Decision

Decision on the Initial Project Assessment of the Offshore Hybrid Asset Pilot Projects

Publication date:	12 November 2024
Contact:	Nick Pittarello
Email:	Cap.Floor@ofgem.gov.uk

In March 2024, we published a consultation on our minded-to position on the Initial Project Assessment (IPA) for the two eligible projects which applied to the Offshore Hybrid Asset (OHA) pilot scheme. These projects are LionLink to the Netherlands, and Nautilus to Belgium, both of which are Non-Standard Interconnectors (NSIs). The IPA is the first stage of the OHA pilot scheme process and considers whether the project is likely to be in the interests of GB consumers. This document summarises the responses to our OHA IPA minded-to consultation and provides our decision on the IPA for the Pilot NSIs.

We consider that both Nautilus and LionLink are likely to be in the interests of GB consumers, and therefore we have decided to grant these projects a Pilot OHA regulatory regime in principle, subject to the conditions set out in this decision document.

We have conducted further analysis to address stakeholder feedback. The rationale, methodology and results of that analysis are detailed within this document to support our approval of the projects referred to above.

Any enquiries related to the text of this publication should be sent to Ofgem at:

10 South Colonnade, Canary Wharf, London, E14 4PU.

This publication is available at www.ofgem.gov.uk. Any enquiries regarding the use and re-use of this information resource should be sent to: psi@nationalarchives.gsi.gov.uk

Contents

Foreword

In this decade, all countries in the North Sea basin are working to reach ambitious offshore wind construction goals to provide clean, zero-carbon power for the whole of Europe. Within this there is a great opportunity for collaboration and coordination, to create a meshed grid harnessing the potential of the North Sea, using world leading energy islands and offshore hybrid cables.

Offshore Hybrid Assets are a novel technology merging interconnection and the transmission cabling for offshore wind, allowing the same cable to be used for multiple purposes. This saves precious material resource on cable and lowers the onshore footprint of infrastructure, saving money for consumers and minimising impact on marine habitats and coastal communities.

We are proud to drive progress forward in GB through our Offshore Hybrid Asset pilot scheme, where we are creating a new regulatory and market framework to enable the construction of this essential new technology. Today we announce two pilot projects to be constructed and regulated under this new framework we are developing.

These pilot projects and the learnings from their development are of immense strategic importance to GB consumers and industry. These projects will connect GB to some of the largest offshore wind resource in Europe, and will allow for future wind farms in GB to be constructed and connected in the most efficient way possible.

We are delighted to taking initiative with Europe in delivering this innovative concept that maximises our common resources, and we look forward to working with the pilot project developers and our counterparts in Belgium and the Netherlands.

Akshay Kaul

Director General for Infrastructure

Executive Summary

OHAs are novel assets that combine interconnection with the transmission of offshore wind. They provide the potential for coordination and efficiency, compared to that of standalone point-to-point interconnectors and radial offshore wind connections. We consider OHAs are a step forward toward a meshed grid in the North Sea, which would best enable the efficient sharing of renewable electricity resources between countries in north-west Europe. There is significant strategic value in coordinated development to reach the extensive offshore wind ambitions for 2050, and development of the technical, regulatory and commercial structures of OHAs will assist in meeting this goal.

The OHA pilot scheme was open for applications between September and October 2022. Following its closure in October 2022, two project applications were found to be eligible for the Initial Project Assessment Stage (**IPA**) stage. These projects are LionLink to the Netherlands and Nautilus to Belgium. Both projects are Non-Standard Interconnectors (**NSIs**), developed by National Grid Ventures (**NGV**).

In March 2024, we published our minded-to positions on the OHA pilot scheme projects within our IPA consultation document for OHAs (**OHA IPA consultation**).[1] We were minded-to approve LionLink, and reject Nautilus, for a Pilot OHA regulatory regime. We have carefully reviewed the responses received from the consultation and carried out additional analysis where we considered necessary, to address the feedback provided. In response to the OHA IPA consultation, we received new information on proposed changes to the connection location and to the configuration of the Nautilus project which merited reanalysis. Based on this new information, on 15 July 2024 we published a re-consultation[2] on the resulting material modifications to the IPA for Nautilus. Following updated analysis, it was found that connection at the originally assessed location, Grain, was acceptable. We have therefore issued our decision on the IPA for Nautilus on the basis that the project connects to Grain. We have updated our modelling for the IPA of Nautilus to account for updates on the Line 2 (offshore substation to Belgium) capacity and on cost and revenue sharing. We respond to the stakeholder feedback from the re-consultation of July 2024 within this decision document.

Following the feedback on the constraint analysis in the OHA IPA consultation, NESO has implemented a constraint reduction factor to the constraint cost results for all OHA Pilot

[1] Initial Project Assessment of the Offshore Hybrid Asset pilot projects | Ofgem
[2] Changes to the Initial Project Assessment of the Nautilus Offshore Hybrid Asset | Ofgem

and Window 3 projects. Our consultants at Arup have also created a new scenario to amend the generation and demand background data for the Ireland Single Market (**I-SEM**). This change was in response to feedback for the IPA consultation for interconnector Window 3, which is running in parallel to the IPA consultation for the OHA pilot scheme. However, as the OHA pilot scheme projects and Window 3 interconnectors are included in the same quantitative modelling, this change has affected the results for the Pilot NSIs. We have taken these changes into account for our final decision on the IPA for the OHA pilot scheme.

Ofgem approves Nautilus to Belgium, and LionLink to the Netherlands, for a Pilot OHA regulatory regime. We believe that these projects show economic and system benefit to GB at a reasonable cost to consumers, and we have been persuaded by the applicant developer that these projects will connect within the connection deadline for the OHA pilot scheme. We further believe there is strategic benefit for GB to be gained by the development of OHA projects in general, and that the learnings from the OHA pilot scheme will contribute to the development of future projects.

Table 1: Ofgem's minded-to position and final decision for the OHA pilot projects

Project	Minded-to Position	High-level Reasoning	Decision	High-level Reasoning
LionLink	Approve	No material concerns (subject to agreement of cost of revenue sharing arrangements with the connecting country)	Approve	No material concerns – cost and revenue sharing arrangements have since been agreed.
Nautilus	Reject	High constraint costs, and uncertainty over the project configuration	Approve	Proportionate constraint costs and clarified configuration of the offshore island enabling positive economic assessment.

1. Introduction

Offshore Hybrid Assets

1.1 Electricity interconnectors are the physical links that connect our electricity system to those of other countries and territories, enabling cross-border trade of electricity. Ofgem's cap and floor regime has been successful in attracting investment to increase interconnector capacity over the last decade.

1.2 Electricity interconnectors to date have been beneficial to GB consumers, mainly by giving GB access to cheaper electricity imports from mainland Europe. As we move to a decarbonised electricity system, and the further development of GB's exceptional wind resource in the future, we expect GB to become a net exporter of electricity as our wholesale price moves from being one of the highest to one of the lowest in Europe. Interconnectors are no longer expected to predominantly be a source of cheap electricity imports and instead will be a way of providing flexibility and enhancing security of supply in a renewables-dominated energy system.

1.3 OHAs combine interconnection with the transmission of electricity from offshore wind. These assets are referred to in recital 66 of the EU Electricity Regulation3 and described as "offshore electricity infrastructure with dual functionality (so-called 'offshore hybrid assets') combining transport of offshore wind energy to shore and interconnectors".

1.4 OHAs provide the potential for coordination and transmission asset efficiency benefits, compared to that of standalone point-to-point interconnectors and radial offshore wind connections.

1.5 We consider OHAs are a valuable step toward a meshed grid in the North Sea, which will best enable the efficient sharing of renewable electricity resources between countries in north-west Europe. There is significant strategic value in coordinated development to reach collective offshore wind ambitions for 2050. Development of the technical, regulatory and commercial structures of OHAs will assist in meeting this goal.

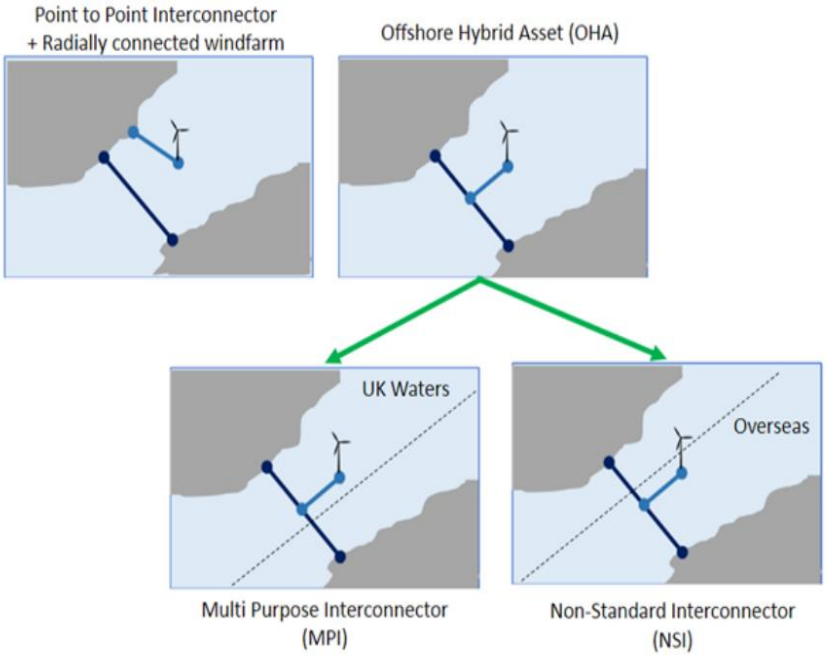
[3] Recital 66 of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast). : REGULATION (EU) 2019/ 943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 5 June 2019 - on the internal market for electricity (europa.eu)

Non-Standard Interconnectors

Context and related publications

1.6 The projects being assessed for the OHA pilot scheme are Non-Standard Interconnectors (**NSIs**), a subcategory of OHA defined by where the offshore wind generation is located. NSIs will conduct only interconnection activities in GB, and are connected to offshore generation in the connecting country, forming an OHA (see Figure 1 below). For the purposes of our OHA pilot scheme, the regulatory description of an NSI is as follows: "an electricity interconnector which is connected to an offshore converter station in the connecting jurisdiction and which does not subsist for the purposes of offshore transmission activities in Great Britain" [4] .

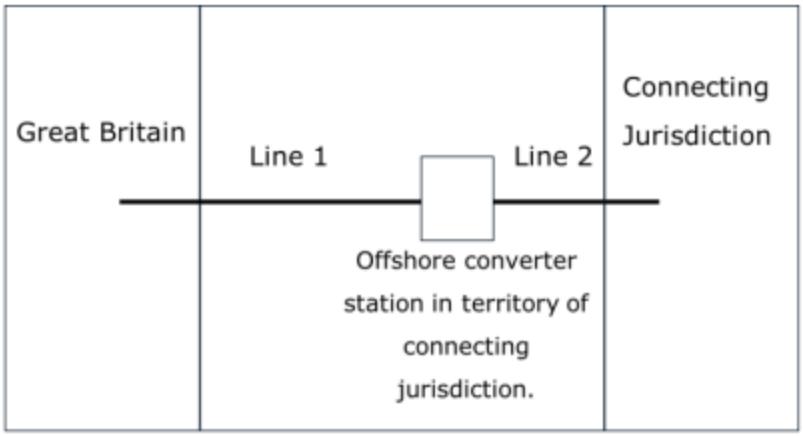
Figure 1: Schematic diagrams of a range of cross-border assets



1.7 We refer to both projects of the OHA pilot scheme together as the Pilot NSIs. The two Pilot NSIs comprise only the assets that connect GB to the offshore converter stations in the connecting countries. We call this Line 1, as shown in Figure 2 below.

