Pathway to 2030", and "Beyond 2030" (tCSNP2) publications, respectively.

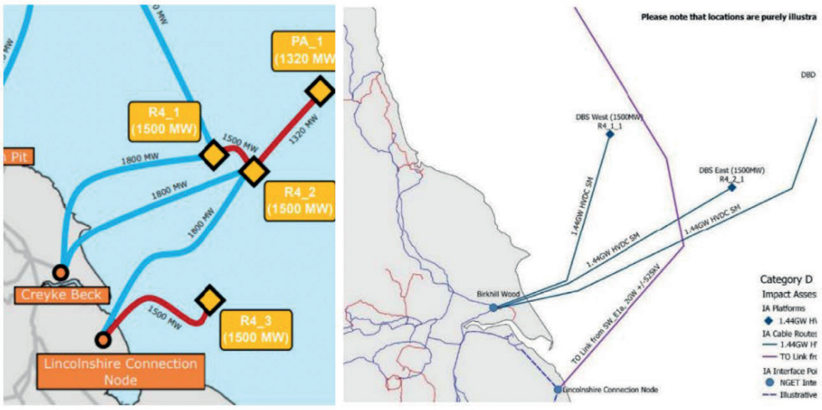
Under the present regime, the delivery models for radial designs are two-fold: "Generator build", with the Generator responsible for the construction of the radial link, before handover to an Offshore Transmission Owner (OFTO) to operate, and alternatively, an "Early Competition OFTO build" model, where a Generator develops the detailed design and with handover to a competitively appointed OFTO for the pre-construction and construction activities, and subsequent operation of the link.

In its Pathway to 2030 Decision, Ofgem confirmed that, similarly, there would be a choice of two delivery model for non-radial designs: "Generator build" and "Late Competition OFTO build", with an OFTO responsible for construction and operation of the link in the late competition delivery model. The added complexity of multiple Generators sharing infrastructure in non-radial designs prompted Ofgem to introduce new risk sharing and cost recovery mechanisms within the regime and established two defined roles: Initial Users; responsible for development of the non-radial link, and Later Users which may connect to shared infrastructure at a later date.

Following publication of the HND, projects were handed over to competent delivery bodies to progress the high-level designs towards mature detailed network designs. However, delivery bodies encountered significant challenges with the complexity of coordination, particularly in aligning project schedules of coordinating parties, and managing uncertainty and risk, particularly in project financing. Furthermore, the coordinated scheme located in the coastal waters of Lincolnshire (the "South Cluster", see Figure 1 - HND South Cluster original and revised DND designs) encountered issues with low technology maturity and immature supply chain in the chosen multi-terminal HVDC design, resulting in the ESO's Assessment that a new radial design would be more effective than the original non-radial design.

1 https://www.nationalgrideso.com/document/302691/download#:~:text=These%20parties%20are%20known%20as,rangi ng%20in%20levels%20 of%20interconnection.

Figure 1 - HND South Cluster original and revised DND designs



a. *Original cluster design* b. *New cluster design*

This report examines the complexities of coordination, and makes a series of recommendations to Ofgem, NESO and The Crown Estate to develop effective coordination in offshore grids.

This Report Finds:	
The underlying causes of failure to achieve coordination are:	• Complexity of coordination • Misaligned incentive mechanisms and risk apportionment • Ineffective coordination mechanisms • Regulatory and policy uncertainty • Financial risks and uncertainties
These underlying causes are also evident in the sector’s approach to:	• Planning • Financing and cost recovery • Delivery models and governance • Information sharing • Technology interoperability • Supply chain

This Report Sets Forth Recommendations Focused In Three Areas:	
1.	Removing barriers to coordination within the existing offshore regime
2.	Adoption of an alternative delivery model for non-radial projects which would enable better coordination in offshore grids
3.	Opportunities for better coordination in future offshore regimes, applicable to both radial and nonradial projects

1.1 Removing barriers to coordination within the existing offshore regime

The widely adopted "Generator build" regime can be quickly improved, ahead of the delivery of HND and HNDFUE projects, key recommendations to alleviate barriers to coordination within the existing offshore regime include:

- introduce coordination in the processes of offshore (and landfall) planning, routeing, consenting and surveys for radial designs, which could deliver many of the community and environmental benefits, characteristic of non-radial designs, but with less complexity, cost, and delay.
- consider larger allowances for first coordinated projects to reflect increased risk.
- reform the Cost Assessment process to reduce financial risks and uncertainty for initial users.
- develop a compensation mechanism to protect later users from financial impacts of delayed infrastructure delivery.
- establish a robust process for handling delays and potential handovers between initial and later users.
- review asset classification to reduce interfaces between different licensee types.
- provide guidelines on information sharing within competition law constraints.

1.2 Adoption of an alternative delivery model for non-radial projects

Ofgem should reconsider its decision to adopt a late competition OFTO build model, and instead implement a "Very Early Competition Third Party build and operate" model for delivery of non-radial designs (hereinafter referred to as the "third party model").

Definition of a very early competition third party build and operate model ('third party model'): Third parties to Ofgem and the NESO, such as GB TOs, EU TSOs, OFTO-led consortia, Generators, future CATOs, or any other organisation that could demonstrate competence in the delivery of large electricity transmission infrastructure, would be appointed through a very early competition for coordinated infrastructure projects. Ofgem's proposed late competition 'OFTO' delivery model, could be perceived to favour organisations that have already acquired OFTO licences through the radial regime. Therefore communication should be carefully crafted to ensure it does not discourage other potential third parties from participating. The third party would be granted an OFTO licence under the third party build and operate model.

Ofgem's previous decision to exclude early competition delivery models was based on its assessment that development of the tender process could take up to 24 months, followed by a further 18 months for implementation. The development of a third party model and associated framework should be progressed at pace by Ofgem, but should not delay (or prevent) the delivery of HND and HNDFUE projects under existing delivery models. While acknowledging the complexity of such a process, as the industry collectively pursues net zero goals, it becomes increasingly important for all stakeholders, including regulatory bodies, to explore ways to expedite critical processes where feasible. A swifter implementation could better align with the urgency of rapid infrastructure development to support the energy transition.

Figure 2 - Very early competition third party build and operate model

Network Planning	Detailed Network Design	Pre-construction (e.g. consenting)	Procurement and Construction	Operation
NESO	Third Party	Third Party	Third Party	Third Party

+ Reduces complexity in delivery and avoids coordination between Generators in competition with one another
+ Aligns with established policies favouring competition
+ Facilitates participation from non-TOs (e.g. European TSOs) whom may have strong links with supply chain

− Like existing delivery models, fragmented responsibility across third parties lowers 'buying power' for transmission equipment

The third party model (see Figure 2) should apply to all future non-radial offshore transmission infrastructure, including "wet onshore" infrastructure which is currently classified as TO build. Specifically, it would benefit a coordinated regime by:

- reducing the number of parties involved in delivery
- avoiding mid-project handovers
- promoting more efficient coordination within the existing competitive framework.

A broader framework should be implemented to support the new delivery model, this would include:

- implementation of comprehensive tender pre-qualification criteria, including; valuing financing, consenting, supply chain, design, construction, and project management expertise.
- implementation of strong incentives for timely delivery, akin to the Accelerated Strategic Transmission Investment (ASTI) Outcome Delivery Incentive (ODI).
- protection for Generators from delays or significant overspends for infrastructure they have no role in developing.
- move responsibility for surveys and environmental impact assessments to NESO and The Crown Estate.
- consider socialising more of the costs of offshore transmission, as is the case in European countries, which would reduce complexity and uncertainty in network charging.

1.3 Opportunities for better coordination in future offshore regimes, applicable to both radial and non-radial projects

Opportunities for better coordination in future offshore regimes, applicable to both radial and non-radial projects include:

- incorporating lessons learned from HND and HNDFUE exercises into the CSNP methodology.
- creating a taskforce to develop common technical standards for offshore transmission infrastructure.
- establishing mechanisms for coordinated surveys and assessments to reduce duplication.
- establishing a NESO market insight function to maintain data on technology choices, maturity, supply chain, and costs to inform planning.
- developing clear data governance and sharing protocols balancing competition concerns with coordination needs.

The report emphasises that if UK offshore wind targets are to be met whilst striking an appropriate balance between environmental, social and economic costs, changes to the regulatory framework are needed to overcome evident barriers to coordination. Implementing these recommendations would help to address the complexity, misaligned incentives, and financial risks currently hindering efficient delivery of coordinated offshore grid infrastructure.

1.4 Recommendations Table

NO.	AREA	RECOMMENDATION	APPLIES TO	TIMEFRAME	RESPONSIBLE
P1	Planning	Crown Estate, and the NESO should encourage coordination in the processes of offshore (and landfall) planning, routeing, consenting and surveys for radial designs, which could deliver community and environmental benefits with less complexity, cost, and delays than alternative non-radial designs.	Existing Regime	Short / Medium Term	NESO, TCE
F1	Financing and Cost Recovery	Ofgem should consider introducing larger allowances for the first coordinated projects that pave the way for coordinated grid designs, reflecting the increased risk that Developers are being asked to assume	Existing Regime	Short Term	Ofgem
F2	Financing and Cost Recovery	Ofgem should reform the Cost Assessment process for coordinated projects to reduce the significant financial risks and uncertainty faced by initial users	Existing Regime	Short / Medium Term	Ofgem
F3	Financing and Cost Recovery	Ofgem should develop a compensation mechanism to protect later users from financial impacts of delayed delivery of transmission infrastructure	Existing Regime	Short / Medium Term	Ofgem
F4	Financing and Cost Recovery	Ofgem should establish a robust process for handling delays and potential handovers between Initial Users and Later Users to provide greater certainty to generators	Existing Regime	Short / Medium Term	Ofgem
F5	Financing and Cost Recovery	Ofgem should review the asset classification process and consider how it can be more closely integrated with Network Planning to reduce the number of interfaces between different parties and licensee types in delivery of coordinated infrastructure	Existing Regime	Short / Medium Term	Ofgem
F6	Financing and Cost Recovery	Develop a more stable and predictable TNUoS charging mechanism with longer-term visibility to support investment decisions in offshore wind projects	Existing Regime	Short / Medium Term	Ofgem
I1	Information Sharing	Ofgem should provide guidance on what information can be shared at different project stages of coordinated design, within the confines of competition law	Existing Regime	Short / Medium Term	Ofgem
P2	Planning	The Crown Estate and NESO should be responsible for surveys and environmental impact assessments for non-radial project built under a very early competition third party build and operate model	Adoption of an alternative delivery model	Short / Medium Term	NESO, TCE

1.4 Recommendations Table

NO.	AREA	RECOMMENDATION	APPLIES TO	TIMEFRAME	RESPONSIBLE
D1	Delivery Model	Ofgem should reconsider its decision to adopt a late competition OFTO build model, and instead adopt a very early competition third party build and operate model for coordinated infrastructure	Adoption of an alternative delivery model	Medium Term	Ofgem
D2	Delivery Model	Ofgem should encourage new entrants into a very early competition third party regime with strong incentives for timely delivery of offshore infrastructure, instilling confidence in better whole system outcomes.	Adoption of an alternative delivery model	Medium Term	Ofgem
D3	Delivery Model	Ofgem should subsume the principles of the proposed OFTO build model qualification criteria into the new third party delivery model, prioritising construction expertise, and should implement a tiered entry system for new market participants	Adoption of an alternative delivery model	Medium Term	Ofgem
D4	Delivery Model	Generators should be protected from cost impacts resulting from late delivery or overspend under any future very early competition third party build model, as is the case in other European countries (NL, DE, FR, PL).	Adoption of an alternative delivery model	Medium Term	Ofgem
P3	Planning	The NESO should establish a market insight function which maintains a library of latest and future technology choices, technology maturity, supply chain considerations and associated unit and project overhead costs, and timings, to inform strategic planning	Future offshore regimes	Short / Medium Term	NESO
P4	Planning	The NESO should urgently identify lessons learned from the HND and HNDFUE exercises and incorporate those into the CSNP methodology	Future offshore regimes	Short Term	NESO
P5	Planning	The NESO should implement a clear mechanism for relevant stakeholders to provide early input into the design of offshore infrastructure within the CSNP	Future offshore regimes	Short Term	NESO
P6	Planning	Ofgem and the NESO should clearly define the roles and responsibilities of initial user, later users, TOs, the NESO, and Ofgem within the DND phase	Future offshore regimes	Short Term	Ofgem, NESO
P7	Planning	Ofgem should make the NESO formally responsible for coordinating the Detailed Network Design process alongside introducing a governance process for Cluster Forums and the DND	Future offshore regimes	Short Term	Ofgem
F7	Financing and Cost Recovery	Ofgem should consider socialising more of the costs of coordinated offshore grid	Future offshore regimes	Short / Medium Term	Ofgem

1.4 Recommendations Table

NO.	AREA	RECOMMENDATION	APPLIES TO	TIMEFRAME	RESPONSIBLE
I2	Information Sharing	Ofgem should oversee the development of clear data governance and data sharing protocols that balance competition concerns with coordination needs	Future offshore regimes	Short / Medium Term	Ofgem
I3	Information Sharing	Led by Ofgem and the NESO the sector should establish mechanisms for coordinated surveys and assessments to reduce duplication. This could involve third-party entities conducting surveys on behalf of multiple developers or creating standardised methodologies for data collection and sharing	Future offshore regimes	Short / Medium Term	Ofgem, NESO
I4	Information Sharing	Led by Ofgem and the NESO the sector should establish clear responsibilities for data handling and maintenance, and create common data catalogues accessible to all relevant stakeholders to ensure the use of consistent, up-to-date information across projects	Future offshore regimes	Short / Medium Term	Ofgem, NESO
I5	Information Sharing	Ofgem should establish clear roles and responsibilities at all stages but especially Detailed Network Design, with clear expectations set for scope and timeliness of information sharing	Future offshore regimes	Short / Medium Term	Ofgem
T1	Technology Interoperability	The NESO should establish a technology interoperability taskforce, with support from TOs and in coordination with ENTSO-E, to develop common technical standards for offshore transmission infrastructure	Future offshore regimes	Short / Medium Term	NESO
T2	Technology Interoperability	The NESO should monitor and engage with projects investigating the interoperability of different technologies in offshore grids to learn from their findings	Future offshore regimes	Short / Medium Term	NESO
S1	Supply Chain	The newly established technology interoperability taskforce (Recommendation T1) should identify and implement a framework for design standardisation across GB networks and developers to allow for greater coordination and interoperability of projects. Where possible, this should include alignment with IEC and EU standards and plans	Future offshore regimes	Short / Medium Term	NESO

2 UK OFFSHORE GRID DEVELOPMENT STATUS QUO

2.1 Government Objectives

The UK has been a global leader in offshore wind development over the past two decades. The first offshore wind farm in UK waters was commissioned in 2000[2], and the sector has since grown rapidly to become a cornerstone of the UK's renewable energy strategy. As of 2023, the UK had over 14 GW of operational offshore wind capacity making it the largest offshore wind market in Europe and the second largest in the world after China. As of May 2024, an additional 12.3 GW was under construction and more than 100 GW was in the early stages of development[3].

The UK Government has set ambitious targets for offshore wind deployment as part of its strategy to achieve net zero emissions by 2050. The current target is to reach up to 60GW of offshore wind capacity by 2030, including 5GW of floating offshore wind[4]. This represents a significant scaling up from current deployment and will require substantial investment in new projects and supporting infrastructure. With every increase in Government ambitions for offshore wind there are knock-on impacts on the timeframe for grid delivery, resulting in updated supply and demand backgrounds and changing needs-cases for new projects going through detailed design. UK 2030 offshore wind targets were increased from 30GW in 2019, to 40GW in 2020, and to 50GW in 2022, and potentially increasing further.

2.2 Prevailing Offshore Grid Regime

Throughout this report, where possible, a distinction is made between UK government policy (including Northern Ireland) and policy which applies to the countries of Great Britain (England, Scotland and Wales). Northern Ireland, being within the Integrated Single Electricity Market on the island of Ireland, has a different regulatory framework to the rest of the UK set by the Utility Regulator and the System Operator for Northern Ireland. Ofgem is the electricity market regulator for Great Britain; since most of the offshore wind capacity in the UK is installed in GB waters, Ofgem policies are the focus of this report.

2 https://guidetoanoffshorewindfarm.com/offshore-wind-history

3 https://gwec.net/global-offshore-wind-report-2024/

4 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1167856/offshorewind-investment-roadmap.pdf

2.2.1 Delivery Models

To date, the transmission infrastructure connecting offshore windfarms in Great Britain (GB) waters to the onshore transmission network has been designed and delivered by the developer of each offshore windfarm, this is known as the "Generator Build" model (see Figure 3 - Selected Delivery Model Options for an overview). The Generator Build model was the initial approach adopted for the development of offshore transmission infrastructure in GB in the early 2000s and initially allowed wind farm developers to design, build, and operate the transmission assets.

UK legislation requires the separation of concerns in electricity markets, and so as the sector developed, Ofgem, the electricity markets regulator in Great Britain, introduced the Offshore Transmission Owner (OFTO) regime. This was originally intended to replace the Generator Build model[5] with the OFTO assuming responsibility for financing, procurement, and construction of offshore transmission infrastructure, however these plans were later reconsidered to allow developers a choice between Generator Build and OFTO Build models. There are longstanding concerns around the implementation of the OFTO Build model and, despite several revisions of the model and public consultations through the 2010's and 2020's which sought to resolve these regulatory challenges, to date no offshore transmission infrastructure has been delivered under the OFTO Build model.

Figure 3 - Selected Delivery Model Options

Delivery Model option	Network Planning	Detailed Network Design	Preconstruction (e.g. consenting)	Procurement and Construction	Operation	Examples
Generator build	NESO	Offshore Generator	Offshore Generator	Offshore Generator	OFTO	GB status quo
Very early third party build and operate	NESO	Third party	Third party	Third party	Third party	Recommended in this report
Early OFTO build	NESO	Offshore Generator	OFTO	OFTO	OFTO	GB 2012-2024 (never utilised)
Late OFTO build	NESO	Offshore Generator	Offshore Generator	OFTO	OFTO	GB proposed 2024 onwards
TO build, OFTO operate	NESO	TO	TO	TO	OFTO	
TO build and operate	NESO	TO	TO	TO	TO	Similar to models used in NL, BE, DE, FR

5 https://www.ofgem.gov.uk/sites/default/files/docs/2009/06/main_0.pdf

2.2.2 Offshore Transmission Owners (OFTOs)

Since no OFTO build projects have taken place, the main role of OFTOs is to own and operate the transmission assets connecting offshore wind farms to the onshore grid. OFTO's are selected through a competitive tender process regulated by Ofgem, during which the transmission assets are transferred from the Generator to the OFTO. OFTOs are responsible for the ongoing operation and maintenance of the transmission assets, with some of their revenue linked to performance. This model aims to deliver reliable and cost-effective transmission infrastructure.

2.2.3 Seabed Leasing

The Crown Estate (for England, Wales, and Northern Ireland) and Crown Estate Scotland manage the leasing of seabed areas for offshore wind development. Once potential sites are identified, the process moves into competitive bidding rounds where developers submit proposals to lease specific areas. Following the bidding process, selected developers must complete environmental assessments and obtain various consents and licenses, including a Development Consent Order (DCO) and agreements to connect to the National Electricity Transmission System. Figure 4 shows the development cycle for a GB Offshore Wind Farm.

Figure 4 - Development cycle for a GB Offshore Wind Farm[6]

6 https://www.gov.uk/government/publications/accelerating-deployment-of-offshore-wind-farms-uk-offshore-wind-champion-recommendations/seizing-our-opportunities-independent-report-of-the-offshore-wind-champion

2.2.4 Network Planning

As the scale of offshore wind development has increased, there has been growing recognition of the need for a more coordinated approach to offshore grid development due to concerns that the traditional model of individual radial connections for each wind farm is inefficient and results in additional impacts on communities and the environment, The Offshore Transmission Network Review (OTNR), launched in 2020, marked a significant shift in the approach to network planning for offshore wind projects in Great Britain (GB). Previously, the process was Generator-led, with each project connecting to the grid on a radial, point-to-point basis. Following the OTNR the approach is more coordinated, with the aim of delivering a more strategic and efficient network designs which reduce environmental and community impacts. The first example of this approach was the Holistic Network Design (HND), developed by National Grid ESO to facilitate the connection of 23 GW of offshore wind and estimated to provide cost savings of around £4.3 billion[7]. The HND and HND Follow Up Exercise (HNDFUE) provide a recommended offshore and onshore network design for 2030 which allows regional clusters of offshore wind farms to connect together, rather than individually. Detailed Network Design (DND) for each regional cluster is being coordinated through informal "cluster forums" set up by National Grid ESO.

The National Energy System Operator (NESO) is now developing the processes and capabilities to perform holistic planning for the onshore and offshore networks, and will be publishing a 12-year ahead view in the form of an annual Centralised Strategic Network Plan (CSNP) publication.

2.2.5 Connections

Offshore wind farm connections are managed through bilateral agreements between developers and National Grid ESO. Historically, this process has faced challenges such as long queue times and inefficiencies, which have hindered the timely deployment of renewable energy projects. To address these issues, National Grid ESO has introduced significant reforms under the new "First Ready, First Connected" approach[8], aimed at streamlining the connections process and prioritising projects that are ready to proceed. These reforms are expected to significantly reduce the time it takes for new and existing projects to connect to the grid.

2.2.6 Contracts for Difference (CfD)

The Contracts for Difference (CfD) scheme is GB's primary support mechanism for offshore wind projects. Introduced in 2014, the CfD scheme provides long-term contracts that offer price stability to developers, thereby derisking investment and encouraging the development of renewable energy projects. Under the CfD scheme, developers compete in auctions, known as Allocation Rounds, to secure contracts which guarantee a set price for electricity. This mechanism ensures that developers have a predictable revenue stream, which is crucial for securing financing and managing project risks.

7 https://www.gov.uk/government/publications/offshore-transmission-network-review/offshore-transmission-network-review-summary-of-outputs
8 https://www.nationalgrideso.com/news/our-new-approach-long-term-connections-reform

2.2.7 Network Charging

Transmission Network Use of System (TNUoS) charges are a significant component of the costs associated with offshore wind projects. These charges allow Transmission Owners and OFTOs to recover the costs of building, owning, and maintaining transmission assets, both onshore and offshore. Predictability and fair apportionment of TNUoS charges for coordinated projects is one of the key issues affecting coordinated offshore grid development however many of these issues also apply to radial Generator connections, and onshore Generators. The TNUoS Taskforce[9] is examining reforms to TNUoS, and the Review of Electricity Market Arrangements[10] (REMA) may also impact how Network Charging is implemented.

9 https://www.nationalgrideso.com/industry-information/charging/charging-futures/task-forces
10 https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements

3 BARRIERS TO DELIVERING A COORDINATED OFFSHORE GRID QUO

3.1 Planning

3.1.1 Context

The HND and HND Follow Up Exercise (HNDFUE) provide a recommended offshore and onshore network design for 2030 which allows regional clusters of offshore wind farms to connect together, rather than individually. Detailed Network Design (DND) for each regional cluster is being coordinated through informal "cluster forums" set up by National Grid ESO.

The HND recommended transmission network designs for connecting 8 GW of projects from Offshore Wind Leasing Round 4, 11 GW from the ScotWind leasing round, and assumptions for 1 GW of floating wind from the upcoming Celtic Sea leasing round. Additionally, the HND considered 3 GW from other sites near Round 4 and ScotWind locations to explore potential coordination opportunities.[11] The analysis led to some regions having radial connections, some non-radial, and some a mixture of radial and non-radial.

The Centralised Strategic Network Plan (CSNP) is an upcoming initiative that will provide a long-term, strategic approach to transmission network planning in Great Britain[12] . It will integrate planning for onshore and offshore transmission networks as well as cross-border electricity interconnectors and offshore hybrid assets. The National Energy System Operator (NESO) evolving from the current Electricity System Operator (ESO), will be responsible for developing and delivering the CSNP.

Another significant change to the planning process is being introduced based on the recommendations in the Electricity Networks Commissioner's report[13] that explored options to speed up the delivery of transmission infrastructure in Great Britain. The report highlighted the need to bring together various plans across the energy sector and bridge the gap between government policy and network development. The development of a Strategic Spatial Energy Plan (SSEP) was recommended, with the objective of geographically coordinating supply and demand, mapping to national energy demand and Net Zero targets over a period of time. This plan is expected to be delivered by the NESO and should include a Marine Environmental Assessment (MEA), as well as offshore delivery route map prepared by the Crown Estate. SSEP might also become a directive to reject a connection application, if the project is not aligned with the plan[14].

11 https://www.nationalgrideso.com/document/262676/download

12 https://www.nationalgrideso.com/future-energy/beyond-2030/holistic-network-design-offshore-wind

13 https://www.gov.uk/government/publications/accelerating-electricity-transmission-network-deployment-electricity-network-commissioners-recommendations

14 https://www.nationalgrideso.com/document/298496/download

3.1.2 Planning: Barriers

- **The cost and complexity of coordinated designs is greater than initially envisaged:** Developing non-radial offshore grid has proven to be slower, more complex, and potentially more costly than anticipated, challenging the assumed benefits of reduced CAPEX for coordinated projects, particularly in the context of recent unforeseen economic shocks. The HND and HNDFUE did not sufficiently consider the complexity of offshore assets, the technology maturity required to deliver the design, and constructability of the assets.
- **By focusing predominantly on delivering non-radial connections, the existing network planning process misses opportunities for alternative forms of coordination which could deliver similar benefits with less cost and complexity:** Alternative forms of coordination, such as shared cable corridors and onshore works, could potentially deliver similar environmental and community benefits as non-radial designs but with less complexity and cost.
- **HND and HNDFUE encountered significant process challenges:** The Holistic Network Design (HND) and HND Follow-up Exercise (HNDFUE) processes faced challenges insufficient opportunity to understand and account for generator needs appropriately, and unclear roles and responsibilities.
- **There is a need for formal oversight of Detailed Network Design (DND):** The Detailed Network Design (DND) process faces significant challenges in coordinating competing Generators, highlighting the need for formal oversight and clearer processes.

See Planning: Detailed Findings for more details

3.1.3 Planning: Recommendations & Findings

RECOMMENDATIONS FOR THE EXISTING REGIME	
P1 Short / Medium-Term	**For radial designs, Crown Estate and the NESO should exploit coordinated planning, consenting, surveys, cable corridors, and onshore works which could deliver community and environmental benefits with less complexity, cost, and delays than non-radial designs.**
	• Coordinating planning, consenting, surveys, cable corridors, and onshore works for radial connections could deliver many of the community and environmental benefits originally envisaged from non-radial connections with significantly less complexity, cost, and delay. • This approach should be informed by learnings from coordination of cable corridors and onshore works for North Falls and Five Estuaries developments, and coordination of seabed leasing and network planning in the Celtic Sea.

3.1.3 Planning: Recommendations & Findings

RECOMMENDATIONS FOR AN ALTERNATIVE DELIVERY MODEL	
P2 Short / Medium-Term	**The Crown Estate and NESO should be responsible for surveys and environmental impact assessments for non-radial projects built under the very early competition third party build and operate model**
	• Under a very early competition model surveys and environmental impact assessments should be carried out by The Crown Estate and NESO to provide certainty to the network planning process and confidence in the recommended design. • In ideal case this process should complete prior to launch of the tender round to provide certainty to the developer regarding development of the grid infrastructure and connection timeline.

RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
P3 Short / Medium-Term	**The NESO should establish a market insight function which maintains a library of latest and future technology choices, technology maturity, supply chain considerations and associated unit, project overhead costs and timings to inform strategic planning**
	• There are potentially significant benefits to consumers associated with coordinated design. Nevertheless, the cost and complexity of non-radial designs in HND and HNDFUE has far exceeded initial assessment, resulting in more expensive infrastructure, which takes longer to develop, and has increased financing risk and costs. • The market insight function should reference the Offshore Wind Industry Council innovation roadmaps as benchmarks of technology maturity.
P4 Short Term	**The NESO should urgently identify lessons learned from the HND and HNDFUE exercises and incorporate those into the CSNP methodology**
	• Stakeholders reported challenges with the initial HND and HNDFUE designs and identified a need for earlier engagement and better understanding of developer needs, and for improved processes with clear roles and responsibilities.

RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
P5 Short Term	**The NESO should put in place a clear process for relevant stakeholders to provide early input into the design of offshore infrastructure within the CSNP**
	• HND designs did not detail specific offshore assets required and did not properly consider the cost, size and complexity of those assets, resulting in significant rework during DND to make them deliverable and reduce cost/complexity.
P6 Short Term	**Ofgem and the NESO should clearly define the roles and responsibilities of initial user, later users, TOs, the NESO, and Ofgem within the DND phase**
	• Ofgem should define in the Grid Code roles and responsibilities for license holders involved in DND, including setting expectations for minimum attendance requirements, requirement to provide information needed to progress design in a timely manner, and a requirement on all parties to commit to an agreed timescale.
P7 Short Term	**Ofgem should make the NESO formally responsible for coordinating the Detailed Network Design process alongside introducing a Governance process for Cluster Forums and the DND**
	• During the HND and HNDFUE the ESO assumed an informal role as convenor of Cluster Forums to develop the DND for each cluster. Going forwards Ofgem should formally assign the NESO with responsibility to oversee coordination within the DND process and arbitrate between coordinating parties through a regulated governance process or commercial framework.

3.2 Financing and Cost Recovery

3.2.1 Context

The UK's ambitious offshore wind targets require significant investment in transmission infrastructure. However, the current regulatory framework poses challenges for efficiently developing and financing coordinated grid connections serving multiple wind farms. Cost recovery mechanisms play a crucial role in determining the viability and attractiveness of these complex projects.

Figure 6 - Simple breakdown of the Cost Recovery process for Generator build coordinated offshore transmission projects:

Anticipatory Investment Approval	• The Initial User submits an Early Stage Assessment (ESA) to Of gem for approval of the anticipatory elements . • Ofgem reviews to ensure the additional investment is economic and efficient.
Initial Investment	• The initial offshore wind farm developer (Initial User) finances and builds both their wind farm and the shared transmission assets, including additional capacity for future projects.
Transfer Value Determination	• Ofgem assesses the economic and efficient costs of the transmission assets, including approved AI elements. • This becomes the Final Transfer Value (FTV) that the OFTO pays to acquire the assets.
Asset Transfer	• Once operational, the transmission assets are transferred to an Offshore Transmission Owner (OFTO). • The OFTO is selected through a competitive tender process run by Ofgem.
Cost Recovery for Initial User	• The Initial User recovers their investment in transmission assets through the FTV paid by the OFTO. • Any costs deemed inefficient by Of gem are “disallowed” and not recovered .
OFTO Revenue	• The OFTO receives a regulated Tender Revenue Stream (TRS) over 20-25 years to cover costs and provide a return .
Ongoing Changes and AI Cost Gap	• The Initial User pays Transmission Network Use of System (TNUoS) charges for their share of the assets. • The “AI Cost Gap” (costs associated with additional capacity) is initially socialized across all users through TNUoS charges.
Later User Connection	• When a later wind farm (Later User) connects, they begin paying TNUoS charges for their share of the assets. • The AI Cost Gap is gradually repaid as Later Users connect and pay charges.
Consumer Impact	• When a later wind farm (Later User) connects, they begin payingTNUoS charges for their share of the assets. • The AI Cost Gap is gradually repaid as Later Users connect and pay charges.

Anticipatory Investment (AI) refers to the practice of a Generator developing additional transmission capacity beyond their own immediate needs, in anticipation of future offshore wind farms sharing the same transmission assets. Prior to the introduction of AI in 2022[15], the Cost Assessment process for Offshore Transmission Owner (OFTO) final transfers did not provide compensation for Generators undertaking AI. Recognising the barriers this posed to coordinated offshore grid development Ofgem introduced the AI policy to establish a framework for cost recovery of shared transmission infrastructure development.

A key challenge in implementing AI is paying for, and managing the risk of, investments that may not be immediately utilised. To address this, Ofgem proposed a risk-sharing mechanism between consumers and developers:

1. The Initial User (the first Generator to connect) is responsible for TNUoS charges related to non-AI infrastructure elements.
2. Consumers temporarily bear the risk of the AI costs through Transmission Network Use of System (TNUoS) residual charges until the later project connects.HND and HNDFUE encountered significant process challenges: The Holistic Network Design (HND) and HND Follow-up Exercise (HNDFUE) processes faced challenges insufficient opportunity to understand and account for generator needs appropriately, and unclear roles and responsibilities.
3. If they fail to connect, consumers underwrite the cost of the unused AI component.

Ofgem's policy framework includes several key elements:

Extension of AI principles to network charging: This allows recovery of AI costs via TNUoS charges. Consumers underwrite the "AI Cost Gap" - the period between the initial user transferring the asset to an OFTO and the later user(s) connecting. An illustration of the AI Cost Gap is given in **Figure 6**. Later users then repay the AI Cost Gap through TNUoS charges. This was implemented through Connection and Use of System Code (CUSC) modification CMP411[16].

User commitment arrangements: Ofgem invited the Electricity System Operator (ESO) to propose extensions to AI via CMP402[17]. This aims to place financial liabilities on Generators who trigger network investments by agreeing to be later users of shared infrastructure. The goal is to protect consumers from unnecessary costs if a user reduces capacity or cancels a project. As of July 2024, CMP402 is still in development.

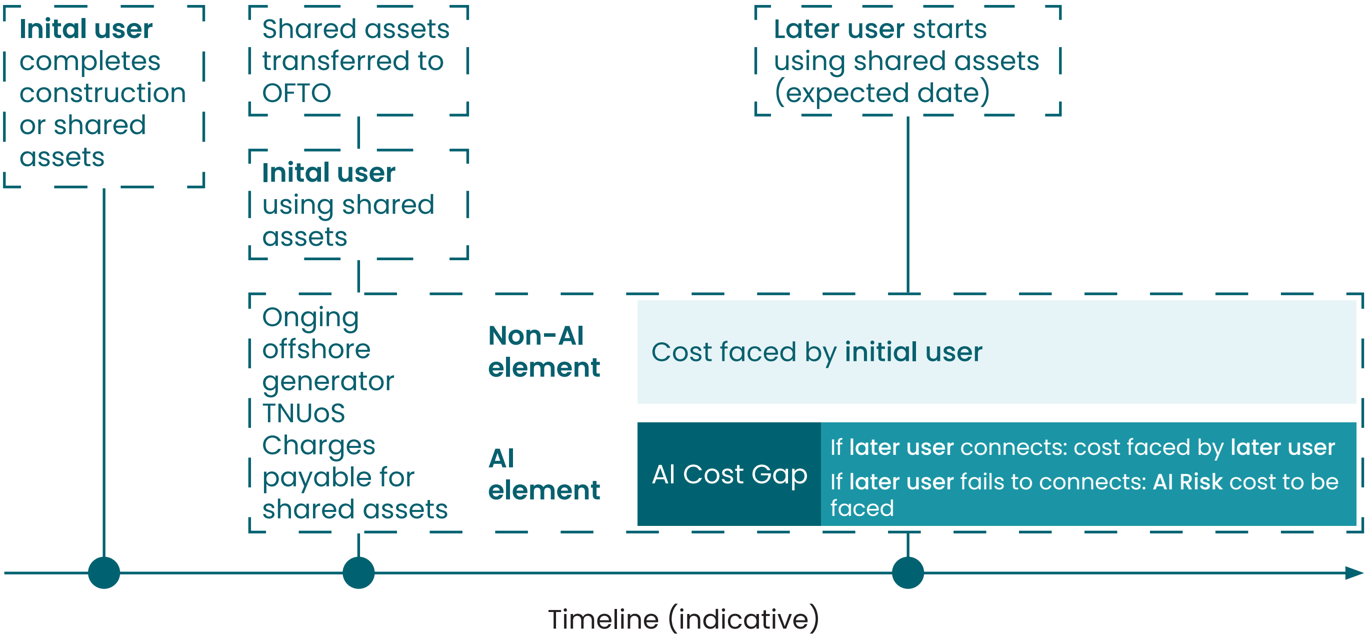
Early-Stage Assessment (ESA)[18] : Introduced in 2023 the ESA provides a framework for developers of offshore transmission infrastructure to seek approval for their anticipatory investments. This process aims to give developers confidence that their investments will be recognised and treated as allowable costs in future assessments. It involves a detailed submission by developers, including cost estimates and justifications, which Ofgem reviews to ensure efficiency and necessity.