[4] See page 17 of: Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme

Figure 2: Schematic diagram of the configuration of a shore-to-shore OHA, of which each Pilot NSI comprises Line 1



Background to the OHA regulatory regime and the IPA of the OHA pilot scheme

1.8 The cap and floor regime is a regulated route for interconnector development in GB, designed to facilitate the delivery of interconnection in a way that is economic, efficient and timely whilst protecting consumers' interests.

1.9 It provides interconnectors with a cap and a floor to regulate revenues. A minimum level of revenue is provided by consumers if the generated interconnector revenues are lower than the floor level. Where the generated interconnector revenues are above the cap level, the developer pays back revenues in excess of the cap to consumers. Interconnectors may also be delivered and operated under the merchant-exempt regulatory route, under which the interconnectors are exempted from specific regulatory and legal requirements, but their developers and operators bear the project development and operational revenue risks.

1.10 The cap and floor regime is awarded through investment windows rather than in response to ad hoc applications. Following the cap and floor regime pilot with the Nemo Link project, we have launched two cap and floor windows, one in 2014, and one in 2016, and took forward eight projects through both windows. Following this, we conducted our Interconnector Policy Review (**ICPR**) in 2020-21,[5] to determine the effectiveness of the cap and floor regime and to consider changes to the assessment process and to the regime for future projects.

[5] Interconnector Policy Review - Decision | Ofgem

1.11 Our ICPR also contained a commitment to open a pilot scheme for OHAs, referred to at the time as 'Multi-Purpose Interconnectors' (**MPIs**), noting the benefits they may provide to the coordination of offshore assets and the integration of offshore renewables.

1.12 We decided that an adjusted version of the cap and floor regulatory regime for interconnectors should apply to the Pilot NSIs.[6] While the details of the regulatory regime for OHAs is evolving, our assessment structure and delivery of such a regime is similar to that of the standard interconnector cap and floor process.

1.13 Projects successful in the IPA stage of the OHA pilot scheme will receive a Pilot OHA regulatory regime, the details of which are to be confirmed separately to this document. This regime is based upon the interconnector cap and floor regime, however with variations to reflect the differing risks and characteristics of OHAs, therefore it is materially different to the award provided to applicants for the interconnector cap and floor regime. This regime is to apply only to the OHA pilot scheme projects and may evolve further for later OHAs.

1.14 Following the IPA decision, each cap and floor project is held to the IPA conditions set out in the IPA decision. For the successful Pilot NSI projects, the IPA conditions relevant to the Pilot OHA regulatory regime are set out in this decision document, in Section 5. These are intended to incentivise timely delivery of projects and to ensure that consumers realise the anticipated benefits that informed our decision at the IPA stage on the needs case for the project.

Non-Standard Interconnectors- eligibility

1.15 The OHA pilot scheme closed for applications in October 2022.

1.16 We determined that the following applicant projects were eligible for assessment at the IPA stage in December 2022:[7]

- LionLink, to the Netherlands, a proposed 1.8GW connection to an offshore converter station on a Dutch offshore converter platform; and
- Nautilus, to Belgium, a proposed 1.4GW connection to an offshore converter station on the Modular Offshore Grid 2 (**MOG2**) Belgian energy island (also known as Princess Elisabeth Island).

[6] Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme (ofgem.gov.uk)
[7] Decision on Multi-Purpose Interconnector pilot project Selection | Ofgem

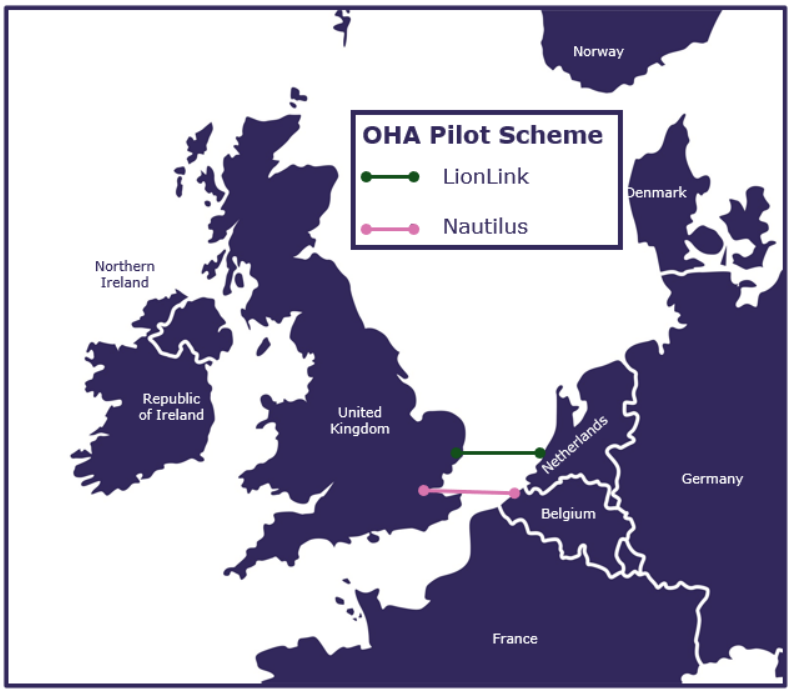


Figure 3: Map showing indicative connection locations for the Pilot NSIs

Non-Standard Interconnectors - Initial Project Assessment

1.17 In March 2024, we published our OHA IPA minded-to consultation for both LionLink and Nautilus, in which we consulted stakeholders for their feedback on our positions and approach. The IPA consisted of three components in line with the OHA Pilot Application Guidance,[8] and Needs Case Assessment Guidance Document.[9] In our Needs Case Assessment Guidance we noted that decision making would not be weighted across these three components. This means there is no numerical threshold by which a project can pass or fail the IPA, and the components are not prioritised in importance in relation to each other. The three components were:

- **The maturity and deliverability analysis** - conducted through Ofgem analysis of applicant-submitted business plans for their projects, structured by the criteria set out in the OHA Pilot Application Guidance.
- **The market modelling** – quantitative modelling on the socio-economic welfare (**SEW**), decarbonisation and security of supply impacts for projects, conducted by our consultants at Arup. The indicators for this assessment were set out in our Needs Case Assessment guidance

[8] Multi-purpose Interconnectors Pilot Regulatory Framework | Ofgem
[9] Cap and Floor Third Application Window and MPI Pilot Regulatory Framework- Guidance on our Needs Case Assessment Framework | Ofgem

document. Arup also provided 'Red-Amber-Green' (**RAG**) ratings for the hard to monetise impacts.

- **The system impacts modelling** - quantitative modelling on projects' constraint cost impacts and other system benefit derived from providing ancillary services to the grid, conducted by NESO. The indicators for this assessment were set out in our Needs Case Assessment guidance document.

1.18 The outputs from the market modelling and system impacts analysis were combined into a Multi-Criteria Assessment (**MCA**) conducted by our consultants at Arup, published alongside the minded-to consultation.

1.19 Based on the analysis as presented in our OHA IPA consultation, we outlined our minded-to position to:

- **Approve LionLink** – on the condition that Ofgem must be reasonably satisfied that the outcomes of the negotiations on cost and revenue sharing will result in arrangements that are in the interest of GB consumers.
- **Reject Nautilus –** due to reservations surrounding high constraint costs and uncertainty regarding the project's configuration.

1.20 We invited feedback from interested stakeholders on this publication, allowing 13 weeks for response. This consultation received a total of 10 responses. We have published responses marked non-confidential alongside this document.

Next Steps

1.21 We are continuing to further develop our pilot regime for OHAs. As part of developing our regulatory regime, we have recently issued a consultation on NSI regime parameters[10] which will define the cap and floor levels for the OHA pilot projects.

Our Decision-making process and Ofgem's Duties

1.22 The Pilot NSIs have been assessed by taking into account all the strategic benefits of point-to-point interconnection, as well as considering the additional benefits that enabling a pilot project of this new configuration and technology delivers. We have also considered the unique risks carried by OHAs in their development (compared to point-to-point interconnectors).

[10] Consultation on further detailed regime parameters for the Offshore Hybrid Asset pilot scheme | Ofgem

1.23 We assessed projects in line with the Gas and Electricity Markets Authority ("the Authority")'s principal objective to protect the interests of existing and future consumers, including interests in compliance with the net zero carbon target. We will only grant a regulatory regime in principle to projects that deliver positively in all parts of our assessment.

1.24 In a decarbonised future electricity system, we expect that further interconnectors to mainland Europe, which include both of the Pilot NSIs, will likely be net exporters, resulting in lower consumer welfare and a marginal rise in the wholesale price in GB. Despite this, future interconnection would likely remain in the consumer interest, as it is likely there are additional benefits to be gained from interconnectors in meeting national and international policy goals related to decarbonisation, economic growth, flexibility and renewable energy integration.

1.25 Section 202 of the Energy Act 2023 amends the Electricity Act 1989 to include a specific requirement for Ofgem to have regard to the Secretary of State's compliance with the UK net zero target when carrying out its regulatory functions (**the Net Zero Duty**), including while conducting the assessment of interconnector and OHA projects for cap and floor support. This new amendment came into force on 26 December 2023.

1.26 Section 108 of the Deregulation Act 2015 requires certain public bodies to have regard to the desirability of promoting economic growth, for the wider UK economy, when carrying out their regulatory functions (**the Growth Duty**). From 2017, the Growth Duty applied to over 50 regulators. On 21 May 2024 the Growth Duty was extended to include Ofgem and the statutory guidance was updated.[11]

1.27 These new duties affect how Ofgem assesses the GB consumer interest when making decisions to grant a regulatory regime in principle, by having regard to the desirability of promoting economic growth and the Secretary of State's compliance with the net zero emissions target when carrying out its duties.

Related Publications

Context for the introduction of Window 3 and OHA Pilot Scheme

Interconnector Policy Review: Decision (December, 2021) Interconnector Policy Review: Decision (ofgem.gov.uk)

[11] The Deregulation Act 2015 (Growth Duty Guidance) Order 2024 (legislation.gov.uk)

Targeting analysis for the Third Cap and Floor Window and MPI Pilot Regulatory Framework (August, 2022) Targeting Analysis for the Third Cap and Floor Window and MPI Pilot Regulatory Framework | Ofgem

Multi-purpose Interconnectors Pilot Regulatory Framework (October 2022) Multi-purpose Interconnectors Pilot Regulatory Framework | Ofgem

Cap and Floor Third Application Window and MPI Pilor Regulatory Framework (July 2022) – guidance on our Needs Case Assessment Framework Cap and Floor Third Window and MPI Pilot Needs Case Framework (ofgem.gov.uk)

Decision on Multi-Purpose Interconnector pilot project Selection (December 2022) Decision on Multi-Purpose Interconnector pilot project Selection | Ofgem

OHA Regulatory Framework

Consultation on the Regulatory Framework, including Market Arrangements, for Offshore Hybrid Assets: Multi-Purpose Interconnectors and NSIs (June 2023) Consultation on the Regulatory Framework, including Market Arrangements, for Offshore Hybrid Assets: Multi-Purpose Interconnectors and Non-Standard Interconnectors | Ofgem

Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme (February 2024) Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme | Ofgem

Initial Project Assessment of the Offshore Hybrid Asset Pilot Projects (March 2024) Initial Project Assessment of the Offshore Hybrid Asset Pilot Projects (ofgem.gov.uk)

Changes to the Initial Project Assessment of the Nautilus Offshore Hybrid Asset (July 2024)

Changes to the Initial Project Assessment of the Nautilus Offshore Hybrid Asset | Ofgem

General feedback

We believe that consultation is at the heart of good policy development. We are keen to receive your comments about this report. We'd also like to get your answers to these questions:

1. Do you have any comments about the overall quality of this document?
2. Do you have any comments about its tone and content?
3. Was it easy to read and understand? Or could it have been better written?
4. Are its conclusions balanced?
5. Did it make reasoned recommendations?
6. Any further comments

Please send any general feedback comments to Cap.Floor@ofgem.gov.uk

2. New analysis conducted since consultation

Responses to our March 2024 minded-to consultation

2.1 We received 10 responses to our March 2024 OHA IPA consultation. The responses we received to the OHA IPA consultation only were from National Grid Ventures (as the one applicant to the OHA pilot scheme), two community action groups, and the regulator and Transmission System Operator (TSO) in Belgium. Other responses, from non-applicant developers and TSOs, addressed both the Window 3 IPA and the OHA IPA consultations. We have published the responses classified as non-confidential, alongside this decision.

2.2 The 10 consultation responses covered the following themes:

a. Modelling approach chosen by Arup (in particular the use of the NESO Energy Future Scenarios 2022 (**FES22**) to estimate socio-economic welfare (**SEW**) impact)

b. Validity of NESO's results on the project constraint costs of the interconnectors

c. Ofgem's consideration of both quantitative analyses from Arup and NESO in coming to the final decision

d. Perceived underestimation of the wider strategic benefits that OHAs can deliver (such as security of supply, decarbonisation and reducing congestion)

e. Treatment of hard to monetise indicators

f. Regulatory delays

g. Ofgem's statutory duties

2.3 Overall, the majority of responses agreed with the strategic benefits of OHAs and the build-out of coordinated infrastructure in the North Sea. Whilst agreeing with the benefits of OHAs, respondents flagged concerns over elements of Ofgem's, Arup's and the NESO's combined analysis. We discuss the feedback we received in response to our March 2024 minded-to consultation within the project specific chapter for Nautilus.

2.4 Within the following paragraphs, we summarise the additional analysis we have undertaken across both OHA pilot projects and W3 projects in response to the feedback we have received. We discuss how this analysis impacts Nautilus and LionLink, within the individual project specific chapters.

Market and system impacts model re-run

2.5 We decided to re-run both Arup's market model and the NESO's system impacts model to address stakeholder feedback. The following changes were implemented in the re-run for both models.

Changes to generation and demand assumptions for the Island of Ireland using Ten Year Network Development Plan (TYNDP) 2022 data

2.6 Following stakeholder feedback within the consultation, and a further investigation of the European FES22, we chose to re-run the market modelling and system impacts modelling for all projects, with the FES22 data for the Irish Single Energy Market (I-SEM) only being replaced with I-SEM data from TYNDP 2022. This re-run has been used to replace the original modelling for final decision-making.

2.7 As Window 3 interconnector and the OHA pilot scheme projects are assessed together in the same quantitative modelling, the I-SEM TYNDP 2022 rerun affects the SEW, emissions and constraint cost results for all projects.

2.8 Further details on this analysis and the reasoning for it can be found within Sections 2 and 3 of our Window 3 IPA decision, published in parallel with this decision.

Nautilus IPA re-consultation changes

2.9 During the OHA IPA consultation period, we received evidence of material changes to the assumptions used in the modelling for the Nautilus OHA pilot project. These changes involved: (i) the configuration of the offshore island impacting the modelled capacity of Line 2 in the overall OHA of which Nautilus forms part; and (ii) cost and revenue sharing.

2.10 Nautilus was originally modelled with a 3.5GW Line 2, and Ofgem was aware at the time of modelling this was subject to change pending a public consultation on the Princess Elisabeth Island in Belgium. Line 2 capacity has now been confirmed by authorities in Belgium as 1.4GW. Line 2 is to run from the energy island to the Belgian onshore transmission network. In addition, a cost and revenue sharing arrangement between GB and Belgium for Nautilus has now been agreed.

2.11 To reflect the nature of these changes, in our re-run of the market modelling and the system impacts modelling for the IPA, we have assumed Nautilus is connected to a 1.4GW Line 2, and in the market modelling we have used the new cost and revenue sharing arrangement.

2.12 As Window 3 and the OHA pilot scheme projects are assessed together in the same quantitative modelling, the change in configuration of Nautilus affects results for all projects. The exact values of SEW and constraint costs change for all projects, however, we confirm that this change alone is not material to the decision outcome for any Window 3 interconnector projects.

2.13 We address this change in configuration in further detail within Section 4 of this document.

Changes relevant to the market model only

Onshore costs

2.14 In the Guidance on our Needs Case Assessment Framework from July 2022, we said that in the IPA process, we were going to use the developer costs stated in each project's Connections Options Infrastructure Note (**CION**) to understand the costs of connecting the project to the national transmission system and the wider reinforcement costs.[12] We stated in paragraph 3.64 of the W3 IPA consultation that these costs from the CIONs of all applicant projects are now outdated because they do not reflect changes to the network resulting from the Holistic Network Design[13] (**HND**) and other recent planning processes.

2.15 We have received updated numbers from the relevant TOs. The costs solely attributable to the applicant projects are no higher than £20 million for any one project and we do not believe they represent an obstacle to the progression of projects in our regulatory process.

2.16 In addition to the sole driver works that are attributable to the interconnector, there are also network reinforcements that are driven by several projects. This is the first cap and floor window taking place at the same time as a strategic network planning exercise, the HND and Beyond 2030.[14] We are confident that the majority of the costs related to these multi-driven works are attributable to offshore wind farms as part of the HND, and not the interconnectors.

2.17 As projects progress through our regulatory processes, we reserve the right to consider all projects' attributable network costs in any future assessment.

[12] Cap and Floor Third Window and MPI Pilot Needs Case Framework (ofgem.gov.uk)
[13] A Holistic Network Design for Offshore Wind | National Energy System Operator
[14] Beyond 2030 | National Energy System Operator

Cost and Revenue Sharing and Cap and Floor Rates

2.18 At the OHA IPA consultation stage, one of the outstanding issues for both of the OHA pilot scheme projects was an agreement with the connecting countries on how costs and revenues would be shared. Agreements in principle have been reached on cost and revenue sharing for both of the OHA pilot scheme projects and these arrangements have been reflected in our modelling analysis for this OHA IPA decision.

2.19 The cap and floor levels in the model have been amended to more closely reflect the cost sharing arrangements as well as the parameters we would expect to see in the Pilot regulatory regime.

Net UK figures for welfare and emissions

2.20 During the IPA process, Ofgem has acquired two new statutory duties related to net zero and economic growth. These are duties which require us to have regard to impact across the whole UK and not only GB.

2.21 To enable a view of the net UK impact of projects on net zero and economic growth, we have split results for the I-SEM SEW and emissions savings between the Republic of Ireland and Northern Ireland, Using the Northern Ireland figure, we have then derived a net-UK figure for SEW and emissions for all projects.

Changes relevant to the system impacts model only

Constraint reduction factor

2.22 Reflecting on consultation feedback, NESO applied a reduction factor to constraint cost results from 2035 onwards across all projects. This reflects the most probable future that nationwide interventions to reduce constraint costs would occur on the system before 2050, without assuming a particular solution. The details of such solution would be uncertain and problematic to model in detail, and it would go beyond the scope of our analysis.

2.23 The constraint reduction factor methodology developed by NESO is based upon the network reinforcements recommended in its latest system planning exercise 'Beyond 2030'.[15] The methodology compares the recommended total network constraint savings to the total cost of the recommended reinforcements. This provides a fixed percentage for each scenario that can then be applied to reduce the constraint cost results of our analysis.

[15] Beyond 2030 | National Energy System Operator (neso.energy)

2.24 The reduction factor incorporates the most up to date effects of recommended reinforcements necessary to the system to reduce constraint costs beyond 2030. However, NESO deemed appropriate to only apply the constraint cost reduction factor from 2035. This approach was followed to reflect potential limitations that transmission owners (**TOs**) might have in delivering additional reinforcements in the early years of the decade.

2.25 More details on the methodology used by NESO can be found in the report published alongside this decision.

Discussion on the interpretation of constraint costs

2.26 In our ICPR decision, we stressed the increasing importance of the impacts of interconnectors on the electricity system. We noted that the role that interconnectors were playing was evolving and we could no longer automatically assume future interconnectors would have a positive impact on consumer welfare. In recognition of this changing role and the increasing need to ensure the entire system is working efficiently, we intended to target Window 3 geographically based on system impact analysis, market signals and project deliverability.

2.27 In our August 2022 targeting document,[16] we decided not to apply locational targeting to W3. However, our key takeaway from the targeting analysis was that future interconnector projects could either result in savings to constraint costs, or incur high additional constraint costs, depending on their flow direction and where they are located in GB. In particular, exporting projects in the south of the country were expected to have substantial constraint costs. We concluded that a project's whole-system impacts would be considered to a greater extent throughout our IPA.

2.28 Our final IPA results confirm that, with the exception of the Irish projects, we can expect the W3 and OHA projects to be mainly exporting over the modelled period. As these projects are located in the southern half of the country, the results show that substantial constraint costs could be expected. We acknowledge that the system needs to address network bottlenecks and therefore constraint cost forecasts may not materialise in full. In response to this, we have applied a constraint cost reduction factor in anticipation of further network developments.

[16] Targeting Analysis for the Third Cap and Floor Window and MPI Pilot Regulatory Framework | Ofgem

3.19 In view of the principles set out in our ICPR decision, the signals provided by the NESO's targeting report and the results from developers' chosen projects, we have considered whether the increase in constraint costs is proportional to the capacity that the project adds to the system across the three scenarios. Each section of this decision corresponding to a separate project sets out our view on whether the increase in constraint costs can be justified in this context.