16 https://www.nationalgrideso.com/industry-information/codes/cusc/modifications/cmp411-introduction-anticipatory-investment-ai-within-section-14-charging-methodologies

17 https://www.nationalgrideso.com/industry-information/codes/cusc/modifications/cmp402-introduction-anticipatory-investment-ai-principles-within-user-commitment-arrangements

18 https://www.ofgem.gov.uk/decision/decision-early-stage-assessment-anticipatory-investment

Figure 7 – Illustration of AI Cost Gap and AI Risk in relation to the AI element of the TNUoS charges to be recovered for the shared assets[19]



AI Cost Gap

19 https://www.ofgem.gov.uk/sites/default/files/2022-10/Impact%20assessment%20on%20allocating%20anticipatory%20investment%20risk%20in%20offshore%20transmission%20systems%20in%20Early%20Opportunities%20%28002%29.pdf

3.2.2 Financing and Cost Recovery: Barriers

- **The Generator build model does not incentivise Generators to construct shared infrastructure:** The current regulatory framework lacks financial incentives for Generators to pursue coordinated offshore transmission projects, as they face increased risks and costs without corresponding profits.
- **Initial Users of coordinated projects are disadvantaged in CfD auctions compared to uncoordinated projects:** The Anticipatory Investment (AI) framework interacts unfavorably with CfD rounds, Cost Assessment processes, and Network Charging, putting Initial Users at a disadvantage in CfD auctions.
- **Later Users are fully exposed to risks from delays caused by the Initial User:** Later Users face significant financial risks if the Initial User's project is delayed, with no established compensation mechanisms.
- **Later Users must commit to take over projects, though this may not be feasible and may result in financial losses:** The requirement for Later Users to potentially assume responsibility for shared infrastructure presents significant technical, financial, and operational challenges.
- **There is no dispute resolution process in case the Initial and Later users cannot agree on transfer of responsibility:** The lack of a clear framework for transferring project responsibility between Initial and Later Users creates significant uncertainty and potential for disputes.
- **Asset classification resulting in different types of licence holder coordinating is a barrier to delivery of coordinated offshore grid:** The asset classification process introduces challenges by requiring different types of license holders to coordinate, leading to conflicting requirements and contractual complexities.
- **The Anticipatory Investment (AI) framework does not fully remove barriers to coordinated offshore grid development:** While the AI framework is welcomed, remaining policy uncertainties and complexities in its interaction with existing policies continue to deter Generators from developing coordinated projects.
- **Unpredictability of TNUoS charges is a key risk in development of coordinated offshore grid:** The difficulty in accurately forecasting Transmission Network Use of System (TNUoS) charges creates substantial challenges for Generators in financial planning and securing investments for coordinated offshore grid projects.

See APPENDIX: Financing and Cost Recovery: Detailed Findings for more details

3.2.3 Financing and Cost Recovery: Recommendations and Key Findings

<table>
<tr><th colspan="2">RECOMMENDATIONS FOR THE EXISTING REGIME</th></tr>
<tr><td>F1
Short / Term</td><td>Ofgem should consider introducing larger allowances for the first coordinated projects that pave the way for coordinated grid designs, reflecting the increased risk that Developers will be asked to assume</td></tr>
<tr><td></td><td>• There is currently no clear incentive for generators to take the risk to develop shared infrastructure. Generators cannot profit from delivering transmission infrastructure, and typically make a loss of around 10%
• In building shared infrastructure Generators are required to spend significantly more CAPEX to enable a competitor project to connect, the CAPEX can be recovered but only after a delay.
• Generators face significant financial risks from incomplete recovery of CAPEX for coordinated infrastructure as a result of Ofgem’s Cost Assessment process, which is triggered by greater than 10% overspend. Triggering of Cost Assessment is considered not unlikely given:
  ◦ the increased complexity of coordinated infrastructure
  ◦ delays caused by coordination processes
  ◦ higher supply chain risks for typically larger and less technologically mature coordinated infrastructure</td></tr>
<tr><td>F2
Short / Medium Term</td><td>Ofgem should reform the Cost Assessment process for coordinated projects to reduce the significant financial risks and uncertainty faced by initial users</td></tr>
<tr><td></td><td>• The scheduling of the ESA process, CfD rounds, FID, the AI decision, and final Cost Assessment means that Initial Users are guaranteed to have cost uncertainty from either the AI decision or the Cost Assessment process. The risks inherent in this process are amplified by typically higher supply chain risk for the equipment needed for coordinated infrastructure due to its immature and constrained supply chain.
• The 10% margin of error allowed in ESA CAPEX estimates is not sufficient to mitigate the uncertainty in design and supply chain risk for ESA submissions submitted early in the development process in time to secure the commitment of the Later User and have AI certainty for CfD and FID.
• Unlike for traditional radial links, disallowed costs for shared infrastructure do not translate into proportionately lower TNUoS charges for the Initial User, since some of the reduced CAPEX is subtracted from the TNUoS charges of the Later User(s).</td></tr>
</table>

3.2.3 Financing and Cost Recovery: Recommendations and Key Findings

RECOMMENDATIONS FOR THE EXISTING REGIME	
	• The significantly increased cost of coordinated projects means that disallowed costs resulting from the Cost Assessment process (Generators reported a range of 10-30% disallowed costs) present a severe risk to project financing. The risk and uncertainty of potentially disallowed costs makes FID for coordinated projects extremely challenging
F3 Short / Medium Term	**Ofgem should develop a compensation mechanism to protect later users from financial impacts of delayed delivery of transmission infrastructure**
	• Later users are exposed to significant risk delayed delivery and energisation, and there is no mechanism in place to compensate later users should such an event materialise. This presents barrier to coordination as there is an imbalance in risk hence most generators would seek to be the initial user of coordinated infrastructure to maintain control over delivery of the connection, or to avoid coordination altogether. • The compensation mechanism should substantially remove risk of late delivery from Later Users, since they play no role in construction, and a limited role in planning and consenting.
F4 Short / Medium Term	**Ofgem should establish a robust process for handling delays and potential handovers between Initial Users and Later Users to provide greater certainty to generators**
	• There is significant uncertainty over the feasibility and potential legal, commercial, and financial impacts of attempting to hand over responsibility of coordinated projects from the Initial User to the Later User in the event of a delay. This uncertainty creates significant financial risks for Later Users and impacts the ability of Later Users to get board and investor approval to sign the joint AI letter.

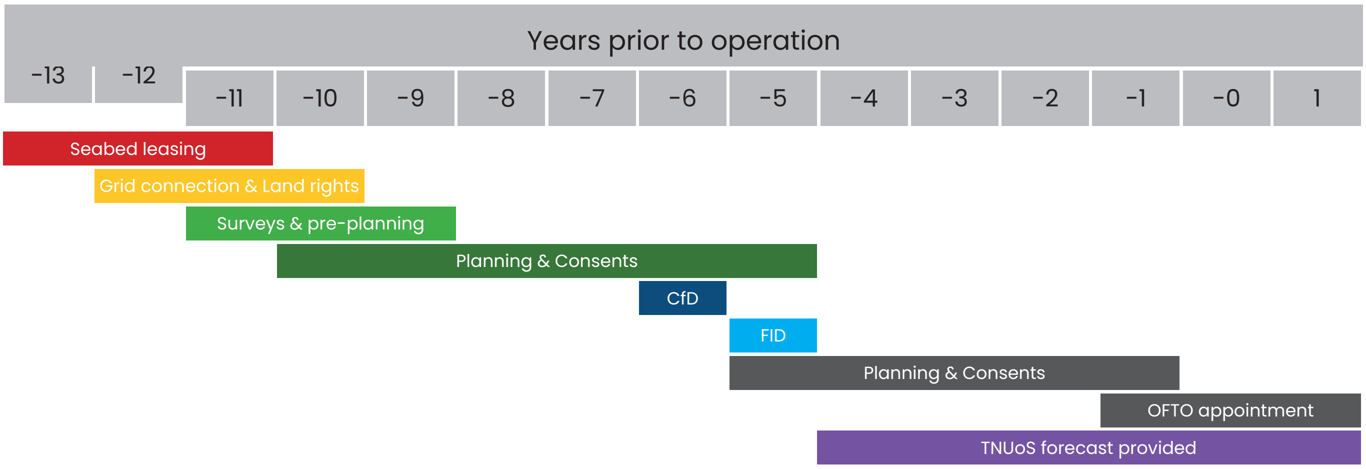
RECOMMENDATIONS FOR THE EXISTING REGIME	
F5 Short / Medium Term	**Ogem should review the asset classification process and consider how it can be more closely integrated with Network Planning to reduce the number of interfaces between different parties and licensee types in delivery of coordinated infrastructure**
	• Coordinating with more than one other party is viewed as extremely challenging given the complexity of aligning designs, schedules, and incentives (e.g. commercial, regulatory, license conditions).
F6 Short / Medium Term	**Develop a more stable and predictable TNUoS charging mechanism with longer-term visibility to support investment decisions in offshore wind projects**
	• Unpredictable TNUoS charges increase investment risk and financing costs • Uncertain policy environment adds to the difficulty of predicting charges, such as uncertainty over future rules for MITS nodes and local circuit classification affecting Generators connecting to TO owned offshore bootstraps
RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
F7 Short / Medium Term	**Ofgem should consider socialising more of the costs of coordinated offshore grid**
	• The uncertainty and risks associated with developing coordinated offshore grid under the current regulatory regime make project financing very challenging and more costly, Generators must build higher financing costs and risks from uncertainty into CfD bids. Costs are ultimately passed to the consumer one way or another, what is not in doubt is that current polices are creating unnecessary and costly delays to delivery of offshore wind capacity which will lower energy bills and is vital to achieving UK Net Zero and Energy Security. • The Anticipatory Investment policy in its current form is not intended to enable the development of highly coordinated offshore grid, for instance where the identity of the Later User is not yet known. • Ofgem introduced the AI policy to respond to a particular set of problems and further adaption may be required for different forms of highly coordinated networks.

3.3 Delivery Model – OFTO Build Feasibility

3.3.1 Context

UK legislation requires the separation of concerns in electricity markets, and so as the sector developed, Ofgem, the electricity markets regulator in Great Britain, introduced the Offshore Transmission Owner (OFTO) regime. This was originally intended to replace the Generator Build model[20] with the OFTO assuming responsibility for financing, procurement, and construction of offshore transmission infrastructure, however these plans were later reconsidered to allow developers a choice between Generator Build and OFTO Build models. There are longstanding concerns around the implementation of the OFTO Build model and, despite several revisions of the model and public consultations through the 2010's and 2020's which sought to resolve these regulatory challenges, to date no offshore transmission infrastructure has been delivered under the OFTO Build model.

Figure 8 - Typical Wind Farm Development Timeline[21]



The challenges associated with coordination of transmission infrastructure between Generators who are in competition has resulted in renewed efforts to provide an OFTO build alternative that Generators have confidence in. In March 2023 Ofgem decided that the delivery model options for non-radial offshore transmission assets within HND and HNDFUE would be Generator build and late competition OFTO build. Ofgem launched a consultation on the OFTO build model which as of July 2024 is closed and awaiting decision.

20 https://www.ofgem.gov.uk/sites/default/files/docs/2009/06/main_0.pdf
21 https://www.ssen-transmission.co.uk/globalassets/documents/tnuos/tnuos-offshore-wind-addendum---sept-2021.pdf

Ofgem's approach for OFTO build in non-radial HND and HNDFUE projects is known as the late competition OFTO build model. Under a late competition OFTO build model:

- the OFTO is responsible for construction and for financing construction
- the generator has responsibility over engineering and detailed design, which will be based on the high-level design provided by the NGESO in the HND and HNDFUE.
- responsibility for procurement remains undecided at the time of writing of this report

This offers more flexibility in how Generators choose to develop OFTO build projects, as shown in Figure 9 – OFTO build (OFTO Procurement) - Ofgem 2024 and Figure 9 - OFTO build (Generator procurement) - Ofgem 2024. However, this flexibility is within the confines of a Late Competition OFTO build model, in which the Generator is responsible for initial project design and preliminaries such as consenting.

Figure 9 – OFTO build (OFTO Procurement) - Ofgem 2024[22]

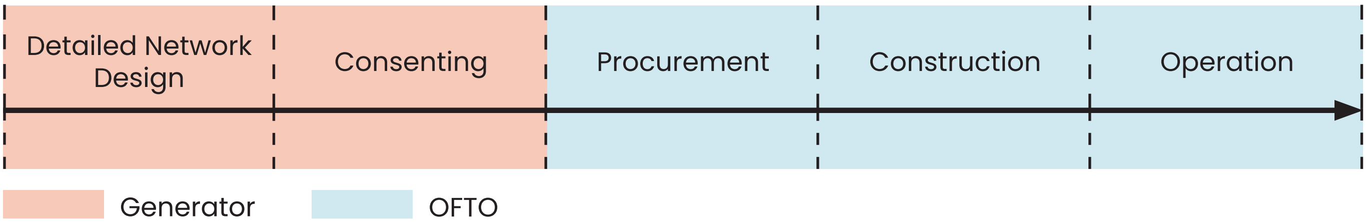
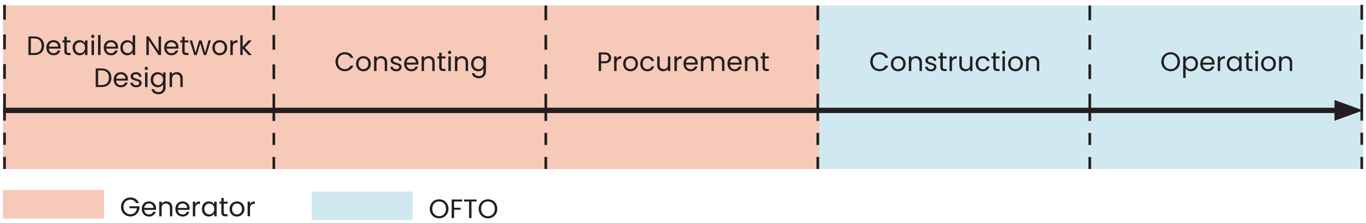


Figure 10 - OFTO build (Generator procurement) - Ofgem 2024



Ofgem's initial view is that Generator procurement is the preferred option for the following reasons:

- Generator procurement is the most feasible short-term option due to supply chain constraints.
- Generators have experience procuring offshore transmission assets and can start early in development.
- This option allows overlapping procurement with consenting, mitigating delays.

Ofgem further note that:

- Generator procurement presents risks for OFTOs include inheriting mature projects and pre-appointed contractors, and that OFTO procurement may be revisited in the future as supply chain improves and bidders gain experience.
- Industry standards development may address asset quality concerns, making procurement party less critical.

However, while the Late Competition OFTO build aims to facilitate coordination, significant barriers remain that could impede efficient delivery of the offshore grid infrastructure needed to support the UK's energy transition goals.

22 Consultation on initial proposals for an OFTO Build model to deliver non-radial offshore transmission assets (ofgem.gov.uk)

3.3.2 Delivery Model – OFTO Build Feasibility: Barriers

- **Under the existing regime the involvement of multiple parties in delivery creates excessive complexity in market and regulatory structures, hindering efficient coordination:** The involvement of multiple parties in project delivery creates complexity and challenges in aligning schedules, financing, and designs, suggesting a third-party model could provide a clearer framework for coordination.
- **OFTOs lack necessary construction experience and capabilities to effectively manage coordinated asset delivery:** The current OFTO regime does not ensure that OFTOs have the necessary risk appetite, financing, and experience to manage complex coordinated asset delivery, potentially leading to increased risks and costs.
- **The current pool of potential bidders for OFTO build coordinated projects is potentially limited:** The limited pool of potential bidders for OFTO build coordinated projects may result in reduced competition and poor value for consumers, with GB TOs and EU TSOs potentially being more suitable candidates for these complex projects.
- **Generators should not be penalised for delays or significant overspends for infrastructure which they have no role in developing:** The current risk allocation in Ofgem's proposed OFTO build regime may discourage coordination by placing disproportionate risks on generators for delays or overspends in transmission infrastructure development.

See APPENDIX: Delivery Model – OFTO Build: Detailed Findings for more details

3.3.3 Delivery Model - OFTO Build Feasibility: Recommendations and Key Findings

RECOMMENDATIONS FOR AN ALTERNATIVE DELIVERY MODEL	
D1 Medium Term	**Ofgem should reconsider its decision to adopt a late competition OFTO build model, and instead adopt a very early competition third party build and operate model ("third party model") for coordinated infrastructure**
	• The currently proposed late competition OFTO build model does not resolve uncertainty and inequity in cost allocation and risk sharing mechanisms which undermines its viability for coordinated infrastructure. • The third party model would reduce the number of parties responsible for delivery and operation of transmission infrastructure from four to two (the NESO and third party) whilst encouraging competition and added build capacity provided by new entrants. • This would avoid handover mid-way through projects, reduce complexity in market and regulatory structures, and promote more efficient coordination within the existing competitive framework • The third party model should apply to all offshore transmission infrastructure, including "Wet Onshore" infrastructure which is currently classified as TO build. This would help resolve lack of engagement from coordinating parties which have later development timelines and/or less incentives to quickly progress coordinated designs. • Ofgem should aim for the new delivery model to be available in time for coordinated projects in Leasing Round 6. • The new delivery model should be optional for coordinated HND and HNDFUE projects to prevent further delays to in-flight projects.

RECOMMENDATIONS FOR AN ALTERNATIVE DELIVERY MODEL	
D2 Medium Term	**Ofgem should encourage new entrants into the very early competition third party regime with strong incentives for timely delivery of offshore infrastructure, instilling confidence in better whole system outcomes.**
	• The current pool of potential bidders for OFTO build coordinated projects is potentially limited due to the complexity of developing this infrastructure, and the predominance of the Generator build model. • Competent third parties which could demonstrate significant experience in delivering large scale transmission infrastructure should be encouraged to enter the market, such as GB TOs, CATOs, EU TSOs, Generator-led consortia, OFTO-led consortia, or other competent organisations meeting tender pre-qualification requirements (see Recommendation D3) • A similar approach to the ASTI Output Delivery Incentive could help ensure timely delivery
D3 Medium Term	**Ofgem should subsume the principles of the proposed OFTO build model qualification criteria into the third party model, prioritising construction expertise, and should implement a tiered entry system for new market participants**
	• The design of the current OFTO regime does not ensure that OFTOs have the necessary risk appetite, financing, and experience required to effectively manage highly complex coordinated asset delivery, with the current OFTO market dominated by a relatively small number of financial investors and asset operators who lack significant construction experience. • Ofgem should enact pre-qualification criteria for third party model projects which value financing, consenting, supply chain, design, construction, operation, and project management capabilities. • A tiered qualification system may allow new entrants to gradually build experience and take on larger projects over time
D4 Medium Term	**Generators should be protected from cost impacts resulting from late delivery or overspend under the third party model, as is the case in other European countries (NL, DE, FR, PL).**
	• Generators should not be penalised for delays or significant overspends for infrastructure which they have no role in developing. The generator would be entirely reliant on the third party to complete the project on time to be able to export and sell power to the grid. • Generators could be compensated based on wind speeds and their CfD price (or the wholesale price) during the delay period

3.4 Delivery Model - Lessons From Other Jurisdictions

3.4.1 Context

An increasing number of offshore wind markets are emerging as governments around the globe establish political targets for the deployment of this technology. A key prerequisite for harnessing the full potential of offshore wind in any country is careful consideration of the delivery models for the offshore grid which will enable the integration of the generated electricity into the national energy system. Two perspectives that determine a delivery model can be considered:

- governance across different project development phases (planning, detailed design, permitting and environmental studies, procurement, construction, operation and decommissioning)
- governance across different types of assets (offshore substation platform offshore cables, onshore substation platforms)

In the following sections, OWIC presents an overview of the different delivery mechanism options, the rationale for their selection, and the lessons learned.

3.4.2 Delivery Model – Lessons from Other Jurisdictions: Recommendations and Key Findings

RECOMMENDATIONS FOR AN ALTERNATIVE DELIVERY MODEL	
D1	**There are many benefits to adopting a centrally-led coordinated offshore grid delivery and asset governance model, with TOs being the most logical options for GB.** **However, the third party model would provide the best compromise between the benefits of central delivery, and ensuring sufficient resource capacity to deliver UK offshore wind targets**

	• Arguments for transitioning from developer to a European-style TSO-led delivery model, and in most cases for the resulting asset governance include:
	    • Offshore transmission delivery by TSO reduces the delivery risks for offshore wind project where coordination between multiple wind projects is sought.
	    • Offshore transmission delivery by TSO lowers the risks to project developers by shifting liabilities for availability to TSO, improving offshore wind business case and facilitating expansion of generating capacities.
	    • Having a TSO as a central party responsible for all offshore wind projects in a country allows for economies of scale both in development and operational phases.
	    • Centrally-led delivery facilitates faster offshore wind buildout, especially in markets with constrained supply chain and logistics.
	    • Shifting responsibility to TSO improves bankability of projects and allows to attract larger investment in offshore wind development at early stages.
	    • Avoiding competitive tender provides significant time savings during project development
	• OWIC acknowledges that the TOs experience of the delivery of offshore transmission assets is limited to the recent “bootstraps”, and the TOs improving resources for the deployment of onshore transmission assets, however they do have the scale and experience needed to deliver large infrastructure projects. It has been demonstrated that where strong incentives are in place, TOs can be capable of rapid deployment of transmission infrastructure. This is evidenced by the progress made towards delivering Accelerated Strategic Transmission Investment (ASTI) projects which incorporates a new “Output Delivery Incentive (ODI).[23]
	• See Figure 11 - Overview of alternatives to the Generator build model for non-radial offshore transmission for a comparison of alternatives to the Generator build model considered in this report

23 https://www.ofgem.gov.uk/sites/default/files/2023-08/Accelerated%20Strategic%20Transmission%20Investment%20Guidance%20And%20ubmission%20Requirements%20Document.pdf

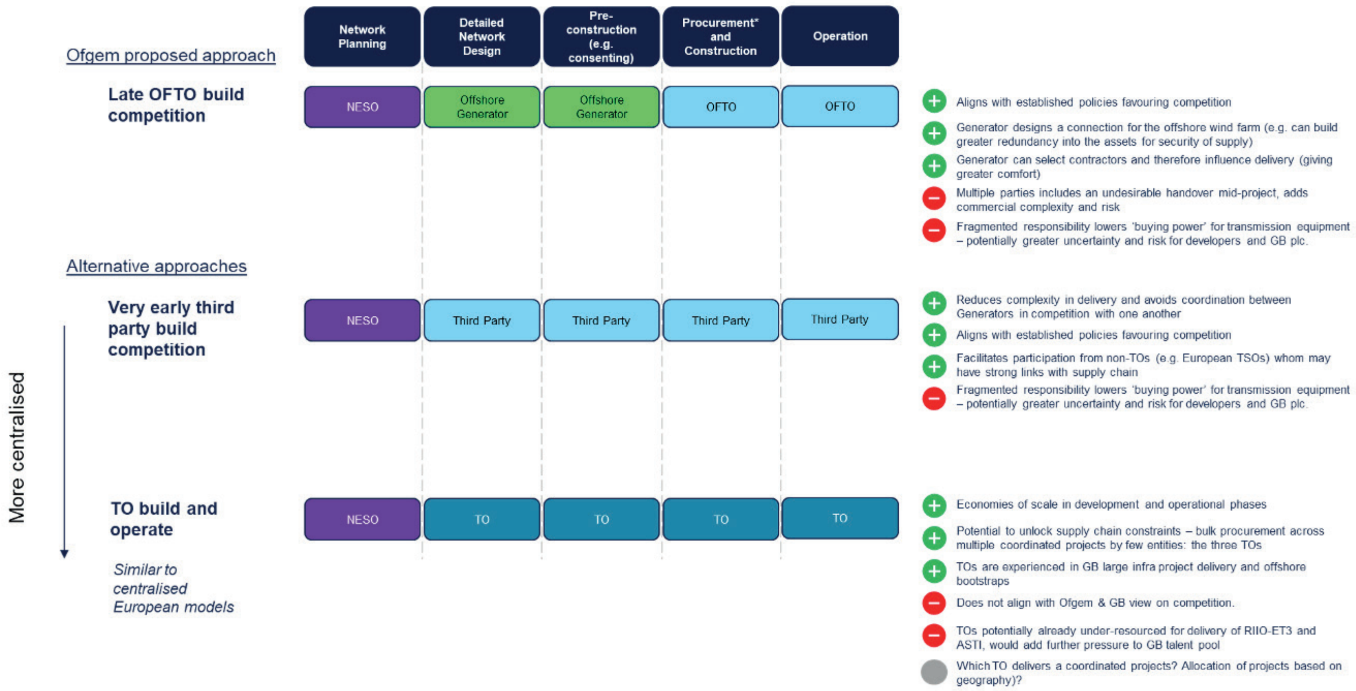
OWIC's review of the offshore grid delivery models adopted in other European countries showed a trend towards centralised delivery models, especially in countries where coordinated offshore grid delivery is sought. While in the early stages of offshore wind sector growth all countries relied on developer-led offshore wind delivery regime, as long-term offshore network plans mature, and renewable targets become more ambitious governments opt for centrally-led delivery model.

In most countries the central party responsible for the governance of different project delivery phases and for the eventual asset governance is the national Transmission System Operator (TSO). The TSO is typically a state-owned regulated corporation tasked with planning, design, financing, construction, operation and maintenance of the national offshore grid.

In GB, the closest analogue of a TSO would be TOs. Unlike typical European TSOs, GB TOs are not state-owned. Yet, they receive regulated income derived from network charging and are responsible for the provision of a vital public good of building, operating, maintaining and owning the onshore transmission grid. In countries, where TSO-led offshore grid regime is utilised, the costs of the offshore grid are socialised through network tariffs, levies and taxes.

What is key is that the TSO receives regulated incentive-based income for the successful fulfilment of its tasks which is more important than the eventual ownership. This allows it to attract lower cost finance and ensures investor certainty.

Figure 11 - Overview of alternatives to the Generator build model for non-radial offshore transmission



3.4.2.1 Comparison of two models

OWIC recommends considering the following factors in deciding whether to follow the developer- or centrally-led approach to offshore grid delivery: maturity of the sector and level of institutional competences, share of the total achievable offshore wind energy potential in the national electricity supply, access to finance and cost of capital achievable by state and private parties, onshore grid strength, supply chain constraints, geopolitical synergies or risks.

A summary of the pros and cons of two regimes is presented below.

Table 3-1 Comparison of TSO-led and Developer-led models

	TSO-led delivery	Developer-led delivery
Planning and Design		
Pros	• Standardised construction design • Standardisation of electrical components • Full control on future planning with potential for synergies between projects • Holistic view on whole system needs	• Need for minimal functional specifications to be delivered by the TSO/TO • Good fit between wind farm requirements and offshore transmission system • Limited contractual interfaces
Cons	• Need for more detailed design (FEED) to be delivered by the TSO/TO • Potential for suboptimal system design, misalignment with developer needs	• Potential large design variations (topside, support structure, electrical components) • Individual project-by-project approach
Procurement and Construction		
Pros	• Economies of scale across multiple projects can lead to cost savings • Standardisation of components can lead to better alignment with future operations • More favourable financing conditions for TSOs/TOs • Better coordination with onshore grid reinforcements	• Initial investments made by developer • Lower liability for a TSO/TO as risk is carried by developer • Incentive to ensure higher asset availability and on-time delivery through direct impact on revenue

Cons	• Higher initial investment needed potentially not covered by fees imposing burden on state budget
	• Large project organisation needed with experienced procurement and construction managers, especially when multiple projects are being developed
	• Need for financial compensation mechanism towards developers in case of delays
		• Less control by the TSO/TO on
		  • project schedule
		  • quality assurance
		  • variations
		• Cost of capital is likely to be higher for developers
		• Need for interface management between TSO/TO (onshore reinforcement) and developers

	TSO-led delivery	Developer-led delivery
Asset management / Operations		
Pros	• Better standardisation of assets, hence potential for cost savings in maintenance • Synergies between operation of onshore grid and offshore transmission system	• Synergies in operation of OWF and transmission system • Availability incentivised through direct impact on revenue
Cons	• Availability incentives needed	• Project-by-project optimisation

3.4.3 Asset governance

The asset governance in the majority of cases follows directly from the project phase governance, i.e. the party responsible for the design, procurement and construction of an asset, retains the ownership and remains responsible for its operation, maintenance and decommission.

The only existing exception is the GB OFTO regime where developers have historically built assets and later transferred the ownership to competitively appointed OFTOs. Another exception are the Danish offshore energy islands, where the exact scheme is not confirmed yet. It is known that eventually the state will retain the 51% ownership of the islands, even though their delivery might be the responsibility of private developers, thus at some point the transfer of ownership will have to take place.[24]

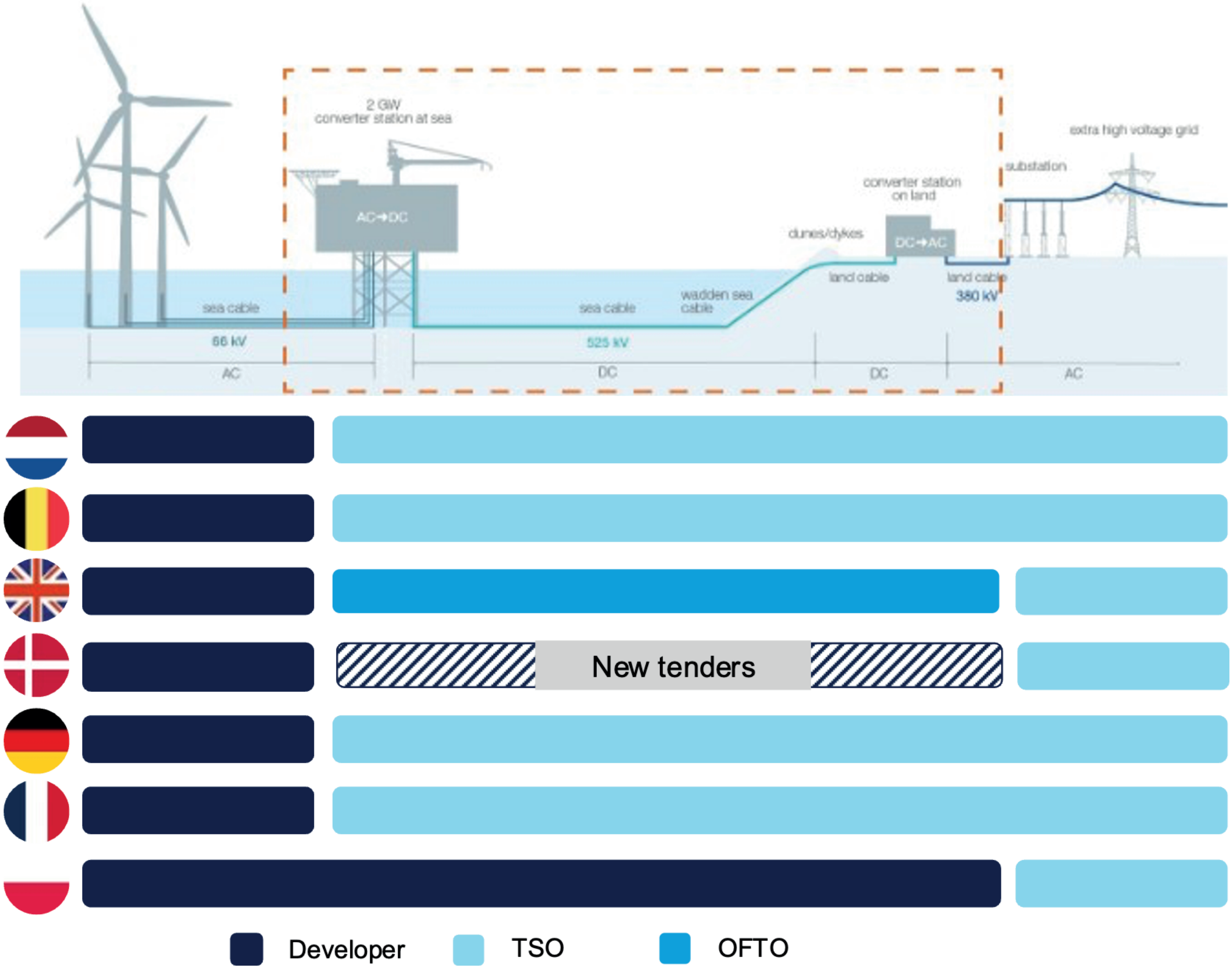
Based on the review of the offshore transmission asset ownership boundaries, OWIC concludes that there is an international tendency towards TSO-led development model which implies that the TSO owns and operates the offshore grid. The only exception is Denmark which shifted from TSO- to developer-led approach for its upcoming two projects. Arguably, the decision to follow a specific model can be impacted by political preferences in a given country.

In France, Germany, the Netherlands, Belgium, and GB offshore transmission assets including offshore platform with the substation and transmission cables are owned and operated by a TSO (in GB this role is fulfilled by OFTOs). Except for the GB, these assets are also developed by the TSO of each country. In GB assets are built by a developer and then transferred to OFTO historically.

On the other hand, Poland and Denmark has chosen developer-led approach for its two upcoming tenders anticipating that the overall project costs can become lower, and innovation will be stimulated, if a developer takes responsibility for the construction and ownership of offshore substation, including the platform.

24 https://ens.dk/en/our-responsibilities/offshore-wind-power/denmarks-energy-islands

Figure 12 - Offshore transmission infrastructure governance models for selected countries[25]



25 Picture source: TenneT Offshore for HVDC-based connection

Table 3 2 below presents an overview of the offshore wind targets, current installed capacity, ambition to coordinate the offshore grid, and currently functioning offshore transmission delivery and asset governance regimes.

Table 3-2 International offshore wind delivery regimes*

Country	2030 Offshore wind target	Offshore wind operating 2024	Offshore grid coordination ambition	Current project phase governance	Current transmission asset delivery governance
The UK	Up to 60 GW	15 GW	Yes	Developer-led	Developer-led and OFTO owned
The Netherlands	21 GW (by 2032)	4.7 GW	Yes	TSO-led	TSO-delivered and owned
Belgium	5.4-5.8 GW	2.2 GW	Yes	TSO-led	TSO-delivered and owned
Denmark	10 GW	2.7 GW	Yes	Developer-led	Developer-delivered and owned
Germany	30 GW	8.8 GW	Yes	TSO-led	TSO-delivered and owned
France	18 GW (by 2035)	1.5 GW	Yes / No	TSO-led	TSO-delivered and owned
Poland	5.9 GW	0 GW	No	Developer-led	Developer-delivered and owned

*This table provides a simplified overview, there are nuances in different jurisdictions. For example, in Denmark, central government may conduct site investigations and permitting while leaving infrastructure development to developers. Such approaches blend elements of centrally-led and developer-led models. In this table, classification is based primarily on which entity takes responsibility for grid development, but readers should be aware that real-world implementations often involve more complex arrangements and responsibilities.

24 https://ens.dk/en/our-responsibilities/offshore-wind-power/denmarks-energy-islands

3.4.3.1 Lessons learned from EU cross-border cost sharing process

The topic of fair cost allocation and cost sharing deserves significant attention in EU countries too. The nature of coordinated offshore grid is such that it is often difficult to fully attribute the benefits and thus the costs to a single party.

An additional level of complexity appears when offshore coordination takes place at an international level, in which case discussion on fair cost allocation can take significant time and are often carried at the highest political level.