3.20 A disproportional increase in constraint costs would mean further inefficiency in the system requiring NESO to intervene further in the balancing market. The actions that NESO would be required to take would mean consumers having to pay even more for their energy as a result of exacerbated inefficiencies. We have assessed the ratios between the total projected system constraint costs (including the constraint reduction factor) and the project capacities, and they are shown in the tables below.

3.21 We consider that the approved projects are in the consumer interest despite the additional constraint costs they incur. We believe that an increase in constraint cost may remain in the consumer interests depending upon the wider benefits arising from each specific project under consideration. For the avoidance of doubt, our assessment of constraint costs has not been a comparative exercise across all projects.

Table 2: Individual projects' constraint cost impact on the system for the Marginal Additional approach

	Capacity MW	Project constraint costs with constraint reduction factor £bn	Total system constraint cost £bn	% share of total constraint cost	Project capacity share of installed capacity in 2030	Ratio between shares 2030	Project capacity share of installed capacity in 2050	Ratio between shares 2050
LionLink	1800	0.9	54.9	1.7%	0.9%	2.0	0.5%	3.2
Nautilus	1400	1.3	54.4	2.5%	0.7%	3.7	0.4%	5.9

Table 3: Individual projects' constraint cost impact on the system in the Consumer Transformation (CT) scenario for the Marginal Additional approach

	Capacity MW	Project constraint costs with constraint reduction factor £bn	Total system constraint cost £bn	% share of total constraint cost	Project capacity share of installed capacity in 2030	Ratio between shares 2030	Project capacity share of installed capacity in 2050	Ratio between shares 2050
LionLink	1800	0.7	73.8	1.0%	0.9%	1.1	0.5%	2.1
Nautilus	1400	1.2	73.0	1.6%	0.7%	2.2	0.4%	4.1

Table 4: Individual projects' constraint cost impact on the system in the Falling Short (FS) scenario for the Marginal Additional approach

	Capacity MW	Project constraint costs with constraint reduction factor £bn	Total system constraint cost £bn	% share of total constraint cost	Project capacity share of installed capacity in 2030	Ratio between shares 2030	Project capacity share of installed capacity in 2050	Ratio between shares 2050
LionLink	1800	0.0	20.6	0.1%	1.1%	0.1	0.6%	0.2
Nautilus	1400	0.5	20.2	2.4%	0.9%	2.8	0.5%	4.8

Table 5: Total installed capacity in 2030 and 2050 in the three scenarios

Total Installed Capacity (GW)	**2030**	**2050**
Leading the Way	210	339
Consumer Transformation	197	366
Falling Short	163	282

2.29 The above ratios help guide us to assess whether a project's expected constraint costs could be regarded as disproportional. The higher the ratio, the larger the disproportionality between the project's size and the projected constraint cost impact. We have calculated ratios based on the installed capacity at both the beginning (2030) and the end (2050) of the assessment period to derive the indicator.

2.30 We note that constraint costs are a transfer from consumers to producers and should not be subtracted from total SEW results.

Comparison of all project results following new analyses

Table 6: Overview of the OHA performance across the IPA for the consultation

	Maturity	Economic modelling (welfare) £bn	Total European carbon savings mtCO2	Total GB carbon savings mtCO2	Constraint costs £bn	System operability savings (frequency, voltage, reactive) £bn	Avoided RES curtailment (TWh)
LionLink (Netherlands)		-0.2 to 1.6	4.5 to 10.9	-12.7 to -2.0	0 to 1.2	0.31	5 to 28
Nautilus (Belgium)	Configuration TBC	0.4 to 1.0	4.9 to 10.7	-11.5 to -1.7	1.3 to 3.3	0.21	2 to 5

Table 7: Updated overview of the OHA performance across the IPA for the final decision

	Maturity	Economic modelling (welfare*) £bn	Total European carbon savings mtCO2	Total GB carbon savings mtCO2	Constraint costs** £bn	Constraint costs (as % of total GB constraints)	System operability savings (frequency, voltage, reactive) £bn	Avoided RES curtailment (TWh)
LionLink Decision		0.3 to 1.2	4.4 to 10.5	-13.5 to -2.2	0.0 to 0.9	0.1 to 1.7	0.31	6.2 to 27.2
Nautilus Decision	Configuration confirmed	0.1 to 0.2	3.8 to 8.7	-10.1 to -1.5	0.5 to 1.3	1.6 to 2.5	0.21	-2.5 to 1.6

***SEW calculations include cap and floor payments and transfers from Contracts for Difference payments. Updated for Ireland background (Nautilus at Grain 1.4GW L2)**

****Updates after consultation: Ireland background, constraint reduction factor applied (Nautilus at Grain 1.4GW L2). RES curtailment also updated for Ireland background.**

Interpretation note: The monetised figures within this table are not directly comparable. Constraint costs should not be directly subtracted from the welfare figure, as they indicate a transfer from consumers to producers only. The welfare figures are a total of consumer, producer and interconnector welfare. The welfare figures would remain unchanged.

3. Decision - Nautilus

In our March 2024 OHA IPA consultation, we outlined that we were not minded-to offer a Pilot OHA regulatory regime to Nautilus. This was based upon the high constraint cost impact of the project, and uncertainty over the project configuration on the Belgian side, which made it difficult to assess the project's total welfare benefit to GB.

We have since received updated information on the project's configuration, applied a constraint reduction factor to constraint costs (positively impacting the projects constraint costs), and agreed cost and revenue sharing arrangements with the relevant parties. Having considered the updated information and the changes to our analysis, we approve Nautilus for a Pilot OHA regulatory regime in principle, subject to the IPA conditions set out in Section 5 of this document

Background

3.1 At the point of publication of our March 2024 OHA IPA consultation, there was lack of certainty as to whether the energy island will operate in "single" or "split" node configuration.[17] This meant that it was difficult to assess how to model the capacity of the cables from the Belgian Princess Elisabeth energy island to the Belgian shore, which had a substantial bearing on the economics of Nautilus and in assessing the project's SEW benefit to GB.

3.2 In addition to the configuration uncertainty, we said that based on the information we had available, Nautilus's constraint cost projections posed a significant risk for consumers. We also noted that we remained concerned over the potential for significant asymmetry between Line 1 and Line 2 congestion revenue.

3.3 In response to our OHA IPA consultation, we were provided with updated information from both the developer and The Belgian Ministry for Economy and Commission for Electricity and Gas Regulation (**CREG**). The updated information included a proposed change in connection location in GB to Leiston (submitted by NGV) and confirmation from the Belgian authorities that there would be 1.4GW capacity on Line 2 of the OHA.

3.4 We considered that these changes were material and would impact the market modelling and system impacts analysis. Therefore, we ran a re-consultation[18] on

[17] "Split-node" maintains separation between the 1.4GW HVDC cable and the 1.4GW windfarm from the 2.1GW HVAC cables and windfarm.

[18] Changes to the Initial Project Assessment of the Nautilus Offshore Hybrid Asset | Ofgem

Nautilus in July 2024. This included the updated information provided from the developer and relevant authorities, and our updated analysis.

3.5 Since publishing that consultation, we conducted new analysis to address feedback from the OHA IPA consultation, where it was found that connection at the originally assessed location, Grain, was acceptable. Therefore, we have based our analysis for this IPA decision on Nautilus having its GB connection at Grain. We respond to the feedback we received for this re-consultation later in this Section.

Ofgem's view on consultation responses

3.6 We received 10 responses to our March 2024 OHA IPA minded-to consultation, four of which directly responded to our minded-to rejection of Nautilus. NGV and Elia, the TSO in Belgium, submitted a joint response as the two developers of the wider OHA project of which Nautilus is part.

3.7 Suffolk Energy Action Solutions (**SEAS**) disagreed with the minded-to rejection, outlining this project should go ahead, as it considers Nautilus is the most beneficial way of transmitting energy directly to London and the south-east of England. SEAS added that the Nautilus project is consistent with the Future Frameworks (formerly known as the Enduring Regime)[19] policy intent from DESNZ's Offshore Transmission Network Review, and that going ahead with this pilot project will help decision-makers gain an understanding of the practical challenges to be overcome regarding offshore coordination.

3.8 NGV/Elia strongly disagreed with the minded-to rejection of Nautilus, arguing that adding the approval of Nautilus would deliver benefits to British and Belgian consumers, producers and economies. NGV and Elia noted that the Nautilus project allows the UK to extend its energy cooperation with Belgium and has secured strong support from both countries.

3.9 The Belgian Ministry for Economy and CREG also disagreed with our the minded-to rejection of Nautilus. Within their responses they provided additional information as to the project's maturity and configuration. In the following paragraphs we discuss the specific themes raised in response to our minded-to rejection of Nautilus and our own response to this feedback.

Responses regarding confirmed project maturity

3.10 The Belgian Ministry for Economy response clarified certain process steps for grid development in Belgium and confirmed, that the 1.4GW HVDC connection from the

[19] Offshore Transmission Network Review: Future Framework: government response and recommendations (publishing.service.gov.uk)

Princess Elisabeth Island (in split node operation on the island) is the relevant capacity for our IPA analysis. This configuration was also clarified through CREG's response to our March 2024 minded-to consultation.

3.11 The additional information provided by the Belgium Ministry for the Economy and CREG has provided us with clarity on the configuration of the energy island. This information has improved our assessment of the projects maturity and provided us with certainty that the SEW welfare remains positive, with this new configuration.

Responses regarding regulatory delays

3.12 NGV/Elia highlighted that originally the OHA IPA decision was anticipated by the end of 2023, calling for Ofgem to act with urgency to build offshore infrastructure at pace. NGV/Elia added that Nautilus is part of a broader piece of work around the Princess Elizabeth Island and any delays will impact programme costs, scheduling and prevent supply chain commitments.

3.13 We recognise the need for certainty so projects can progress. To ensure these large-scale national infrastructure projects are suitable to be granted direct support from consumers, it is necessary to scrutinise the needs case for individual projects through the IPA and ensure this analysis is robust. While there have been some delays to our process, we have sought to improve the IPA process based on our experience from previous windows.

3.14 For example, for Window 3 and the OHA pilot scheme we have built in further open communication and engagement into the IPA process, for example by introducing a developer workshop stage to determine the modelling methodology based on input from all applicants. By applying to a cap and floor regime window and the OHA pilot scheme, each developer knows how they will be assessed in line with the Application Guidance and the assessment framework, and that a consultation with results will be published thereafter. We have taken time to engage with applicants on the methodology and on their individual projects, and consider consultation is a fair and necessary part of the IPA process. The W3 and OHA IPA was based on very similar assessment frameworks and the IPA was conducted simultaneously.

3.15 Additionally, following receipt of responses to our OHA IPA consultation, we received additional information on the Nautilus project. We consider this updated information constituted a material change and therefore merited further consultation.

Responses regarding procedural unfairness

3.16 CREG highlighted the importance of non-discriminatory treatment of the different OHA projects, both during the assessment and the operational phase.

3.17 Ofgem consider the IPA has been applied fairly between projects. Each pilot OHA project is assessed on its own merits, based on the information provided to us under the assessment framework.