ELWIND is a joint Estonian-Latvian state-run cross-border offshore wind project aiming to raise energy independence in the region by increasing production of green energy and improving interstate electricity connectivity. This unique project linking the two countries could serve as a good example for other countries to increase the security of electricity supply in the whole region. The Connecting Europe Facility (CEF) has been developed at the EU level for the implementation of such projects to promote the transnational transmission of renewable electricity, with the aim of keeping the costs of project implementation as low as possible while creating maximum benefits for society. The state will eventually arrange an auction, either based on competitive or selective bidding principles in order to find developers who will build and operate the wind parks based on agreed terms.

It is not clear how the connection between the two wind farms will be financed.

At a national level however, the most common solution adopted by EU countries to date was to shift the financing responsibility for coordinated offshore grid to state owned TSO companies. This essentially means that the costs of coordinated offshore grids are socialised through grid tariffs and / or taxes and levies. Such regime is adopted in the Netherlands, Belgium, France and Germany.

In case of delays in offshore grid delivery, the responsible TSO will have to compensate the Generator who is not able to connect on time.

See APPENDIX: Delivery Model – Lessons from Other Jurisdictions: Detailed Findings for more details

3.5 Information Sharing

3.5.1 Context

As the sector moves towards more integrated offshore networks, effective information sharing becomes crucial for efficient project delivery and cost reduction. However, the tension between the need for coordination and the competitive nature of the industry creates a complex environment for information sharing.

Types of information which could be shared between coordinating parties include survey data (such as, seabed conditions, and wildlife surveys), environmental impact assessments, technical specifications of transmission assets and infrastructure, project timelines and development schedules, and cost estimates for shared infrastructure.

The potential benefits of information sharing include:

- Producing a more optimised coordinated grid design which ensures compatibility between different projects in shared corridors or interconnected systems
- Reducing environmental impacts from designs and avoiding duplication of survey work
- Accelerating project timelines by avoiding delays caused by lack of information
- Lowering costs by enabling better decision making and avoiding duplication and delays.
- Improving the accuracy of cost estimates and reducing investment risks,
- Facilitating better planning and decision-making by all stakeholders and generally supporting the development of a more integrated and efficient offshore network.

Wider work on Data sharing which could be applied to coordinated offshore grid include the work of the North Sea Transition Authority (NTSA) to develop data sharing infrastructure and principles[26], and Ofgem Data Best Practice Principles[27] which currently apply to Network Companies.

3.5.2 Information Sharing: Barriers

- **There is a strong disincentive to share information between competitors:** The competitive nature of the offshore wind sector, particularly in the CfD bidding process, creates a strong disincentive for Generators to share information, potentially hindering coordination and raising legal concerns under competition law.
- **Lack of data governance and sharing protocols:** The sector lacks adequate data governance and sharing protocols, leading to uncertainty, risk, and ineffective coordination among stakeholders, despite suggestions for improvement such as the NTSA Offshore Energy Digital Strategy Group's data principles and Ofgem's Data Best Practice Principles.
- **Inefficiency fron multiple parties involved in similar surveys:** There is significant duplication of effort in conducting seabed surveys and environmental assessments, with each developer typically conducting their own surveys, leading to inefficient use of resources and unnecessary workload in the consenting processes.
- **Contestability of TO role and data exchange in design and delivery stages:** Generators face challenges in data exchange and engagement with Transmission Operators (TOs) during the detailed design and delivery stages of projects integrating with "wet onshore" assets, leading to potential delays and disproportionate risk for Generators due to misaligned incentives and lack of compensation mechanisms for late delivery of transmission assets.

26 https://www.nstauthority.co.uk/news-publications/data-principles-agreed-as-digital-strategy-group-launches-linkedin-site-to-aid-communication/

27 https://es.catapult.org.uk/insight/new-ofgem-licence-condition-to-require-data-best-practice-by-networks/

See APPENDIX: Information Sharing: Detailed Findings for more details

3.5.3 Information Sharing: Recommendations and Key Findings

RECOMMENDATIONS FOR THE EXISTING REGIME	
I1 Short / Medium Term	**Ofgem should provide guidelines on what information can be shared at different project stages of coordinated design, within the confines of competition law**
	• Initial and let users need to share information on cost and schedule of the offshore transmission system whilst competing in CfD rounds • There are strong commercial disincentives to share information between competitors and potential implications under competition law
RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
I2 Short / Medium Term	**Ofgem should oversee the development of clear data governance and data sharing protocols that balance competition concerns with coordination needs**
	• The offshore transmission sector lacks clear data governance, data interoperability standards, sharing protocols, and common data catalogues to enable efficient data exchange • Ofgem should consider extending Ofgem Data Best Practice principles to Generators and OFTOs
I3 Short / Medium Term	**Led by Ofgem and the NESO the sector should establish mechanisms for coordinated surveys and assessments to reduce duplication. This could involve third-party entities conducting surveys on behalf of multiple developers or creating standardised methodologies for data collection and sharing**
	• There is often unnecessary duplication of surveys and environmental assessments, efficiencies could be achieved by coordinating survey activities and sharing results. Competition amongst Generators means that having a third party carry out surveys to an agreed common standard would be most likely to meet their needs. • Ofgem should consider replicating or building on the work of the North Sea Transition Authority to establish shared data repositories

RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
I4 Short / Medium Term	**Led by Ofgem and the NESO the sector should create common data catalogues and establishing clear responsibilities for data handling and maintenance. These catalogues should be accessible to all relevant stakeholders and regularly updated to ensure the use of consistent, up-to-date information across projects**
	• Data sharing infrastructure to facilitate sharing of survey, consenting, network planning, and design data could result in significant efficiency gains across the sector and enable more effective coordination. This would help avoid project delays from coordination reducing costs for consumers and increase the productivity and competitiveness of the UK's offshore wind sector.
I5 Short / Medium Term	**Ofgem should establish clear roles and responsibilities at all stages but especially detailed network design, with clear expectations set for scope and timeliness of information sharing**
	• Some coordinated projects interfacing with TOs have reported significant difficulties securing the engagement of TOs in the design process and TO's are not incentivised to provide information needed by developers to achieve project timelines in a timely manner.

3.6 Technology Interoperability

3.6.1 Context

Historically, there has been little need for technology interoperability in offshore wind transmission infrastructure. The traditional model of radial connections, where each offshore wind farm has its own dedicated transmission link to shore, meant that each project could be developed largely independently. Generators were free to select transmission technologies and specifications optimised for their specific project requirements, without needing to consider compatibility with other offshore assets or future expansion.

The main principles for the strategic design of the offshore grid are coordination, standardisation, modularity and expandability. These principles are well-understood for point-to-point connections which have been extensively used in GB. However, the principles are less well-understood in relation to multiple connection projects. To ensure that these projects deliver the best value to society and operate successfully, they need to be explored in more depth to identify how they should apply to such projects.

Developments in UK waters do not have common design and operations standards or functional specifications that dictate how multiple projects should connect to each other to mitigate system stability, harmonic and power flow issues. UK-based Generators have extensive experience in addressing such issues with HVAC technologies, but there is less practical experience from implementing HVDC projects.

Coordinated designs require a much higher degree of technical compatibility between components from different manufacturers and across project boundaries. Standardisation of key interfaces, voltage levels, control systems, and other technical parameters is becoming essential to enable coordinated offshore grid which can be expanded in future. Common standards and specifications can also help address supply chain constraints by reducing customisation requirements, and enabling economies of scale and strategic reserves of interchangeable components.

However, achieving this standardisation and interoperability presents major technical and commercial challenges. Different manufacturers have developed proprietary technologies and may be reluctant to change to a different standard. Agreeing on standards across a complex ecosystem of Generators, manufacturers, and TOs requires extensive industry collaboration.

3.6.2 Technology Interoperability: Barriers

- Under-developed technical standards for GB offshore transmission infrastructure: The absence of common design standards for offshore projects, particularly for HVDC technologies, poses challenges for system stability, interoperability, and multi-vendor compatibility in coordinated offshore grid development.

See APPENDIX: Technology Interoperability: Detailed Findings for more details

3.6.3 Technology Interoperability: Recommendations and Key Findings

RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
T1 Short / Medium Term	**The NESO should establish a taskforce, with support from TOs and in coordination with ENTSO-E, to develop common technical standards for offshore transmission infrastructure**
	• Connecting multiple projects through one offshore grid connection poses significant interoperability challenges for both HVAC and HVDC connections due to underdeveloped coordination mechanisms and standards. The UK has extensive experience in point-to-point project development for both HVAC and HVDC, but the connection of multiple projects poses new challenges across the global energy sector. It is expected that HVDC will be the predominant technology used for multi-connection projects in GB. • A key issue is expected to be the physical interoperability of multi-vendor assets in complex multi-project connections. Each vendor uses different proprietary technical standards and specifications making the physical connection of such assets very difficult. • In addition, it is anticipated that different projects on the same connection might have different design and operating philosophies which will need to be aligned for the different assets to connect. There is no single standard that determines what decisions should be made (e.g. around protection strategies, convertor configurations, fault clearing strategies, etc.).

RECOMMENDATIONS FOR THE EXISTING REGIME	
T2 Short / Medium Term	**The NESO should monitor and engage with projects investigating the interoperability of different technologies in offshore grids to learn from their findings**
	• There are multiple projects investigating technological interoperability, including: the European Commission-funded InterOPERA project, grid operator collaborations in Germany and the North Sea Wind Power Hub. • Identify any gaps in research relevant to the GB context and implement research and innovation projects to fill such gaps. These gaps are likely to include a consideration of the GB regulatory framework as well as technical or operating requirements specific to GB (e.g. voltages, grid configurations, fault scenarios).

3.7 Supply Chain

3.7.1 Context

Global offshore wind capacity is expected to reach more than 750 GW by 2035, almost 10 times that installed in 2024, with more than 200 GW attributed to the neighbouring EU market. As a result, Generators and transmission owners around the North Sea are competing for supply chain capacity, trying to secure the equipment required to deliver their projects on time. The lead times for some equipment can be up to seven years which means that projects with delivery dates in the early 2030s have already had to begin procurement processes.

3.7.2 Supply Chain: Barriers

- **Internal fragmentation and differences in standards to the EU exacerbate supply chain constraints for the UK market:** The UK offshore wind industry faces supply chain constraints and higher costs due to fragmented project development, incompatible standards with Europe, and reduced economies of scale.

See APPENDIX: Technology Interoperability: Detailed Findings for more details

3.7.3 Supply Chain: Recommendations and Key Findings

RECOMMENDATIONS FOR FUTURE OFFSHORE REGIMES	
S1 Short / Medium Term	**The technology interoperability taskforce (Section •, Recommendation T1) should identify and implement the most suitable framework for promoting design standardisation across GB networks and developers to allow for greater coordination and interoperability of projects. Where possible, this should include alignment with IEC and EU standards and plans**
	• There is a shortage of capacity across the supply chain for offshore infrastructure projects from manufacturing of key components through to the transportation and installation of equipment. • Across the UK, different developers use different designs and design standards for their projects. This exacerbates supply chain constraints as suppliers cannot produce equipment at scale, thus increasing lead times, costs and the likelihood that suppliers will focus on other more homogenous and larger markets. • The fragmented nature of the UK market is exacerbated when compared to the EU. The UK uses different standards which sets us apart from other markets and reduces our ability to command economies of scale in costs and project lead times.

4 APPENDIX: DETAILED FINDINGS

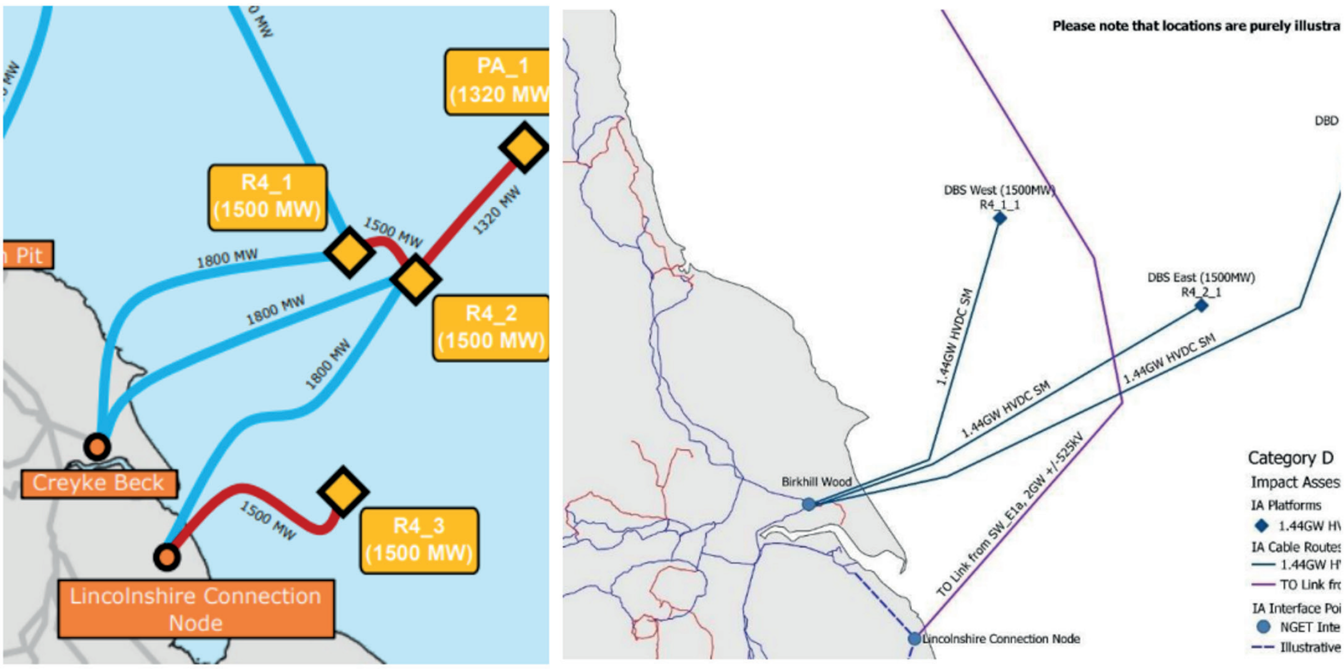
4.1 Planning: Detailed Findings

4.1.1 The cost and complexity of coordinated designs is greater than initially envisaged

Following the publication of the HND, the parties involved (Generators, the Crown Estate, and Transmission Operators (TOs)) progressed to Detailed Network Design. During the HND Detailed Network Design activities in each cluster it has emerged that developing non-radial offshore grid is slower and more complex than initially anticipated, and that non-radial designs can be more costly than traditional radial designs due to the need for larger capacity components and multi-terminal HVDC control systems which have lower technological maturity and greater supply chain constraints. This is evidenced by the ESO's Impact Assessment[28] for the HND South Cluster which resulted in a reduction in coordination (Figure 1) due, in part, to increased supply chain costs and delays relative to a radial design. Therefore, the benefits to consumers and Generators of reduced CAPEX from non-radial offshore grid must be called into question.

If CAPEX for non-radial infrastructure is not reliably lower than for radial connections, this eliminates the main incentive for a Generator to coordinate – to reduce the cost of transmission infrastructure which is ultimately paid by the Generator through network charges.

Figure 1 - HND South Cluster original and revised DND designs



a. *Original cluster design*   b. *New cluster design*

28 https://www.nationalgrideso.com/document/302691/download#:~:text=These%20parties%20are%20known%20as,ranging%20in%20levels%20of%20interconnection.

4.1.2 By focusing predominantly on delivering non-radial connections, the existing network planning process misses opportunities for alternative forms of coordination which could deliver similar benefits with less cost and complexity

The HND and HNDFUE focused on delivering coordination by building non-radial connections shared by multiple parties (Generators, TOs, interconnectors). However, focusing on coordination of cable corridors and onshore works (as is taking place in North Falls and Five Estuaries[29]) and coordination of seabed leasing and network planning (as is taking place in the Celtic Sea[30]) could deliver similar community impact and environmental benefits to non-radial infrastructure but without the complexity, cost, delays, and finance risks caused by non-radial designs. The development of the SSEP and CSNP provide a significant opportunity to develop greater coordination irrespective of radial or non-radial design.

1. Enabling the delivery of rapid expansion of offshore wind capacity by 2030 whilst considering environmental and community impacts up front, in a strategic manner to help projects to gain consent.

   The evidence from HND and HNDFUE is that coordination takes longer to achieve than building radial connections. Environmental and community impacts can also be considered in advance for radial projects.

2. Avoiding and minimising community and environmental impacts compared with the previous radial approach. The strategic network design approach of the HND reduces the number of onshore connections and, where onshore connections are necessary, assessment of connection points has been made with consideration to community impacts up front

   The HND reduced the number of connection locations, but it does not reduce the number of cables which need to come ashore since the same amount of power needs to be transmitted to shore whether the design is radial or non-radial. Coordination of radial connections by sharing cable corridors and onshore works could achieve similar benefits.

3. Significant cost savings (estimated by ESO to be around £4.3 billion) through the planning of a coordinated network that optimises network infrastructure

   Experience from HND and HNDFUE is that coordinated infrastructure can be more expensive than radial designs due to the type and complexity of infrastructure needed, technological and supply chain immaturity, and longer development timelines for coordinated projects. It should not be assumed that there is a cost benefit for non-radial transmission infrastructure vs. radial. Where costs are higher but there are wider benefits to coordination there should be a mechanism to provide Generators with incentives to coordinate.

29 https://www.northfallsoffshore.com/about/frequently-asked-questions/
30 https://www.thecrownestate.co.uk/news/statement-from-the-crown-estate-in-response-to-the-publication-of-the

4.1.3 HND and HNDFUE encountered significant process challenges

Generators reported several challenges with the HND and HNDFUE processes, including insufficient early engagement by TOs, lack of understanding by ESO and TOs of Generator needs, and unclear roles and responsibilities of all parties involved in DND (initial user, later users, TO, ESO, Ofgem). Some of these issues were potentially caused by the fast pace of the work to publish the HND and HNDFUE.

Further challenges resulted from the HND designs not providing details of the specific offshore assets required to realise the coordinated designs. Therefore the HND was unable to properly consider the cost, size, and complexity of those assets. This resulted in significant rework to the coordinated design during the Detailed Network Design (DND) stage.

To resolve these issues Generators and TOs should be involved much earlier in the network planning processes to help inform the ESO of their needs and provide expert insights into the feasibility and cost optimisation of the design.

4.1.4 There is a need for Formal Oversight of Detailed Network Design (DND)

Significant challenges have been identified by all stakeholders involved in the DND forums. These challenges relate to coordinating schedules, financing, and design between Generators who are in competition, have misaligned incentives, different specifications, different ways of working, and are reluctant to share information.

A Generator participating in DND as a Later User may have an incentive to delay the Initial User's project if the Later User has a competing project likely to bid in the same Contracts for Difference (CfD) auction round. By causing sufficient delays, the Later User could potentially push the Initial User's project into a subsequent CfD round, reducing competition for their own project.

National Grid ESO assumed an informal role in convening the DND process clusters. However, the challenges encountered suggest a need for more formal oversight alongside a clear process with defined roles and responsibilities.

The alternative third party model for delivery of coordinate infrastructure proposed in this report could help resolve coordination challenges in DND by enabling incentives to be set which reward all coordinating parties for timely delivery of the wider coordinated network.

4.2 Financing and Cost Recovery: Detailed Findings

4.2.1 The Generator build model does not incentivise Generators to construct shared infrastructure

The current regulatory framework does not provide financial incentives for Generators to pursue coordinated offshore transmission projects. Generators do not profit from delivering transmission infrastructure yet face increased risks, complexities, and costs from doing so. The assumption that generators would benefit from reduced CAPEX costs by sharing infrastructure has been proven to be unreliable given the experience of the HND Southern Cluster which was more expensive to deliver as a coordinated design than as traditional radial connections.

The Tender Revenue Stream is the primary source of income for Offshore Transmission Owners. It is a stable, long-term revenue stream that typically lasts for 20 years. The process of incorporating Generator costs into the TRS involves several steps:

1. Asset Construction: The Generator initially constructs the offshore transmission assets along with the wind farm itself.
2. Cost Assessment: Ofgem (the GB energy regulator) audits the construction costs to ensure that only economic and efficient project costs are used to determine the Final Transfer Value (FTV) of offshore transmission assets when they are auctioned to Offshore Transmission Owners (OFTOs).
3. Transfer Value Determination: Initially, an Estimated Transfer Value (ETV) is used during the tender process to ensure consistency among bidders.
4. Once construction is complete, Ofgem determines the Final Transfer Value (FTV), which represents the amount the OFTO will pay to acquire the transmission assets from the Generator.
5. OFTO Acquisition: The successful OFTO bidder purchases the transmission assets from the Generator at the FTV.
6. National Grid ESO pays the TRS to the OFTO, and recovers TNUoS charges from the Generator.

By design this process is not meant to provide any profit for Generators developing transmission infrastructure, since any profit would have to be paid back by the Generator though the TNUoS charge. However in developing coordinated projects the Initial User faces significantly higher risk than for a comparable uncoordinated radial project. In the absence of some form of incentive for developing coordinated infrastructure which outweighs this risk, Generators will continue to prefer to develop traditional radial infrastructure.

Generators have expressed significant concerns about the risk of cost disallowance during the Ofgem Cost Assessment process which have been reported to be as high as 10-30%. Generators feel that there is a substantial risk of having their costs disallowed, which can lead to financial losses. Because coordinated projects are more expensive, a given percentage of costs being disallowed results in a higher real-terms cost to the Initial User than if they had developed a radial connection. Since the assets are shared, disallowed CAPEX costs absorbed by the initial user no not result in a proportionately lower TNUoS charge (which includes the CAPEX value at FTV in its calculation) since the TNUoS reduction will be shared with the later user(s).

4.2.2 Initial Users of coordinated projects are disadvantaged in CfD auctions compared to uncoordinated projects

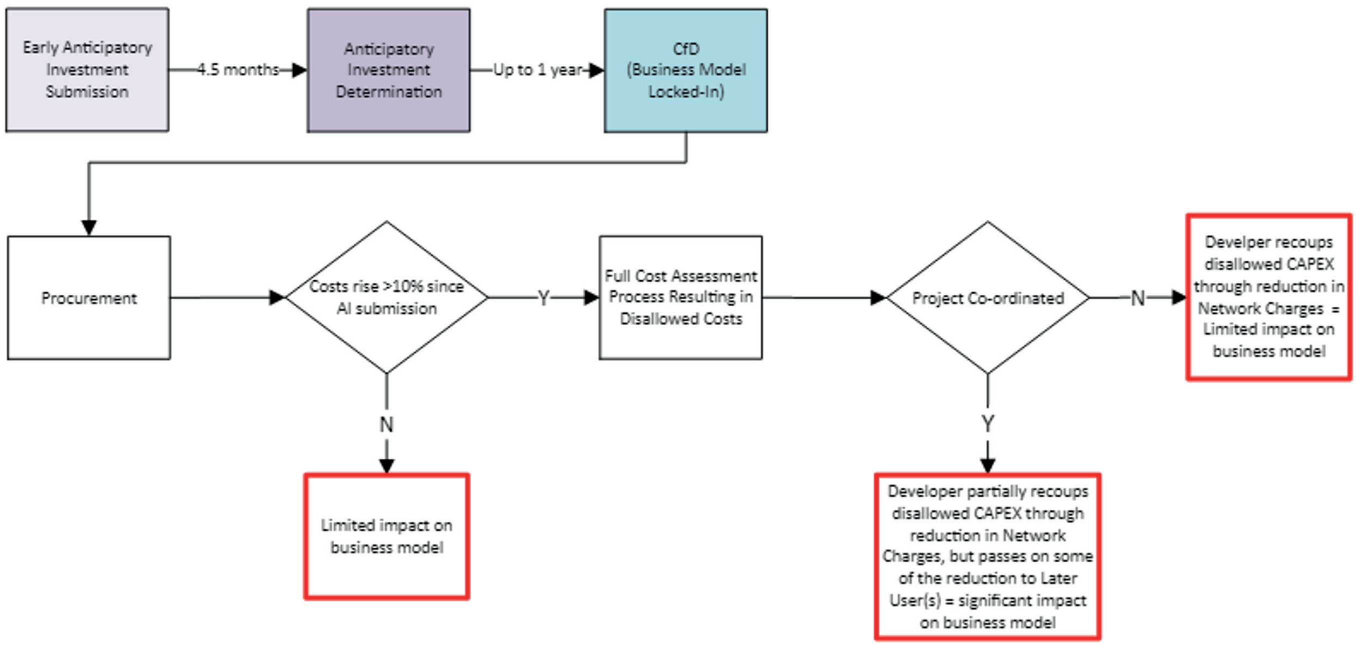
The AI framework does not adequately incentivise Generators to take on the role of initial user in coordinated projects. A significant reason for this is the way that AI policy interacts with the CfD Rounds, Cost Assessment process and Network Charging.

Figure 2 and Figure 3 outline how AI interacts with the CfD rounds, the Cost Assessment Process, and Network charging to impact Business Model. Ofgem provides flexibility to begin the AI process at any time, but whether the Generator begins the process early or late they must bid in the CfD round with significant uncertainty over the accuracy of the business model.

Figure 2: the Generator makes an AI submission under the Early Stage Assessment[31] process early in the project development timeline so that they have certainty on the AI vs. non-AI share of transmission infrastructure costs before the CfD auction.

- Because the submission is made early in the project development timeline there is increased uncertainty over supply chain costs and inflation. There is an increased risk of exceeding the +/-10% cost variance allowed under the AI policy, which would lead to a full Cost Assessment process which commonly results in significant Disallowed Costs.
- Disallowed Costs would be identified after the CfD auction at which point the business model for the wind farm is locked in.
- If the project is not coordinated the Disallowed Costs are subtracted from the Asset Transfer Value to the OFTO, resulting in lower Network Charges for the Generator over the life of the OFTO. However, if the project is coordinated the lower Network Charges are spread between the Initial and Later Users so that the financial impact on the Initial User whose costs were disallowed is greater.

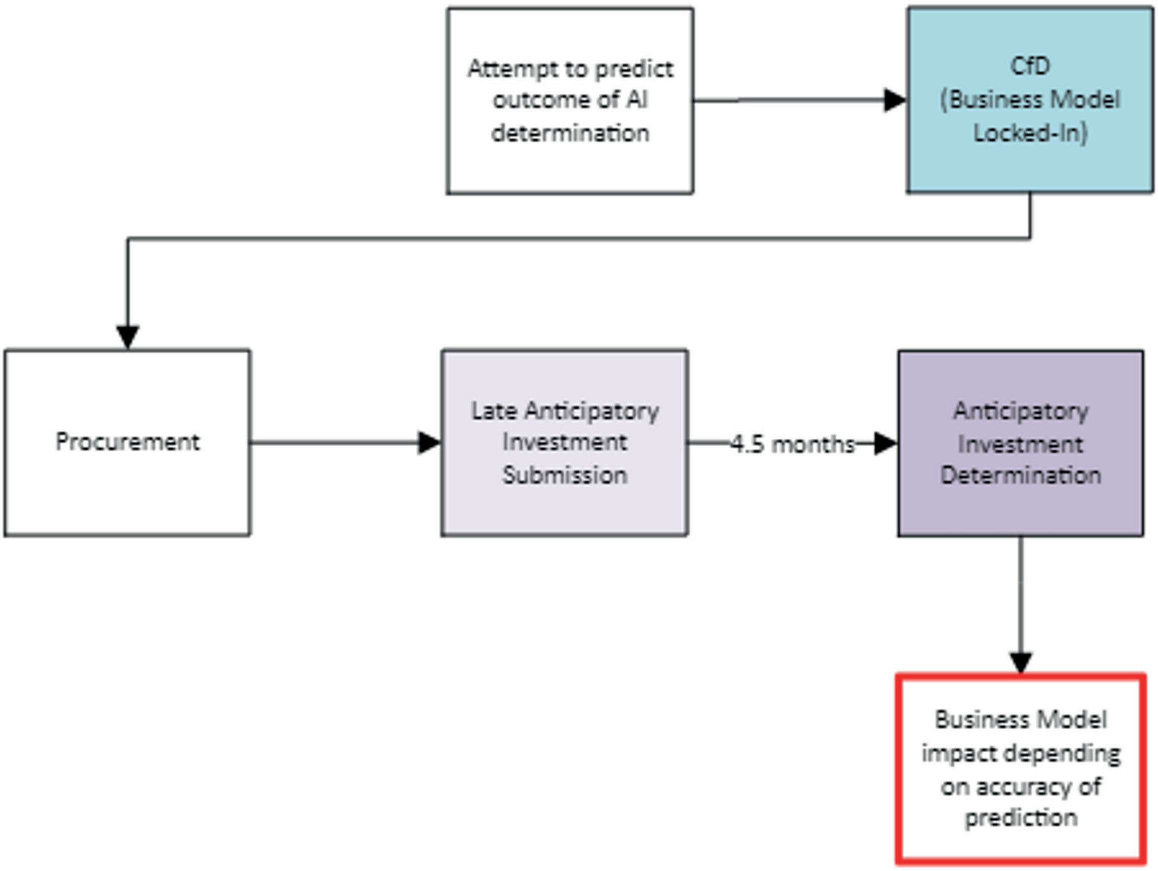
Figure 2 - Early AI submission = high risk of Cost Disallowance



31 https://www.ofgem.gov.uk/sites/default/files/2023-12/Consultation%20on%20the%20Early-Stage%20Assessment%20for%20Anticipatory%20Investment.pdf

Figure 3: the Generator submits AI late in the project development process (after CfD or shortly before) when they have greater confidence in supply chain costs, and less time for inflation risk to materialise. However, the Generator now faces uncertainty in the outcome of the AI determination which will be received after the CfD. The Generator must pre-empt the decision on AI costs; an underestimation of the non-AI portion negatively impacts the wind farm's business model, and overestimation of the non-AI portion inflates the Generators' CfD bid putting them at a competitive disadvantage in the CfD auction.

Figure 3 - Late AI submission = high risk of incorrect AI share prediction



4.2.3 Later Users are fully exposed to risks from delays caused by the Initial User

During project development, if the AI process does not progress under the Initial User it poses risk for the Later User when applying for CfD.

If transmission infrastructure being constructed by the Initial User is delayed and the Later User is not connected in time for their energisation date, the Later User cannot begin generating power. This delay directly impacts their revenue stream as they cannot sell electricity without being connected to the grid.

There is no established course for recompense for the lost revenue due to such delays. This lack of compensation mechanisms leaves the later user vulnerable to financial losses.

4.2.4 Later Users must commit to take over projects, though this may not be feasible and may result in financial losses

The AI application requires Later Users to commit to assuming responsibility for shared transmission infrastructure should the initial user face delays. However, this arrangement presents significant challenges and risks for Later Users.

The technical complexity of ensuring the infrastructure meets the Later User's standards is considerable. A substantial knowledge gap often exists between Generators regarding the Initial User's specifications and standards. Indeed, some Generators have stated they cannot foresee building infrastructure to another company's design.

Financial capacity of Later Users to take on a project is another major concern, particularly if delays are extensive. The Initial User may have already negotiated contracts for the shared infrastructure, necessitating a time-consuming transfer of permits and seabed lease rights. Later Users would need to either take on existing contracts or negotiate new ones, potentially leading to further delays and increased costs. Any pre-qualification process for later users financial ability to take over a project would create additional barriers to entry.

The process of transferring responsibility to the Later User would likely be extremely complex from both financial and legal standpoints, resulting in significant further delays. Given the high level of risk associated with taking over the construction of coordinated assets, it is doubtful that an investment board would approve such a decision. The financial and operational uncertainties make this option highly unattractive for any Later User.

4.2.5 There is no dispute resolution process in case the Initial and Later users cannot agree on transfer of responsibility

The process for handling delays and potential handovers between Initial Users and Later Users in coordinated offshore wind projects is currently fraught with significant uncertainty and risk. This creates major challenges for project planning, financing, and coordination between parties.

A key issue is the lack of clarity around the legal, commercial, and financial implications of transferring responsibility for a coordinated project from the Initial User to the Later User in the event of delays. Without a well-defined framework, Later Users face substantial financial risks that are difficult to quantify or mitigate. This uncertainty makes it challenging for Later Users to secure board and investor approval to commit to the project by signing the joint Anticipatory Investment (AI) letter.

The handover process itself lacks clear criteria and procedures. There are no established guidelines for when a handover should occur due to delays, nor are there defined steps for executing such a transfer. It remains unclear how contracts, permits, leases, and other project assets would be transferred between parties. This ambiguity creates significant potential for disputes between Initial and Later Users.

Exacerbating this issue is the absence of a formal dispute resolution mechanism. Ofgem has stated that it is up to the parties involved to determine if a handover is appropriate, but provides no framework for this decision-making process. Without a neutral arbiter or defined resolution procedures, disagreements could lead to prolonged disputes and further project delays.

The current situation also creates misaligned incentives between parties. Initial Users may be reluctant to hand over a project they've invested significant resources in, even if delays occur. Meanwhile, Later Users face major risks in taking over a delayed project, with no clear upside for assuming those risks. There are no incentives or requirements for the parties to reach an agreement on handover. As coordinated projects are relatively new, there is little precedent for how handovers would work in practice, and stakeholders lack experience in managing such transitions in the offshore wind sector.

4.2.6 Asset classification resulting in different types of licence holder coordinating is a barrier to delivery of coordinated offshore gird

The asset classification process, which occurs after network planning, introduces challenges by requiring different types of license holder to deliver and operate shared offshore transmission links. Each type of license holder operates under a different regulatory framework, leading to conflicting commercial, regulatory, and technical requirements and incentive structures. Interfaces between different licensee types introduces contractual complexities and extends negotiation timelines, as contracts must align responsibilities, liabilities, and performance standards across various licensee types.

In coordinated projects, where assets (and sub-components of assets) may serve multiple purposes or benefit various parties, the boundaries of responsibility between different licensees can become unclear.

4.2.7 The Anticipatory Investment (AI) framework does not fully remove barriers to coordinated offshore grid development

Generators broadly welcome the introduction of the AI framework, and it goes some way to overcoming coordination barriers they face. However, remaining policy uncertainties, and risks and complexities in how AI interacts with the existing policy regime, means that generators remain reluctant to develop coordinated projects using AI.

As of July 2024 no generator has submitted an application under the new Early Stage Assessment (ESA) process for AI, however we note that while the process remains untested, there has been interest from developers. The primary concern reported by Generators is uncertainty surrounding AI policy implementation and cost recovery mechanisms and rules. Generators are uncertain over what costs will be recoverable and when, creating uncertainty for project financiers on expected returns. Generators noted that the ESA policy still has ambiguity around thresholds used for various costs and the timing for some processes which impact project bankability.

The ongoing work under code modification CMP402: Introduction of Anticipatory Investment (AI) principles within the User Commitment Arrangements[32] creates further uncertainty over the cost of user commitment to the later user, which may act as a disincentive to coordination.

Highly coordinated projects involve complex interdependencies between multiple Generators, TOs, interconnectors, and OFTOs, with different priorities and incentives and different timelines. The AI policy seems to be designed with a simpler model in mind where one Generator builds a radial asset and another connects to it in future. However, the reality of coordinated projects is far more complex, with multiple parties sharing infrastructure and needing to align their schedules and technical specifications. Given the finance risks and extremely high complexity Generators do not consider it feasible to deliver highly coordinated projects under either the Generator build model or AI.

32 https://www.nationalgrideso.com/industry-information/codes/cusc/modifications/cmp402-introduction-anticipatory-investment-ai-principles-within-user-commitment-arrangements

4.2.8 Unpredictability of TNUoS charges is a key risk in development of coordinated offshore grid

The inability to accurately forecast Transmission Network Use of System (TNUoS) charges creates substantial challenges for the development of a coordinated offshore grid. Generators struggle to create accurate long-term financial models and business plans, which are essential for securing investment making a Final Investment Decision (FID).