3.18 The IPA evaluation covered a multicriteria assessment framework including system impact and market modelling analysis, and the hard to monetise impacts. Additionally, the projects were assessed on their individual deliverability and maturity.

3.19 The IPA is not weighted nor mechanistic. The final decision on whether to award a regulatory regime in principle, is taken by the Authority with regards to the Application Guidance for the OHA pilot scheme and the Authority's principal objective. The Authority's principal objective, contained in section 3A of the Electricity Act 1989, is to protect the interests of existing and future consumers, including their interests in the Secretary of State's compliance with the duties in sections 1 and 4(1)(b) of the Climate Change Act 2008 as well as their interests in the security of the supply of electricity to them.

3.20 During the IPA process, the projects are assessed on their own merits and their results are not directly compared against each other. We look to offer a regulatory regime, in principle, to any project that we consider to be in the consumer interest and deliverable prior to the end of 2032.

Responses regarding economic modelling

Unquantified benefits of OHAs

3.21 NGV/Elia disagreed with Ofgem's approach to economic modelling, contending that Ofgem's approach is too narrow and appears to be primarily based on the traditional approach to assessing point-to-point interconnectors. NGV/Elia added, that if hybrid projects continue to be tested only on SEW, there will be risk of stagnation in the essential build-out of cross-border infrastructure. NGV/Elia argued that cost-benefit analysis should focus on benefits beyond the SEW, such as security of supply, decarbonisation and reduction/avoided wind curtailment. NGV/Elia was also critical of the scope of our quantified metric for security of supply, measured by an interconnector's ability to mitigate the occurrence of unserved energy hours, i.e. periods in which supply and demand on the grid do not match. This was perceived as being limited.

3.22 NGV/Elia also noted it was unclear as to what extent benefits of security of supply, decarbonisation and avoided wind curtailment were accounted for within the hard to monetise impact analysis. On avoiding curtailment of renewable energy, NGV/Elia outlined this is an unquestionable wider benefit of increased

interconnection capacity and flagged that this not monetised within Ofgem's analysis.

3.23 With regards to assessing the impact of security of supply, NGV/Elia suggested that an alternative means of measuring the project's contribution to GB could be to assess the impact it may have on the Capacity Market (**CM**). [20] NGV/Elia noted, with 1.4GW of capacity, Nautilus will deliver significant power flows to GB as other operational interconnectors do today when GB margins are tight and that the magnitude of this flexible capacity will provide crucial benefits to system security.

3.24 Based on our experience from previous windows (under the cap and floor regime), we expanded the assessment framework for Window 3 and the OHA pilot scheme to respond to our ICPR. This window goes further than previous windows in quantifying carbon impact, security of supply impact, avoided curtailment and value brought by interconnectors' participation in ancillary services. Indicators, and the methods for calculating them, were provided to developers firstly in advance of the window opening in the Needs Case Assessment Guidance document,[21] and later in advance of the modelling commencing via workshops and agreed with applicants before the window commenced.

3.25 Arup have also clarified in the market modelling report, published alongside our March 2024 minded-to consultation, which potential benefits of interconnectors they have considered out of scope for the modelling. We maintain that the scope of quantified benefits remains fit for purpose for this decision.

3.26 The methodology for assessing security of supply, determined by our consultants at Arup, is derived from a method recommended in European body ENTSO-E's published guidance on conducting cost-benefit studies for network infrastructure projects.[22] The proposed methodology was presented to applicants in advance of the IPA modelling commencing, firstly through the Needs Case Assessment Guidance document in July 2022,[23] and then through engagement with applicants in summer 2023. No feedback was presented by applicants on this point at the time and, therefore, this was confirmed as our methodology. We consider that such a

[20] The Capacity Market was established in 2013 by HM Government to ensure sufficient reliable electricity capacity is available on reserve in moments of stress on the system. Generators compete in an auction to receive payment for remaining active at certain forecasted hours of high demand.

[21] Cap and Floor Third Application Window and MPI Pilot Regulatory Framework- Guidance on our Needs Case Assessment Framework | Ofgem

[22] See page 48 ENTSO-E 4th ENTSO-E Guideline for cost-benefit analysis of grid development projects (eepublicdownloads.blob.core.windows.net)

[23] Cap and Floor Third Application Window and MPI Pilot Regulatory Framework- Guidance on our Needs Case Assessment Framework | Ofgem

change should have been proposed by applicants in prior engagement with applicants before the methodology was settled.

3.27 With regards to weighting the security of supply and decarbonisation indicators more heavily than the SEW, we consider this would not have been an appropriate solution. The IPA has not been weighted deliberately to allow for decision-making that can balance all components of the analysis. Emissions savings, avoided curtailment, security of supply, and ancillary service benefits, were relatively low figures when comparing to the more traditional indicators of value such as SEW and constraint costs. We consider that we have balanced our assessment of indicators in a fair way.

Decarbonisation Benefits

3.28 On decarbonisation benefits, NGV/Elia note that OHAs can play a key role in enabling the deployment of offshore renewables to meet the UK decarbonisation objectives and targets. This was outlined in our ICPR and in our decision to open the dedicated OHA pilot scheme. They outline that in the case of these early hybrid interconnection opportunities, it is right that alignment with government policy direction and strategic benefits contribute to Ofgem's assessment of the pilot projects.

3.29 NGV/Elia recognised within their response that Ofgem's cost-benefit analysis has assessed vast decarbonisation benefits across GB and Europe. NGV/Elia nonetheless noted that the monetised measure fails to capture this positive contribution (as the decarbonisation impacts represented in Ofgem's analysis are shown as a societal cost to GB). NGV/Elia noted that in any assessment of decarbonisation impacts, it is right to account for the net effect across relevant geographies, rather than impact within a single jurisdiction (e.g. GB alone).

3.30 The societal cost to GB is only measurable on a GB scale as it shows the impact of carbon on the economy for GB. The methodology of calculating the societal value of CO2 is taken from the HMT Green Book. This is set out within Arup's Market Modelling report.[24] Our assessment contains multiple metrics for determining carbon impact including in tonnes and the emissions market value, which were stated upfront to applicants within the modelling workshops. We maintain that our existing assessment contains sufficient measurement of carbon impact,

[24] See page 125, Market Modelling Analysis for Cap and Floor W3 and Offshore Hybrid Assets Pilot Projects (ofgem.gov.uk)

monetisable or not (in GB and Europe[25]), to make a reasoned judgement on projects' impact.

3.31 We also acknowledge that in both LionLink and Nautilus' cases, they are projected to be primarily exporting OHAs, with the more frequent flow direction being from the linked offshore wind farms to the connecting country, or from GB to the connecting country. This means that the projected increase in the GB wholesale electricity price that would result from exporting is sufficient to increase the output of gas-fired generation in GB. Consequently, the carbon benefit of coordination of wind and interconnection resources in these projects may less often materialise for GB consumers than it does to the consumers of the connecting states.

3.32 There are therefore trade-offs to consider in our assessment of the carbon impact of these projects. Our IPA process seeks to balance the positive impact of interconnection globally on decarbonisation and the impact of prominently exporting projects on GB emissions. We also consider that by developing OHAs we are unlocking the development of future projects for the North Sea grid that may have a stronger direct benefit to GB's decarbonisation goals. We consider that our decision fairly balances the emissions results shown with the other indicators in our assessment.

French border capacity included in the Interconnector Baseline

3.33 The market and system impacts models contain all operational interconnectors connected to GB and interconnectors with existing cap and floor regulatory approval in the GB baseline, assessing the impact of the Window 3 and OHA applicant projects in addition to this baseline. NGV/Elia challenged the level of assumed GB-France interconnector capacity in the baseline, owing to the continued uncertainty of existing projects' regulatory route in France. At the time of starting the modelling, 14.4GW of capacity had secured cap and floor approval, therefore, we maintain this was an appropriate projection to have used for this analysis. Projects holding a cap and floor regime in principle are subject to IPA conditions and Ofgem may conduct an IPA revisit if it is determined these conditions have been breached.

Use of First Additional and Marginal Additional approaches

3.34 NGV/Elia outlined their view, that Ofgem's primary reference to Marginal Additional (**MA**) results, will provide the most conservative view of project benefits. NGV/Elia noted that combined use of the First Additional (**FA**) and MA modelling produces

[25] European carbon emissions impact refers to all EU states, GB and Norway

an envelope of upper and lower bounds for potential project impacts. However, the prioritisation of MA results, will risk distorting system margins and significantly understating expected benefits that the project will deliver. NGV/ Elia suggested Ofgem should review the FA results of the strongest three to four projects (including Nautilus) or undertake a second iteration of the MA analysis for Nautilus on a smaller pool of strongest projects.

3.35 In response to the point NGV/Elia raised, we consider that relying on MA for decision-making is the most procedurally fair outcome and also ensures the decisions we make are resilient and more accurately reflect consumer benefit.

3.36 Shortlisting projects to create an FA to MA 'middle ground' would have involved pre-emptively deciding projects' suitability for a cap and floor regime, going against our stated assessment framework in advance of the opening of the window. We conducted a sense-check on the ranges of the figures in the market modelling going from FA to MA and found that conducting a FA/MA mixture that put projects approximately in the middle of this range would not change the outcome of any project's decision. Creating an FA/MA mixture for the system impacts analysis would also not have been beneficial for any project, as the FA contains higher constraint costs for all projects. We decided not to investigate this point further.

3.37 In addition, the FA case, by removing competitor projects, generally results in higher SEW attributed to projects, higher revenue projections, and higher constraint costs. If decisions were made based on FA results it is likely more projects would be selected for approval, and thus the real interconnector capacity constructed and its subsequent impacts would match the MA case. Therefore, it would be more reasonable to test projects under an MA case.

Use of the NESO's Future Energy Scenarios, developed in 2022, to model projections for connecting countries

3.38 NGV/Elia criticised the choice of the FES22 as the EU energy scenario assumptions, adding that these scenarios imply an extreme projection of GB as a net exporter. NGV noted that further cost-benefit analysis undertaken by NGV, has produced more varied results (predominantly with GB export but at far less pronounced levels based on a less exaggerated difference in assumed GB and EU connecting country decarbonisation trajectories). Therefore, in NGV/Elia's view, the IPA cost-benefit analysis is an outlier, resulting in the highest net exports from GB.

3.39 NGV/Elia noted an interconnector project's cost-benefit analysis will be highly sensitive to the energy scenarios used in the modelling, on both sides of the cross-border connection. In NGV/Elia's view, the EU assumptions in Ofgem's analysis do not fully capture the more recent government policy positions of connecting

countries. NGV/Elia noted that this will fundamentally impact the projected price differentials and interconnector flows, which in turn will affect the profile of SEW benefits and projected constraint costs (in this case resulting in a faster trajectory of decarbonisation for GB than in Belgium, Netherlands and the rest of the EU).

3.40 NGV/Elia highlighted the results of assessments undertaken by NGV and Elia have indicated different distributions of economic benefits for Nautilus, owing to differences in the European input assumptions.

3.41 The decision to use the FES22 (as the scenarios underpinning both the Arup and NESO modelling) was established after the modelling workshops in 2023. The option was presented by Arup to developers for consideration, who outlined that it is a replicable and transparent dataset. These are also the default scenarios created and used by GB's national system operator NESO for its other analyses on network reinforcements and nationwide constraint costs.

3.42 We consider that by using FES, this allowed for consistency in the modelling between Arup and NESO. The European backing data for FES is already built using TYNDP data for Europe which is widely recognised by the governments and regulators across the EU. When considering alternative data sources, creating bespoke scenarios based on specific countries' energy policy projections fell outside the scope and timing for this analysis, and the FES22 is already created from TYNDP data (and TYNDP is created from countries' energy policy projections).

3.43 Following NGV's/Elia's feedback as well as that of respondents to the W3 IPA consultation, we have investigated the impact of using draft 2022 TYNDP data for the FES22 further. Following this investigation we have re-run the market modelling and system impacts modelling to rectify outdated renewables projections for the I-SEM specifically, which has affected the results for all Window 3 and OHA applicants.

3.44 This change was not made for other connecting countries, as countries other than Ireland already showed renewables generation projections broadly in line with GB, despite the time lag in merging the European and GB data sources to create the FES22. While we acknowledge NGV's/Elia's concerns that the European assumptions may not fully capture most recent energy policies, we maintain that for other connecting states, the FES22 remain fit for purpose for this assessment. See Section 2 of the Window 3 IPA Decision for further detail.

Addressing future changes to the GB network

3.45 CREG noted that GB is considering a zonal reconfiguration to address structural internal congestions and reduce constraint costs.[26] It added that it would like to understand the impact zonal pricing would have on the SEW benefits of Nautilus for the involved parties.

3.46 It remains unclear how, when or if zonal pricing will be introduced in GB. We cannot take inchoate policy into account in our decision-making.

3.47 We agree in principle with respondents that it is possible that a network-wide intervention may be implemented to mitigate the full constraint costs projected across the network from materialising. Therefore, to account for this possibility while remaining agnostic to which specific solutions are implemented, we have chosen to apply a reduction factor to the constraint costs in the later years on these Window 3 projects, as detailed in Section 2.

Responses regarding use of analytical data from third parties

CION

3.48 The Connections Infrastructure Options Note (CION) is created by NESO at the time a project applies for a connection agreement.[27] The CION is a comparative assessment conducted by NESO and transmission owners,[28] to assess suitable connection locations for the project, based upon a select list of locations that the developer has indicated it would like to be considered for.

3.49 The CION is the first point at which the constraint cost impact of the project is assessed by NESO and known to developers. For the IPA, we run our own constraint cost assessment with NESO, which is wider in scope (extending to each project's whole GB impact). The assessment created as part of the CION may only extend as far as the zone in which the assessed substation is located.[29] Therefore, the differing geographical scope of the CION and the IPA constraint cost assessment renders them incomparable.

3.50 For most applicant projects to Window 3 and the OHA pilot scheme, there is an approximately eight-year gap between projects obtaining connection agreements and applying to a cap and floor window. The reality is that significant amounts of

[26] Review of Electricity Market Arrangements: second consultation (publishing.service.gov.uk)
[27] 43631-Connection and Infrastructure Options Note (CION) Process Guidance Note - Issue 003.pdf (nationalgrid.com)
[28] In GB these are National Grid Electricity Transmission, Scottish Power Transmission, and Scottish and Southern Electricity Networks, depending on area in GB.
[29] For grid management purposes, GB is split by NESO into 17 zones.

grid development and future system planning have occurred within that time, driving the difference in results.

3.51 NGV/Elia disagree with the principle that a second assessment of constraint costs could be undertaken by NESO which would discredit the first. However, calculation of constraint costs has been a regular part of our cap and floor IPA assessment for previous windows and has expanded in scope and significance for Window 3 and the OHA pilot given the focus on the system benefit rather than the pure economic benefits of interconnection. We now have access to more up to date information which changes the picture materially since the CION process and that should not be ignored.

Constraint costs

3.52 With regards to constraint costs, NGV/Elia noted that they were concerned by the output of NESO's GB constraint cost modelling being used within the overall cost-benefit analysis. NGV noted that the modelled constraint costs were over-estimated and should not be interpreted as consumer disbenefits. NGV/Elia noted this should instead, be interpreted as providing a signal for network reinforcement by National Grid.

3.53 We acknowledge that future changes on the network could affect the constraints of each project and that the NESO's modelling report indicates that constraint costs provide a signal for the need for further network reinforcements, or non-network solutions.

3.54 In addition, network planning commitments were outlined by NESO in their Beyond 2030[30] after the modelling for OHAs was conducted, and to include these results in the modelling now would compromise the analytical quality of the model, as the Beyond 2030 analysis used FES23 as its basis, and the IPA modelling used the FES22.

3.55 In considering all these issues above, we conclude the following. High constraint costs are a system-wide issue not specific to interconnectors, and we cannot ignore the impact of a project which exacerbates this increasingly prevalent cost to the GB network. However, we agree in principle with respondents that it is possible that a network-wide intervention may be implemented to mitigate the full constraint costs projected across the network from materialising. To account for this possibility while remaining agnostic to which specific solutions are implemented, we have chosen to apply a constraint reduction factor to the constraint costs in the later years on these OHA projects.

[30] See also on this link a separate Beyond 2030 report for interconnectors: Beyond 2030 | ESO (nationalgrideso.com)

Responses regarding Ofgem's compliance with Net Zero Duty

3.56 NGV/Elia highlighted that Ofgem's recently mandated Net Zero Duty strengthens Ofgem's ability to consider a broader view of long-term environmental, economic and fiscal growth impacts when making regulatory decisions such as this on strategic energy infrastructure. In NGV's view, the assessment of the OHA projects should also reflect this new duty, which directly links consumers' interests to the UK's net zero targets. Throughout their response, they referenced the benefits of interconnection to the achievement of net zero.

3.57 With regard to the Net Zero Duty, we consider interconnectors can provide the following benefits to GB:

- GB direct carbon impact through imports. Expanding interconnection is strategically beneficial as it could help reduce carbon emissions directly, by allowing for diversification of our energy supply through trading low carbon resources with other countries.
- GB growth in low-carbon generation through exports. Expanding interconnection could encourage the growth of GB's domestic wind energy resources through providing export opportunities and making operating a low-carbon intermittent grid more manageable. These factors enable the growth of low-carbon generation in GB, further reaching the net zero carbon target.

3.58 Carbon reduction anywhere in the world is beneficial to GB. Both of the Pilot NSIs contribute positively to reducing emissions overall, which reflects the contribution that GB interconnectors are making to net zero targets globally. However, as both of the Pilot NSIs are projected to export, the increase in the GB wholesale price that would result is sufficient to increase gas-fired generation in GB and thus increase GB emissions.

3.59 Our IPA process seeks to balance the positive impact of interconnection globally on decarbonisation and the impact of prominently exporting interconnectors on GB emissions. We consider that our decision fairly balances the emissions results shown for applicant projects with the other indicators in our assessment. Our model predicts that GB exports surplus wind power when prices are near zero and there is no gas-fired power on the system. However, the overall increase in effective demand from the connecting countries in our model is sufficient to raise GB wholesale prices sufficiently to trigger dispatch of peaking gas plant in some periods.

Responses to the Nautilus re-consultation

3.60 Our decision in this document is based on Nautilus connecting at Grain. However, below we have considered and responded to relevant material from stakeholder

feedback which we received to the Nautilus re-consultation. These responses were addressed in this decision document because their arguments are focused around procedural unfairness, and are relevant to our IPA decision-making, regardless of the decision not to move ahead with connecting Nautilus at Leiston.

Fair treatment of projects within Window 3 and the OHA pilot scheme

3.61 A respondent stated that Ofgem had informed applicant developers during the period the W3 IPA consultation was open, that Ofgem would not complete further modelling before consultation closure.

3.62 This, in the respondent's view, was contradicted by Ofgem performing updated analysis to address the SEM interconnector allocation issue (see page 45 in W3 IPA decision on Moyle and EWIC ownership). The respondent is of the view that Ofgem's decision to request NESO and Arup to conduct further modelling, as a result of changes to the Nautilus grid connection location and configuration, reinforces the view that it would be unfair for Ofgem to make its final W3 IPA decision without considering further modelling to address issues set out by developers in responses to the W3 IPA consultation. The respondent states that it has a legitimate expectation that Ofgem will treat all projects fairly.

3.63 An additional respondent raised similar points, that Ofgem confirmed no further modelling would be undertaken. This respondent, having reviewed project timelines to date, also believed that additional modelling would have already been undertaken before closure of the W3 IPA consultation.

3.64 The respondent outlines the perceived unfairness and claims that Ofgem misrepresented its position regarding further modelling work and, therefore, additional analysis should have been completed on all projects that raised concerns with the initial IPA modelling.

3.65 In light of the respondent feedback, it should be clarified that Ofgem's first statement to applicants in April 2024 was that Ofgem would not conduct any new modelling while the W3 IPA consultation was open. It is important that we receive and analyse all responses before taking decisions on how best to respond to feedback. We have upheld this position, as - where we have conducted additional modelling before consultation closure - it was only to amend a factual error in the original analysis.

3.66 In Ofgem's view, as the developer of Nautilus changed material aspects of the project, the analysis we previously had conducted no longer reflected the assessed project. The remodelling for Nautilus took place after we had been notified of these changes and after the consultation closure. We required all developers of Window 3 and the OHA pilot scheme to keep us updated about material changes affecting

their projects. If a developer notifies us of material changes to a project's configuration, ie. capacity, location, or connection date, we reserve the right to revisit the IPA for the project.[31] This is a different circumstance to Ofgem responding to stakeholder interim feedback on our modelling in advance of consultation closure.

3.67 The Moyle and EWIC allocation issue addressed for Window 3 was a correction made to the modelling to resolve a factual error in the original analysis.

3.68 Some applicant developers have put forward requests for Ofgem, prior to consultation closure, to change our stated methodology for the quantitative assessment of the IPA and to re-run our analysis. However, Ofgem has an agreed methodology for assessment and we have conducted our quantitative modelling according to the Needs Case Assessment Guidance document and according to what was agreed with the developers during the 2023 modelling workshops.

3.69 Such requests by developers were put forward to Ofgem to change our previously agreed methodology via consultation response. We reviewed the substance and justification of these requests after consultation closure. Our decision in relation to each of these requests is outlined later in this document.

3.70 Finally, we remind stakeholders that Window 3 and the OHA pilot scheme are two separate schemes.

Nautilus IPA eligibility

3.71 Two respondents noted that a condition of IPA eligibility, was the submission of evidence that the project has a GB connection agreement for connection prior to the end of 2032.

3.72 In their consultation responses, request evidence that a grid connection with NESO was agreed with Nautilus at the Isle of Grain. They both note that the NESO Transmission Entry Capacity (TEC) Register[32] states that the connection point for Nautilus is the Friston 400kV substation.

3.73 An additional respondent also noted that Nautilus did not hold an interconnector licence, the evidence of which would have been visible on the Ofgem website, and therefore did not meet the eligibility criteria.