TNUoS predictability is an issue affecting on-shore Generators as well as offshore Generators, and the TNUoS Taskforce[33] is working to address these challenges. However, there are other aspects of TNUoS predictability which are specific to offshore generators such as difference in Circuit Classification approaches between onshore and offshore networks.

For instance, under current rules Generators not directly connected to a Main Integrated Transmission System (MITS) node but connected to a circuit used for boundary reinforcement are subject to local tariffs to recover the cost of the circuit. This would result in Generators connecting to “wet onshore” assets such as such as Eastern Green Link 2[34], an offshore “bootstrap” circuit designed to reinforce the on-shore network, bearing the full cost of infrastructure that benefits the wider network through their TNUoS charges.

Grid Code modification CMP426[35] aims to address this issue by reviewing the cost recovery mechanism for these circuits to ensure a more equitable distribution of costs among network users using the wider tariff. This example illustrates the significant uncertainty in magnitude of the TNUoS charges which can be faced by Generators connecting to coordinated infrastructure. These generators face significant uncertainty over project financing, and risk either delaying FID or being disadvantaged in CfD auctions as a result.

4.3 Delivery Model – OFTO Build: Detailed Findings

4.3.1 Under the existing regime the involvement of multiple parties in delivery creates excessive complexity in market and regulatory structures, hindering efficient coordination

Aligning schedules, financing, and designs between multiple parties is extremely challenging, leading to increased costs and risks. The involvement of multiple parties in delivery and handover of responsibility mid-way through the project lifecycle creates excessive complexity in market and regulatory structures, hindering efficient coordination. Since the late OFTO build model involves a handover of responsibility during project development this model would likely face many of the same challenges as the Generator build model in aligning incentives, sharing risks, and coordinating between multiple delivery parties.

The third party model could address these issues by providing a clear framework for coordination from the outset with a single organisation responsible for delivery from DND through to operation. This would remove barriers from handover of responsibilities during project development, risk apportionment, and assigning liability for delays.

33 https://www.nationalgrideso.com/industry-information/charging/charging-futures/task-forces#Transmission-Network-Use-of-Systems-charges-Task-Force

34 https://www.ssen-transmission.co.uk/projects/project-map/eastern-green-link-2/

35 https://www.nationalgrideso.com/industry-information/codes/cusc/modifications/cmp426-tnuos-charges-transmission-circuits-identified-hnd-onshore-transmission

4.3.2 OFTOs lack necessary construction experience and capabilities to effectively manage coordinated asset delivery

Under the existing OFTO business model, OFTOs are not responsible for any element of construction – they take responsibility for the asset after it has been constructed and tested. If OFTOs were to become responsible for the construction of an asset, they would need to develop new capabilities and skills, regulations and incentives would need to be realigned and new handover mechanisms and processes would need to be established between generators and OFTOs. These changes will require considerable effort to implement and may still result in unacceptable risks to various stakeholders as well as additional costs being passed onto consumers.

The current OFTO regime does not ensure that OFTOs have the necessary risk appetite, financing, and experience required to effectively manage highly complex coordinated asset delivery. The market is dominated by a relatively small number of financial investors and asset operators who lack significant construction experience. There is insufficient consideration of practical delivery aspects in initial plans and a lack of standardised technical specifications for coordinated infrastructure. Generators may bear disproportionate risk if OFTOs cannot effectively manage construction, either through direct liabilities or project delays. Consumers may ultimately bear increased costs if OFTOs price in significant risk premiums to account for their lack of experience.

The latest Ofgem proposal for OFTO build partially addresses OFTO competence, it mentions that the tender evaluation process will likely include assessment of technical competence and deliverability, with potentially greater weighting relative to funding than under Generator build.

4.3.3 The current pool of potential bidders for OFTO build coordinated projects is potentially limited

The current pool of potential bidders for OFTO build coordinated projects is potentially limited due to the complexity of developing this infrastructure and the predominance of the Generator build model. This limitation exacerbates the challenges of coordination, as there may not be enough qualified entities to take on these complex projects, resulting in reduced competition and poor value for consumers.

Onshore TOs have significant experience in delivering large scale transmission infrastructure; European TSOs (e.g. Tennet) have significant experience of delivering offshore transmission infrastructure and have access to supply chain frameworks which can assist in reducing delivery timescales and risk. Given the proposed responsibility of the third party for delivering all stages of offshore transmission development from detailed design to operation, it is expected that organisations such as GB TOs and EU TSOs would constitute the majority of qualified bidders. These types of organisation are better able than current OFTOs to address some of the coordination challenges, such as ensuring on-time delivery through expertise in design and construction, supply chain access, and experience in aligning schedules and designs between multiple parties.

A potential alternative to the very early competition third party delivery model is a TO build model, with GB TO's assigned to delivery offshore infrastructure either competitively or based on geography. However we view the third party model as more favourable because:

1. European TSOs and other competent new entrants can provide additional build capacity, expertise, and supply chain access.
2. There is reduced risk of overburdening GB TOs which are already facing significant demands from ASTI projects and other on-shore transmission upgrades.

4.3.4 Generators should not be penalised for delays or significant overspends for infrastructure which they have no role in developing

For the third party model proposed in this report, generators should be protected from costs resulting from delays or significant overspends for infrastructure which they have no role in developing. Compensation mechanisms exist in other jurisdictions (NL, DE, FR, PL) with similar centralised delivery models, typically these are based on the wholesale market price (averaged over a certain period) or the subsidy value times the hourly output calculated based on the wind measurements.

Under Ofgem's currently proposed OFTO build regime, generators often bear disproportionate risks for delays or overspends in transmission infrastructure development, despite having limited control over these aspects. This misalignment of incentives and risk apportionment discourages coordination, as it adds complexity and risk without clear financial benefits for individual Generators.

Ensuring that generators are not penalised for delays or significant overspends for infrastructure which they have no role in developing would help address this misalignment. It would reduce the financial risks and uncertainties faced by generators, potentially making coordinated projects more attractive and easier to finance.

Ofgem has proposed several options for dealing with cost variations, all of which include passing risk of overspend onto Generators to some degree:

Option:

1. **Re-opener mechanisms** would be used in a post-construction cost assessment to seek approval for TRS variations post tender. Full overspend passed onto Generators via. TRS recovery though TNUoS charges.
2. **Threshold reopener mechanisms** – same as option 1 except cost assessment triggered only if the construction cost exceeds a threshold that is set by Ofgem, e.g. 10% of the target cost. Overspend above threshold passed onto Generators via. TRS recovery though TNUoS charges.
3. **OFTO / generator 'pain-gain' share mechanism** in which the OFTO shares cost overruns with Generators.
4. **An OFTO / generator / consumer pain-gain share mechanism** would apply as outlined above up to a non-project specific cap, with cost variations beyond the cap allocated to consumers.

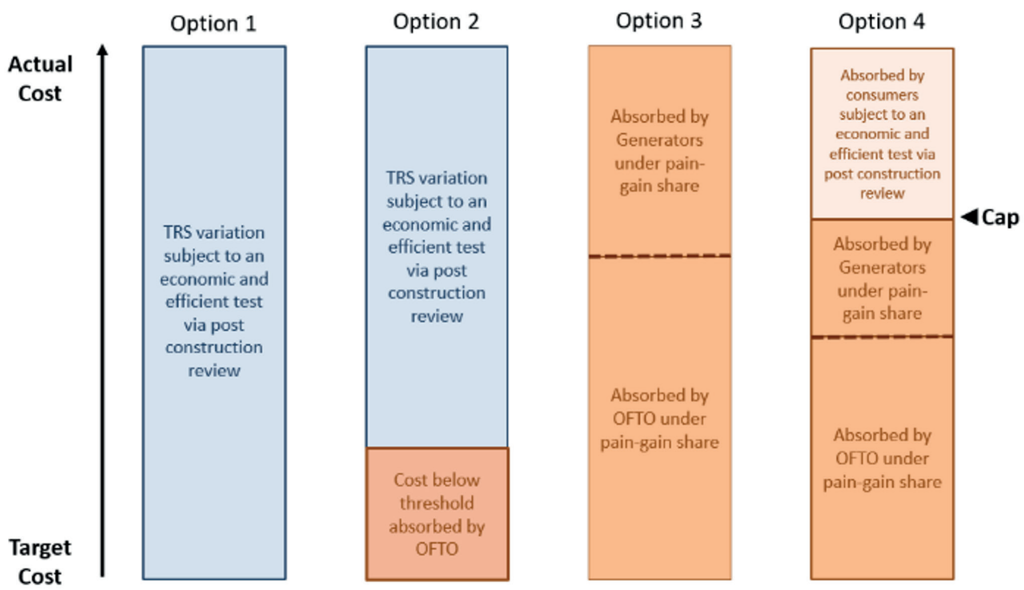


Figure 4 - Proposed mechanisms for dealing with cost variations.

For Late Competition OFTO build the risks inherent in the options above are likely to result in Generators continuing to prefer the Generator build option over the OFTO build option. Adequate delay compensation may be possible to build into construction contracts, however this seems likely to result in higher risks for OFTOs translating into increased tender prices with costs ultimately passed to the consumer.

Our findings highlight several complexities that need to be considered in relation to the late competition OFTO build model, with many of them creating additional risk for OFTOs or generators, or both. In most cases these additional risks will be priced into OFTOs' bids and will result in higher costs being passed through to consumers. Perhaps the best example of this is in the procurement stage where the trade-off is between procurement being delayed by waiting for the OFTO to take on this responsibility and the OFTO having to deliver on contracts negotiated by another company. The first option could lead to delays in the asset being completed and therefore delayed benefits for the consumer. The second option increases the risk for the OFTO and will lead to them include higher costs in their tender, thus resulting in higher costs to consumers.

Additionally, several areas require realigned regulatory incentive mechanisms which can help to reduce, though not entirely eliminate, the risks for OFTOs and generators. For example, in the case of incentivising the timely delivery of an asset, the possible penalisation of OFTOs would not necessarily prevent delays to the project. Thus, an OFTO could include higher costs in their construction forecasts to cover possible penalties resulting in higher costs to consumers while generators may still lose revenue from a delayed project.

4.3.5 Ofgem should develop a very early competition third party build and operate model

The late competition OFTO build model proposed by Ofgem poses many challenges for the development of coordinated offshore grid, namely involvement of multiple parties and handover during development creates complexity, and OFTOs lack necessary construction experience.

Ofgem should reconsider its 2022 decision[36] not to take forward early competition models and develop a very early competition third party delivery model. GB TOs, CATOs, EU TSOs, Generator-led consortia, OFTO-led consortia, or other competent third parties would be ideal candidates to take on this role. A very early competition model has the benefit of reducing the number of parties involved in delivery, and avoids handover mid-way through project development, two key barriers identified with the current delivery model.

Ofgem's decision to exclude early competition delivery models was based on their assessment that the implementation could cause a three- to four-year delay in achieving the PT2030 targets.

> "Models entailing a competition prior to the development of the DND would require additional time for us to develop and implement a tender process. We estimated that development of the tender process could take up to 24 months and implementation a further 18 months. This would interrupt project development with a potential hiatus of up to 42 months."

Ofgem should consider accelerating the timeline for developing a tender process for the third party model. While acknowledging the complexity of such a process, the pace at which other strategic frameworks in the energy sector have been developed suggests there may be room for a more streamlined approach. As the industry collectively pursues net zero goals, it becomes increasingly important for all stakeholders, including regulatory bodies, to explore ways to expedite critical processes where feasible. A swifter implementation could better align with the urgency of rapid infrastructure development to support the energy transition.

36 https://www.ofgem.gov.uk/sites/default/files/2023-03/PT2030_Final_IA_FINAL.pdf

In Ofgem's 2022 consultation[37] respondents highlighted that the very early OFTO competition provided benefits from:

- "the same entity designing, constructing and operating assets"
- "introducing innovation and competition while reducing process complexity"
- "if well designed and timed… [it] could give developers confidence"

Concerns highlighted were:

- "OFTOs' perceived lack of experience in construction"
- "the risk of delay in the DND being started thereby incurring associated delays on the rest of the process"
- "risk that changes required following any consenting process might require further changes to design that would not be subject to competitive pressures."

To address these concerns we recommend that Ofgem should implement pre-qualification criteria for the new delivery model which value financing, consenting, supply chain, design, construction, operation, and project management capabilities and expertise. Comprehensive pre-qualification criteria would help ensure that third parties are better equipped to handle the complexities of coordinated infrastructure projects and give Generators confidence that third parties can deliver infrastructure on-time. A tiered qualification system could allow new entrants to gradually build experience and take on larger projects over time, expanding the pool of third parties capable of delivering coordinated offshore grid.

The risk of delay to start of DND is a valid concern and Ofgem would need to carefully consider the design of the tender process to minimise such a delay. Ultimately, delays to undertake a tendering process is a largely unavoidable trade-off of introducing competition. However we note that:

- The existing regime has seen significant delays to complete DND given the involvement of multiple parties
- A competitive model which attracts additional build capacity from outside GB could reduce delivery timescales compared to relying on non-competitive centralised delivery models which rely on resource constrained GB TOs to delivery coordinated offshore grid

In the Planning section of this report we recommend that in the third party model, surveys and environmental impact assessments should be carried out by The Crown Estate and NESO to provide certainty to the network planning process, increase confidence in the recommended design, and reduce the likelihood of design changes post tender award. Ideally this process should complete prior to launch of the tender round to provide certainty to the developer regarding development of the grid infrastructure and connection timeline.

One drawback of the third party build model is that it does not address supply chain constraints and achieve economies of scale in procurement for coordinated assets. However, given the fragmentation of the GB electricity market with three TOs and six DNOs, multiple Generators, and OFTOs, almost all conceivable delivery model options other than NESO or another central body being responsible for procurement would result in reduced economies of scale. Given that NESO has no existing expertise or capabilities in procurement of offshore transmission infrastructure, such a significant change would likely be more disruptive to delivery of offshore grid than models which retain some fragmentation, at least in the medium term.

37 https://www.ofgem.gov.uk/sites/default/files/2022-01/Offshore%20Coordination%20Summary%20of%20Responses%20and%20Next%20Steps.pdf

On balance the third party model for coordinated offshore grid development offers several significant benefits. By reducing the number of parties involved and eliminating mid-project handovers, this model addresses key complexities in the current system. It ensures continuity and streamlines processes by allowing a single entity to design, construct, and operate assets throughout the project lifecycle.

The model has the potential to boost developer confidence if competent parties enter the offshore transmission market and if protection for late delivery is ensured. By opening participation to a diverse range of entities, including GB TOs, CATOs, EU TSOs, OFTO and Generator-led consortia, it broadens the pool of expertise and build capacity available for these complex projects. This expansion of capabilities and supply chain access could lead to faster delivery timelines, particularly when compared to relying solely on resource-constrained GB TOs. While the implementation of this model may introduce some initial delays, these could be offset by the long-term efficiencies and improved delivery capabilities it would bring to the sector.

4.4 Delivery Model – Lessons from Other Jurisdictions: Detailed Findings

4.4.1 Project phase governance

Offshore grid delivery usually comprises the following steps – 1) maritime and spatial planning, 2) site investigations, 3) environmental studies and permitting, 4) tendering or seabed lease + subsidy competition, 5) financing and procurement, 6) construction, 7) operation and maintenance. Countries with a developed offshore wind sector have adopted varying models where the responsibilities for these steps are typically split between governmental energy agencies (usually subordinates of local Energy Ministries), transmission system owners (TSOs) and private developers.[38]

This section describes important considerations in attributing responsibilities to different actors involved in the delivery steps for the offshore grid. The main differences are between a 'Developer-led' and a 'Centrally-led' delivery model.

Developer-led delivery

As a rule of thumb, in the early stages of sector development, countries opt for a developer-led approach, whereby a private offshore wind developer takes responsibility for all stages of offshore grid delivery once the prospective site and locations have been identified by the government, starting from step 2) site investigation and all the way to operations.[39] The interface between the developer and the TSO or TO is established at the onshore point of connection (POC).

The advantage of this approach is that most of the delivery risks are pushed onto private developers who already possess the necessary technical competences, unlike the state agencies and the TSO who have not yet been involved in offshore grid development. In addition, this approach might facilitate development at a higher pace, and thus faster transition towards established decarbonisation targets. This comes at the expense of higher overall system costs as developers need to reflect the risk premium in their tender bids and usually have higher cost of capital than state-owned entities, including TSOs.

Another disadvantage of such an approach is that the relevant TSO has little say in the timing of delivery and electrical specifications at the point of connection. Hence, the TSO needs to plan the relevant onshore grid reinforcements at the POC in a reactive manner, not being able to develop its system holistically or having to delay the connection of the offshore wind until the onshore system is ready.

38 Tendering always falls under responsibility of the governmental energy agency.

39 Today, step 1) maritime and spatial planning is usually governed by the government both in developer-led and in state-led regimes, even though completely deregulated regimes (also called open-door) existed in the past. Thereby, a developer could proactively approach government with the proposal to build a wind farm and the corresponding grid connection in a non-predefined location (e.g. Denmark) and take responsibility for the whole delivery cycle. Today such regimes are uncommon and are not expected to take place by OWIC due to a high upfront investment cost for site selection required from developers.

The availability of an offshore transmission system is incentivised directly as it impacts the revenue of the developer, who will normally seek to achieve synergies between the design of the wind farm and the offshore grid.

Variations of this approach have been pursued in GB (Generator build OFTO model), Denmark, initial projects in the Netherlands, Belgium, Germany, Poland and the US. They allowed these countries to stimulate early development of the offshore wind sector at pace while minimising risks to the state.

Centrally-led delivery

As the national offshore wind sector starts maturing and first projects are delivered, governments have to assess the total potential for offshore wind in the country. Where offshore wind energy is projected to take a significant share of the national demand and thus becomes a strategic asset in ensuring security of supply, OWIC sees a centrally-led offshore grid delivery approach as superior to a developer-led approach for delivering coordination.

Countries like the Netherlands, the GB and Germany have switched from a project-by-project approach to a holistic planning of their onshore reinforcements, offshore grids and cross-border interconnections recognising the significant impact of offshore wind sector developments on the entire energy system. In these countries, the government (and regulated entities representing them) is responsible for all stages of offshore grid delivery.