[31] Our right to revisit the IPA applies also after a cap and floor regime in principle has been granted to an interconnector project, because projects that received positive IPA decisions from Ofgem are then subject to IPA conditions. If Ofgem forms a view that a project fails to comply with one or more IPA conditions, it may revisit the IPA for this project. Such IPA reviews have taken place for FABLink and GridLink after these two projects have been granted their respective IPA decisions.

[32] Interconnector Register | National Energy System Operator

3.74 We can confirm that Nautilus passed the IPA eligibility criteria, and that a valid connection agreement to GB at Grain prior to the end of 2032 was submitted to Ofgem. Evidence of application for an interconnector licence was an eligibility criterion for Window 3, however, not for the OHA pilot scheme. This was due to the uncertainty surrounding licencing of OHAs at the time.

Changes to results

Configuration

3.75 As set out above, we have received additional information on the configuration of the overall OHA of which Nautilus forms a part of. The original and updated configurations of the OHA with Nautilus is shown in Figures 3 and 4 below. The original analysis for the OHA IPA consultation assumed that the total cable capacity from the MOG2 energy island to the Belgian onshore transmission network would be 3.5GW (comprised of 1.4GW HVDC and 2.1GW HVAC capacity lines). However, it has since been clarified and confirmed that this energy island will operate as a "split node" maintaining separation between: (i) the 1.4GW HVDC cables linking to Nautilus and a 1.4GW windfarm; and (ii) the 2.1GW HVDC cables linking to a 2.1GW windfarm. This means that the capacity of Line 2, connecting to Nautilus at the MOG2 energy island, will be 1.4 GW

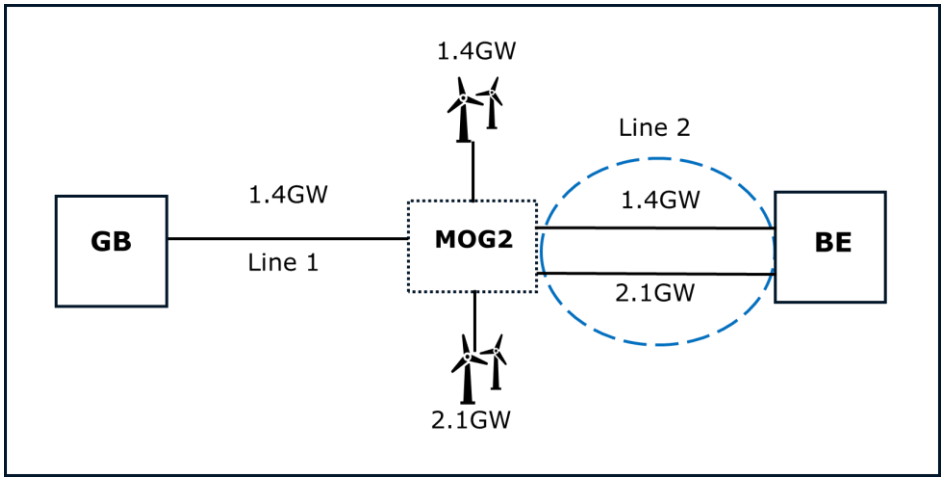


Figure 4: The original configuration of the shore-to-shore OHA between GB and Belgium, as modelled in our analysis, in which Nautilus comprises Line 1

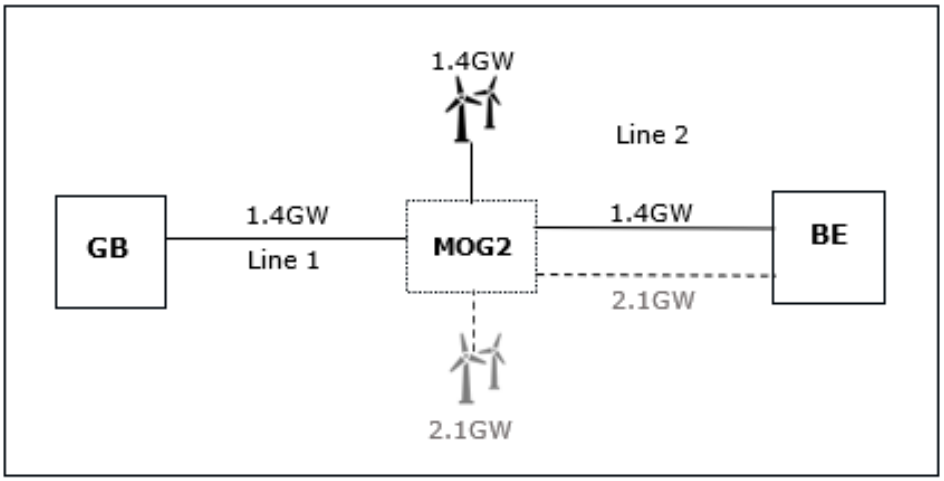


Figure 5: The updated configuration of the shore-to-shore OHA between GB and Belgium, as modelled in our revised analysis, in which Nautilus comprises Line 1

Cost and Revenue sharing

3.76 Since the original IPA consultation, an updated cost and revenue sharing arrangement has been agreed and has been used in our analysis of SEW for this IPA decision.

Maturity and deliverability assessment

3.77 There has been no need to revisit the deliverability indicators, and these remain as they were in the IPA consultation.

Market modelling and system impacts analysis

3.78 The table below is a summary of the changes to certain project indicators since the IPA minded-to consultation. The full table of results across all indicators can be referenced in the Annex.

	Total SEW for GB (real 2022 GBP, NPV 3.5% discount rate) **£bn**	**Total SEW for UK** (real 2022 GBP, NPV 3.5% discount rate) **£bn**	**Total European carbon savings** (EU + GB & Norway) **mtCO2**	**Balancing market impacts (Constraint costs)** (real 2022 GBP, NPV 3.5% discount rate) **£bn**
Nautilus (results from minded-to position)	0.4 to 1.0	**not previously calculated**	4.9 to 10.7	1.3 to 3.3
Nautilus (results for decision)	0.1 to 0.2	0.1 to 0.2	3.8 to 8.7	0.5 to 1.3

Numbers expressed in range of results between all scenarios for the MA approach. Each indicator shows the total result for the project over a 25-year period.

Socio-Economic Welfare

3.79 The welfare results for Nautilus have changed since the IPA minded-to consultation due to updates to certain inputs in our modelling as outlined above.

3.80 The total SEW RAG rating has not changed. This means that the project continues to deliver total welfare benefits to GB in all scenarios. The re-run results for this indicator show a decrease from £0.99bn to £0.14bn in the Leading the Way scenario (**LW**), a decrease from £0.99bn to £0.22bn in the Consumer Transformation scenario (**CT**), and a decrease from £0.37bn to £0.11bn in the Falling Short scenario (**FS**).

3.81 This positive SEW welfare is largely driven by strong producer welfare. Consumer welfare continues being negative in all scenarios with a decrease in LW and FS and an increase in CT. Producer welfare has decreased across all scenarios. Interconnector welfare has increased in all three scenarios.

3.82 Our re-run analysis continues to project Nautilus being more frequently an exporter across all scenarios and therefore contributing to an increase in wholesale prices in GB relative to the equivalent scenarios without the project.

Revenue expectations

3.83 We continue to anticipate Nautilus making payments above the cap in the early years of the modelled period in LW and CT. However, the project is now projected to require floor payments in the early years in FS and the later years in LW and CT.

3.84 These new floor payment projections are largely driven by an increase to the assumed floor level against which the project revenues are assessed. The assumed floor level is based on the regime parameters for the projects of the OHA pilot scheme that we published for consultation[33] on 20 September 2024.

3.85 We note that the increase of the floor level is mainly driven by updating the cost of debt parameter with the current market figures. The result of such update is a higher cost of debt than the one against which the project was assessed in our minded-to IPA consultation.

3.86 We recognise that the project may require support from consumers in some years. However, we highlight that the project remains positive for GB as a whole in terms of socio-economic welfare. In addition, we also consider that this project could bring other benefits to consumers which our quantitative analysis does not account

[33] Consultation on further detailed regime parameters for the Offshore Hybrid Asset pilot scheme | Ofgem

for, including enabling the development of a meshed grid in the North Sea as well as other benefits previously discussed.

3.87 We are aware of the uncertainties affecting the revenues of this type of project. Therefore, we remain attentive to any material changes that may be detrimental to consumers and reserve the right to re-assess the case for this project.

Decarbonisation

3.88 Results from our re-run analysis suggest that Nautilus continues to increase CO2 emissions in GB, but contributes to a large net decrease in Belgium and across Europe. A cross-border approach to decarbonisation is important for progressing global climate ambitions.

Security of Supply

3.89 The results for this indicator remain largely the same as well as its RAG Rating. As at the consultation stage, no unserved energy (USE) hours are observed in the CT and FS scenarios. Overall, there remain benefits in the LW scenario and thus this project continues to deliver benefits to consumers in this indicator.

Constraint costs (balancing market impacts)

3.90 NESO has undertaken further analysis on constraint costs impacts of Nautilus. This takes into account all the changes to the modelling which have taken place since publication of the OHA IPA consultation. Additionally, the constraint reduction factor has been applied from 2035 onwards to account for predicted future network reinforcements. This is in common with all of the other OHA pilot scheme and Window 3 projects.

3.91 NESO results suggest that the project continues to have positive and negative impacts across different boundaries of the system. On balance, the project continues to increase constraint costs under most scenarios but to a lower extent than in the original IPA analysis mainly because of the application of the reduction factor.

3.92 NESO's analysis suggests that the introduction of Nautilus into the system would represent between 1.6% to 2.5% of the increase in the total constraint costs if they were to materialise. We note that Nautilus' share in the projected installed capacity in GB would range from 0.4% to 0.9% when looking at the 2030 and 2050 installed capacity projections.

3.93 The RAG rating for this indicator has changed from red to amber. The range of constraint costs has decreased across all scenarios since our consultation. The upper bound has reduced from £3.3bn to £1.3bn. The lower bound has also reduced

from £1.3bn to £0.5bn. Based on this information, the range of constraint costs are manageable and would not pose considerable risk to consumers.

System Operability indicators

3.94 The system operability indicators were not re-run by NESO as changes were expected to be too marginal for the time and effort that it would have taken to re-run the model. We have carried over the results from the consultation stage, so the RAG ratings have not changed for these indicators. More details on this can be found in NESO's report published alongside this decision.

RES curtailment

3.95 The updated RES curtailment analysis from NESO shows that the curtailment savings on the system as a result of Nautilus have reduced. Nautilus is now expected to deliver -1.7 to 1.6 TWh of curtailment savings over 25 years. A positive figure means a reduction in curtailed renewable energy and a negative figure means an increase in curtailed renewable energy. This marginal increase in curtailment is present in two scenarios. addition in curtailment is present in two scenarios and is a low level.

Network costs

3.96 Network costs have been assessed by Ofgem and are not considered to be an obstacle for this project. The details of onshore works are not disclosed in this decision due to their commercially sensitive data.