This allows to achieve significant savings in the total energy system costs as the offshore and onshore power system are planned and delivered in synergy. Yet, it comes at the cost of having to establish dedicated organisations responsible for the organisation of different delivery stages. Where the TSO has great in-house competence in the delivery of offshore projects, or can attract these competences from the labour market or through specialised advisory firms, it can achieve significant economies of scale by defining standard functional specifications and procuring multiple projects at once. As a state company, in a centrally-led approach, TSOs can usually attract capital at a lower cost. However, this role of the TSO creates significant financial exposure and adds burden to the state budget. Therefore, regulators need to review the tariff structures for the TSO to be able to regain the development costs.

Supply chain considerations

In the last few years, while more and more countries globally (EU, the UK, the US, ASEAN region countries) see offshore wind as an important ingredient of their decarbonisation journey, the supply chain has become a major bottleneck for project delivery and deserves a special attention in the context of offshore transmission delivery model evaluation.

Across all major component types, including HVAC- transformers, HVDC- converters, high voltage cables and support structures, there is a massive shortage of both manufacturing capacity and qualified resources. The lead times for project developers have reportedly increased by 2 to 3 years, simply due to the fact that manufacturers have their order books full for the next few years. Consequently, they cannot keep their own expansions up with the pace of the offshore transmission development plans. This has become a consequence of prolonged decision-making processes, and uncertainty of investment in renewable technology, which was a prime characteristic of many countries in the past.

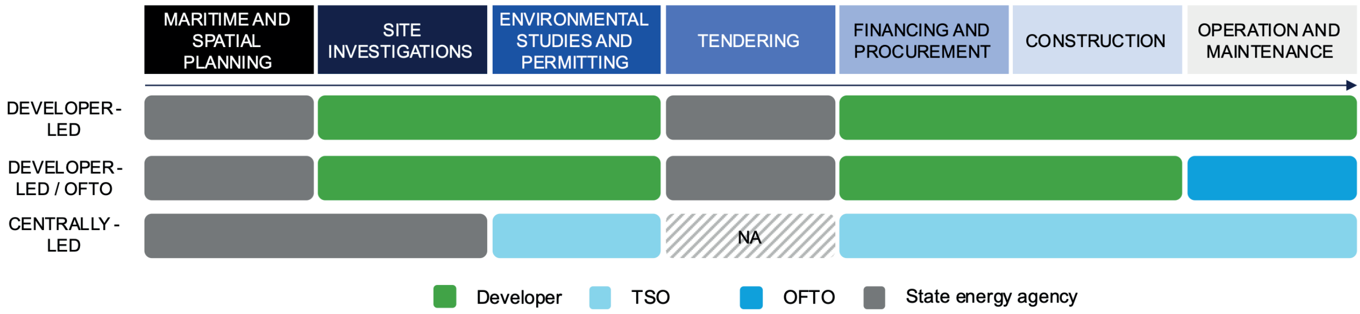
For emerging countries to mitigate supply chain risks, it is important to give certainty to the supply chain by means of early engagement. Development of a domestic supply chain can be stimulated by favourable tax regimes (such as in the US), preferential treatment in permitting and licensing stages, and future pipeline certainty. All these types of instruments fall under the remit of the government or public companies.

An example of how a central body can maximise the benefits of coordination is the case of Dutch TSO TenneT responsible for all offshore grid connections in the countries Exclusive Economic Zone. TenneT has developed and implemented a single procurement programme for its upcoming projects which entailed advance engagement with manufacturers, development of unified functional specifications and providing certainty on the scale of its need.[40]

Further, in a centrally-led regime, regulators have to carefully design grid availability incentives to ensure that the offshore wind does not get curtailed due to poor maintenance that falls outside the developer's responsibility. In this context, the GB Offshore Transmission Owner (OFTO) regime, so far only applied to radial connections, is a good example of how to shift the asset ownership after construction from developer to an independent regulated third party who takes responsibility for its operation and maintenance in return for a regulated revenue stream.

Overall, in countries with large offshore wind potential, strong institutional- and funding capacity, centrally planned and led offshore wind delivery process are preferred. Predominantly, the reasons are relatively higher process speed and efficiency, standardisation and economies of scale that can be achieved in centrally coordinating the design, delivery, operation and maintenance of the offshore grid.

Figure 5 - Offshore grid delivery models



40 https://www.tennet.eu/about-tennet/innovations/2gw-program

4.5 Information Sharing: Detailed Findings

4.5.1 There is a strong disincentive to share information between competitors

The offshore wind sector is characterised by intense competition, particularly in the Contracts for Difference (CfD) bidding process. This competitive environment creates a disincentive for Generators to share information that could potentially benefit their rivals, especially prior to CfD award. However, in coordinated projects initial and later users are required to share information on the cost and schedule of the offshore transmission system.

A number of Generators reported that there is an incentive for Generators to slow down competitors project timelines, especially if that results in less competition for their own projects in an upcoming CfD round. Therefore, where information sharing accelerates (or de-risks) the project timeline of a competitor there is a strong disincentive to share that information.

Any information which relates to or influences CAPEX costs, such as detailed engineering information related to shared transmission infrastructure, is potentially commercially sensitive since transmission infrastructure costs are factored into the CfD strike price under Network Charging costs. Sharing such information could furnish a competitor with advantageous information on project competitiveness leading into a CfD round.

This could also potentially result in implications under the Competition Act 1998 which prohibits agreements or undertakings that have as their object or effect the prevention, restriction, or distortion of competition. Sharing of commercially sensitive information could be seen as anti-competitive if it reduces uncertainty about competitors' market behaviour. The Competition and Markets Authority (CMA) has powers to investigate suspected breaches of competition law. Penalties for infringement can be up to 10% of worldwide turnover.

As a result, Generators are wary of sharing information that could be seen as anti-competitive, particularly regarding CfD bids. This legal context creates an imbalance in risk apportionment, with Generators bearing the potential legal risks of information sharing.

Underscoring the barriers to coordination that this presents is that the Anticipatory Investment application is carried out through submission of a letter which coordinating Generators undersign. This puts commitments on the Later User to take over the project in case it is delayed. However, since there is likely to be commercial information that Generators cannot share there is significant risk inherent in entering such an arrangement.

The reluctance to share data between Generators stems from fundamentally misaligned incentives. The current regulatory framework promotes competition between Generators, creating a situation where individual project success is prioritised over sector-wide efficiency and Generators withhold information that could lead to more optimal overall grid design and development.

Once coordinating projects secure CfD contracts, provided they have similar project timelines, both parties are incentivised to share information needed to ensure timely delivery of the transmission asset.

4.5.2 Lack of data governance and sharing protocols

Given the misaligned incentives for data sharing, the sector lacks adequate data governance and sharing protocols to provide clear guidelines on what information can (or cannot) be shared, when, and with whom. This creates uncertainty and risk for Generators and results in less effective coordination.

Even where Generators would consider sharing information with competitors, without clear rules and safeguards, they are more likely to err on the side of caution, limiting information sharing even when it could be beneficial for the overall development of the offshore grid.

The absence of common data catalogues accessible to all stakeholders (the NESO, Crown Estate, TOs, OFTOs, and Generators) results in information silos, reducing the potential for synergies between projects and limiting the ability to optimise the overall offshore grid design. It also leads to inefficiencies in data management and increases the risk of using outdated or inconsistent information in project planning and execution. While there have been suggestions for centralised data catalogues, implementation remains a challenge. This lack of a shared information resource represents a significant ineffective coordination mechanism.

The North Sea Transition Authority (NTSA) Offshore Energy Digital Strategy Group (DSG)[41] has recently published a set of data principles for offshore energies industries which lay out desired actions and behaviors which could be used as a starting point for establishing improved data sharing between coordinating parties:

- Leading in the energy transition through a shared data ecosystem
- Increasing the value of internal and external data
- Targeted use cases, collaboration for targeted solutions
- Advancing digital model/digital twin accuracy through data sharing
- Facilitating accessible, secure data repositories for all stakeholders
- Enhancing operational efficiency and reduced risk through data collaboration

It should be cautioned that no renewable developers or TOs were involved in the DSG and it does not specifically address the needs of coordination for offshore grid, however the wider work of the NSTA which includes a National Data Repository of O&G industry geoscience and engineering data provides a clear direction for developing data sharing infrastructure for coordinated offshore grid.

Ofgem Data Best Practice Principles[42], which applies to Networks, could also be taken as a starting point for developing data sharing frameworks for coordinated offshore grid, either by extending or amending the principles for coordinating parties and including the new requirements in their license conditions.

1. Identify the roles of stakeholders of the data
2. Use common terms within Data, Metadata and supporting information
3. Describe data accurately using industry standard metadata
4. Enable potential users to understand the data by providing supporting information
5. Make datasets discoverable for potential users
6. Learn and understand the needs of their current and prospective data users
7. Ensure data quality maintenance and improvement is prioritised by user needs
8. Ensure that data is interoperable with other data and digital services
9. Protect data and systems in accordance with Security, Privacy and Resilience best practice
10. Store, archive and provide access to data in ways that maximise sustaining value
11. Ensure that data relating to common assets is Presumed Open
12. Conduct Open Data Triage for Presumed Open data

41 https://www.nstauthority.co.uk/news-publications/data-principles-agreed-as-digital-strategy-group-launches-linkedin-site-to-aid-communication/
42 https://es.catapult.org.uk/insight/new-ofgem-licence-condition-to-require-data-best-practice-by-networks/

4.5.3 Prevention of multiple parties involved in similar surveys

There is significant duplication of effort in conducting seabed surveys and environmental assessments. Each developer typically conducts their own surveys, leading to inefficient use of limited resources such as survey vessels and adding unnecessary workload into the consenting processes. This duplication is a clear example of ineffective coordination mechanisms in the sector. The existing statement of intent between The Crown Estate (TCE) and NESO, and the recent partnership announced between GB Energy and TCE provides an opportunity for increased coordination of survey activities and network planning. The Celtic Sea leasing round was the first seabed leasing process in the UK to have a grid concept from the ESO ready to inform the seabed leasing process[43]. This approach could go further with NESO and TCE undertaking surveys of leasing areas and cable corridors and making these available to the sector.

4.5.4 Contestability of TO role and data exchange in design and delivery stages

For projects which integrate with TO "wet onshore" assets (offshore assets which are considered part of the onshore network) such as offshore bootstraps, there are challenges in data exchange between TOs and Generators during the detailed design and delivery stages.

Generators have reported difficulties in engaging TOs in asset design discussions leading to potential project delays. Whilst Generators seek early involvement to optimise their projects and deliver transmission assets in time for energisation dates, TOs do not share this incentive and naturally prioritise their own objectives.

Generators carry a disproportionate share of the risk from delayed transmission asset delivery, since the contractual and financing agreements are based on a fixed energisation date and there is no compensation mechanism if transmission assets are delivered late by a third party

4.6 Technology Interoperability: Detailed Findings

4.6.1 Establish a taskforce to develop common standards for GB offshore transmission infrastructure

The UK does not have common design and operations standards or functional specifications that dictate how multiple projects should connect to each other to mitigate system stability, harmonic and power flow issues. UK-based Generators have extensive experience in addressing such issues with HVAC technologies, but there is less practical experience from implementing HVDC projects.

In addition, what has worked well with individual projects, where each developer must adhere to a common set of technical standards established by the Security and Quality of Supply Standards (SQSS), may be more nuanced where projects are not only connected to the onshore system but also to each other. Electrical behaviour of two or more coordinated and physically connected projects, and their interaction with the onshore transmission system, can often be different from that of two similar individual projects. Especially, coordinated projects featuring equipment delivered by different vendors may be prone to such interoperability challenges.

HVDC technology-based solutions come with their own challenges, some of which are similar to those of HVAC and are largely related to compatibility and multi-vendor interoperability. These include protection strategies and philosophies (normally open or normally closed switches), converter

43 Statement from The Crown Estate in response to the publication of the Holistic Network Design by National Grid ESO | The Crown Estate ENTSOE

configurations (symmetrical monopole or bipole), fault clearing strategies, control, information exchange, etc. As with AC technology, solutions for individual projects exist and a wealth of experience is available from point-to-point interconnector and offshore wind links developed across the world and particularly in GB. It is the connection of multiple projects, often delivered by different vendors that poses the primary barrier to coordination.

Issues arise across system level aspects such as selection of DC voltage for the initial project (which will then have to be used by the later user as well) and the sizing of individual links which is driven by SQSS compliance requirements. Similarly, at a project level, developers willing to physically interface their projects need to ensure that mechanical and communication interfaces are compatible, and that dynamic performance, i.e. control and protection schemes can safely interface with each other.

Given the scale of offshore wind development and constantly increasing distance from shore, HVDC technology is expected to play a bigger role. As such HVDC interoperability is more challenging than HVAC due to its novelty, and therefore deserves more attention by the industry.

Today, HVDC systems from different suppliers are not interoperable: a converter station of vendor A can't be connected to a converter station of vendor B as they use different proprietary specifications and standards.[44] Consequently, it will be impossible to connect currently planned and built HVDC-connections to a more and more interconnected and meshed offshore grid. For the cost-efficient and scalable development of the HVDC grid infrastructure, the single-vendor approach, as currently applied in point-to-point projects, must evolve towards multi-vendor and multi-purpose capabilities for HVDC technology. Purchasing equipment from various manufacturers should be possible, similar to how it is done for HVAC technology. Multi-purpose, multi-terminal, multi-vendor characteristics are key for the future HVDC infrastructure.

4.6.2 Monitor and engage with projects investigating the interoperability of different technologies in offshore grids to learn from their findings

In addition to developing projects through the National HVDC Centre[45], the UK should maximise the benefits of research being conducted by other parties and monitor existing research projects to understand the implications of their findings for the UK.

The European Commission has set up a €90m 5-year research and demonstration project InterOPERA that aims to address the challenge of HVDC interoperability in offshore grids.[46] InterOPERA aims to enable real-life projects through commercial tenders building on the development of frameworks, functional specifications and dedicated grid codes for HVDC. The most futuristic approach is to develop a joint standard in Europe which ensures multi-vendor interoperability of converter stations and grid components so that grid planners and investors can freely choose from the best components and converter stations of the different suppliers.

In Germany, the three grid operators TenneT TSO GmbH, Amprion GmbH and 50Hertz Transmission GmbH have decided to collaborate and link up the offshore converter stations of the grid connections of 10 GWs of offshore wind farms to:[47]

- Simplify the onshore grid integration of this amount of power
- Enable energy trade with neighbouring countries
- Increase the security of supply and availability of the offshore grid and reduce curtailment

No statements have been made whether those will be sourced from different manufacturers or not, but given the limited supply chain capacity, only a multi-vendor solution is feasible.

North Sea Wind Power Hub[48] consortium of Dutch TSO Tennet, Dutch GTSO Gasunie and Danish (G)TSO Energinet has developed functional requirements and parameter ranges for HVDC building blocks of future coordinated offshore grid.[49]

These projects are all relevant and are likely to produce interesting and useful findings. However, differences in the regulatory frameworks employed in the GB and EU, as well as the different network topologies, markets and operating conditions mean that any interoperability recommendations for the EU will need to be evaluated specifically in relation to the GB context.

45 The National HVDC Centre

46 https://interopera.eu/

47 https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2023/02/20230227-bmwk-und-uenb-veroeffentlichen-plaene-zur-vernetzung-von-offshore-windparks-in-der-nordsee.html

48 https://northseawindpowerhub.eu/

49 https://northseawindpowerhub.eu/files/media/document/NSWPH-MTDC-FR_4047-Report%20DB3%20Rev05.pdf ; https://northseawindpowerhub.eu/files/media/document/NSWPH-MTDC-FR_4044_Report-v03.pdf

4.7 Supply Chain: Detailed Findings

4.7.1 Internal fragmentation and differences in standards to the EU exacerbate supply chain constraints for the UK market

Original equipment manufacturers (OEMs) are looking for greater certainty on the rating and functional specifications of the desired equipment. They often require upfront payments to secure manufacturing slots and prefer bulk orders where economies of scale can be achieved due to standardised designs. In this context, the Dutch TSO TenneT has realised a large procurement campaign engaging with key OEMs for cables, converter stations and support structures to ensure that the equipment it needs will be produced and delivered on time. The UK does not benefit from these economies of scale due to the fragmented nature of offshore projects with individual developers being responsible for the design and procurement of equipment for their projects.

These problems are exacerbated for the HVDC market as it is a newer technology with a less mature supply chain. Coordinated infrastructure such as multi-terminal HVDC links require specialist infrastructure and equipment such as special control systems to operate multiple interconnected HVDC converter stations. Chosen designs often push at the limits of what is technically achievable, and it is more likely that there is low supply chain confidence in delivery timelines and costs.

The equipment required to build new or reinforce existing infrastructure must meet a strict set of standards in GB such as SQSS which regulates the electrical behaviour of assets that connect to the onshore grid. However, although developers must conform to SQSS they often have their own approaches to the electrical design of the offshore part of the grid. This means that two offshore projects delivered by different developers are unlikely to be integrated given that the equipment design (both physical and electrical) is often incompatible.

In addition, the standards used within the UK are different to those used across Europe, limiting opportunities for partnership. Equipment manufacturers often need to meet UK-specific requirements (e.g., tower designs).[50] The challenge is to agree a level of standardisation that allows solutions to be built that accommodate genuine differences in requirements, but wherever possible provides access to the benefits of consistency within the UK and with other markets. These potential benefits include speed of supply, diversity of supply, lower cost through economies of scale, and introduction of innovation, amongst others.

These challenges could be mitigated through the establishment of common design standards and ratings which would have to be used by offshore developers for all offshore grid equipment. This would allow greater interoperability between projects and the ability to procure components and services in bulk. In turn, this would create economies of scale keeping costs and timescales down. Where possible, standards and designs should be aligned to those in use across northern Europe. Such alignment would accrue benefits to both markets as suppliers would be able to focus on making production more efficient for a larger addressable market, rather than splitting effort across separate markets.

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