Hard to monetise impacts

3.97 Hard to monetise impacts were not affected by the updates to modelling conducted since the consultation. These indicators have not been reassessed and therefore our RAG ratings have not changed.

Our Decision

3.98 In our March 2024 minded-to consultation, we said we were minded-to not offer an OHA regulatory regime to Nautilus, based upon the impact of the project on the system, and uncertainty over the project configuration on the Belgian side.

3.99 As set out above, since publishing our March 2024 minded-to consultation, we have conducted further analysis and agreed cost and revenue sharing arrangements.

3.100 Having carefully considered the consultation responses received as well as the changes in results, Ofgem have decided to approve Nautilus' application for a regulatory regime in principle, subject to the IPA conditions as set out within Section 5, at Grain.

3.101 The new analysis shows that constraint costs are now significantly lower and proportionate. The confirmation of the project configuration has strengthened the project's maturity which has also supported our approval of the project.

4. Decision - LionLink

In the March 2024 publication, we outlined that we were minded-to offer a Pilot OHA regulatory regime to LionLink. The project demonstrates a total SEW benefit to GB and has shown evidence that satisfies Ofgem that the project is mature and likely to be operational prior to the end of 2032.

Whilst we were minded-to approve this project, we flagged our concerns over the impacts of OBZ arrangements in the Netherlands on the accrual of congestion revenue on Line 1 of the OHA. We said we would need to be satisfied with the outcome of the cost of revenue sharing arrangements to progress the approval of this project.

Since our minded-to consultation, we have agreed in principle the cost and revenue sharing arrangements for LionLink with the Dutch authorities. Therefore, we confirm our approval of this project for a regulatory regime, subject to the IPA conditions as set out in Section 5 of this document.

Background

4.1 Within our March 2024 IPA minded-to consultation, we said that we were minded to offer a Pilot OHA regulatory regime to LionLink. The project demonstrates a total SEW benefit to GB and has shown evidence that satisfies Ofgem that the project is sufficiently mature and likely to be operational prior to the end of 2032.

4.2 We further outlined that as a Pilot NSI, LionLink would be strategically beneficial to GB in further developing the technology of OHAs and in shaping regulatory arrangements for these new types of assets.

4.3 Whilst minded to approve this project, we flagged our concerns over the potential impacts of Offshore Bidding Zone (**OBZ**) market arrangements in the Netherlands on the accrual of congestion revenue on Line 1 of the OHA.

4.4 We stated that, due to the early stage of the cost and revenue sharing discussions, if the revenue earned on Line 1 (i.e. on LionLink, which under our default assumption is shared 50:50 with the owner / operator of this OHA in the Netherlands) is considerably lower than in the case of point-to-point interconnectors, GB consumers may not benefit from above cap payments and may be exposed to floor top-up payments (the materiality of which would be difficult to forecast).

4.5 We outlined, that for Ofgem to issue the Pilot OHA regulatory regime to LionLink, we would need to be reasonably satisfied that the outcomes of the negotiations on cost and revenue sharing will result in arrangements that are in the interests

of GB consumers. These negotiations had not been concluded at the time of our March 2024 minded-to consultation.

Ofgem's view on consultation responses

4.6 We received 10 responses to our March 2024 OHA IPA minded-to consultation, three of which directly responded to our minded-to approval of LionLink.

4.7 The majority of responses agreed with the strategic benefits of OHAs. NGV supported our minded-to position to approve LionLink, citing the benefits to consumers, producers, facilitating the build of offshore wind by increasing export capability, reducing curtailment and paving a way for coordinated hybrid infrastructure in the North Sea. NGV agreed that the purpose of the pilot regime is to identify and address different regulatory framework requirements for new assets.

4.8 Whilst agreeing with our minded-to position to approve LionLink, NGV raised multiple concerns about our overall analysis of projects. NGV argue that our modelling approach is suited to point-to-point interconnectors rather than OHAs and takes a pessimistic view of project benefit. NGV state that if the modelling were re-run, results considered differently, or additional benefits were quantified, the benefit to consumers of Lion Link would show as much stronger. Much of this feedback on our overall analysis is addressed in Section 3 for Nautilus.

4.9 Walberswick against LionLink (**WALL**) and SEAS were both supportive of increased coordination and the more efficient use of transmission assets, to standalone point-to-point interconnectors. However, both parties had concerns over the environmental, social and economic impacts of the project, advocating for a single landfall at an existing brownfield site.

4.10 We discuss the themes raised in response to our OHA IPA consultation the approval of LionLink and our response below.

Responses regarding the economic modelling

Market arrangements

4.11 In our modelling, we have chosen to model the Pilot NSIs each with an OBZ market arrangement for the overall OHAs. NGV agree this is a reasonable assumption for the purpose of modelling (and to help infer conclusions from the analysis). However, NGV note that the choice of market arrangements for the overall OHAs by the connecting country authorities is still to be confirmed as final (at the point of providing their response to the OHA IPA consultation). More

specifically, this is the choice whether to use OBZ or Home Market arrangements for the overall OHA in each of the two Pilot NSIs.

4.12 NGV raised the point that if a Home Market arrangement were to be used instead of an OBZ then this will fundamentally impact the distribution of the benefits included in the cost-benefit analysis, and the results from the cost-benefit analysis should not be interpreted as precise. The sensitivities that NGV identified could be impacted were the market arrangements in GB, the EU and any other state/authority that will govern those assets. However, NGV further commented that while they did not suggest that further analysis should be undertaken by Ofgem based on different market arrangement scenarios, these uncertainties should be understood when considering the distribution of congestion revenues.

4.13 We recognise the ongoing uncertainty regarding market arrangements. The OBZ market arrangement reflects our understanding of the intention of the authorities in the connecting countries at the time of the modelling being undertaken. We expect the proposed OBZ market arrangements for the two Pilot NSIs to be confirmed by the Netherlands and Belgium in the medium term.

Responses regarding use of analytical data from third parties

Infrastructure coordination

4.14 WALL and SEAS outlined their view, that to promote coordination and the more efficient use of transmission assets, Ofgem should be promoting a scheme which includes offshore integration of energy producing assets and interconnectors (via an offshore grid) with single landfall at existing brownfield sites, closer to demand.

4.15 In relation to the point above, the integration of offshore wind electricity and interconnection is precisely what we aim to achieve through the creation of OHAs. We recognise that OHAs have additional benefits to that of point-to-point interconnectors, such as increased coordination. However, as noted in our March 2024 minded-to consultation34, the nature of these pilot projects as NSIs mean the coordination benefits of combining transmission and interconnection assets, for these projects, are captured by the connecting countries' consumers more than by GB consumers. We recognise, however, the need for pilot OHA projects

[34] See paragraph 1.2 Initial Project Assessment of the Offshore Hybrid Asset Pilot Projects (ofgem.gov.uk)

to open the sector and enable the creation of future projects, which would likely include MPIs that can bring this direct benefit to GB.

4.16 Ofgem is not involved in planning and consenting processes. NESO firstly determines a location through the grid connections process. There is then a later planning and consenting process with relevant authorities which is required before a development enters a construction stage.

Responses regarding Ofgem's Maturity assessment

Treatment of hard to monetise indicators

4.17 WALL and SEAS flagged concerns over there being limited evidence or analysis to support the assessment of hard to monetise impacts (such as landscape noise and other matters). Both respondents noted that Arup scores these impacts as red in its RAG rating, which they agree with. However, environmental and local community impacts have been scored as green by Arup, and they considered there was limited explanation as to why.

4.18 WALL and SEAS further outlined that they were disappointed to see that Arup had not provided any estimations of hard to monetise impacts. They cited analysis from the Direct Marketing Organisation, that estimated there could be losses to the Suffolk coast in terms of employment, businesses and tourism. The economic mainstay over the 12 years of overlapping projects (including LionLink) could total a cumulative impact of £1bn in losses.

4.19 In response to the points above, we consider that the hard to monetise impacts section is necessarily high-level in its nature. Hard to monetise impacts fall under the maturity assessment for the OHA pilot scheme, which helps Ofgem understand the progress and preparedness of applicants in meeting their stated connection dates. Applicants are expected to present plans, strategies and progress related to the hard to monetise indicators within their business plans, to show maturity and preparedness and to justify their project plan timeline. Any progress which applicants can demonstrate in this area will be scrutinised.

4.20 Developers are not expected to have completed the planning and consenting stage for their projects prior to applying for the regulatory regime, and as set out above, Ofgem is not involved in the planning and consenting processes. We acknowledge that developers will have often not yet begun this process, and decisions and related studies will be conducted by relevant authorities, with the opportunity for stakeholder engagement directly on those issues at that time.

4.21 Both respondents flagged concerns on the lack of consistency in how the hard to monetise impacts were rated by Arup and Ofgem. In the OHA IPA consultation we acknowledge that both Arup and Ofgem provided RAG ratings for this indicator, and it is Ofgem's that takes priority for decision-making.

Changes to results

Maturity and deliverability assessment

4.22 There has been no need to revisit the deliverability indicators and these remain as they were in our IPA minded-to consultation.

Market modelling and system impacts analysis

4.23 The table below is a summary of the changes to certain project indicators since the minded-to consultation. The full table of results across all indicators can be referenced in the Annex.

	Total SEW for GB (real 2022 GBP, NPV 3.5% discount rate) **£bn**	**Total SEW for UK** (real 2022 GBP, NPV 3.5% discount rate) **£bn**	**Total European carbon savings** (EU + GB & Norway) **mtCO2**	**Balancing market impacts (Constraint costs)** (real 2022 GBP, NPV 3.5% discount rate) **£bn**
LionLink (results from minded-to position)	-0.2 to 1.6	**not previously calculated**	4.5 to 10.9	0.0 to 1.2
LionLink (results for decision)	0.3 to 1.2	0.4 to 1.2	4.4 to 10.5	0.0 to 0.9

Numbers expressed in range of results between all scenarios for the MA approach. Each indicator shows the total result for the project over a 25-year period.

Socio-Economic Welfare

4.24 The welfare results for LionLink have changed since the minded-to consultation due to updates to our modelling as outlined above.

4.25 The total SEW RAG rating has changed from amber to green. This means that the project now delivers total SEW benefits to GB in all scenarios. The re-run results for this indicator show a decrease from £1.6bn to £0.7bn in LW, an increase from £0.0bn to £1.2bn in CT, and an increase from £-0.2bn to £0.3bn in FS.

4.26 This positive total SEW welfare is largely driven by strong producer welfare and positive IC welfare in all scenarios. Producer welfare has increased across all scenarios and has changed from an amber RAG rating to a green RAG rating since our minded-to consultation. This is because producer welfare has now become

positive in all three scenarios. IC welfare has changed from a red RAG rating at IPA minded-to consultation to a green RAG rating. This is because IC welfare has increased and become positive in all three scenarios. Finally, consumer welfare has changed from an amber RAG rating to a red RAG rating, as the LW scenario has decreased from £3.5bn to -£3.1bn.

4.27 Our re-run now anticipates LionLink being a predominant exporter across all scenarios and therefore contributing to an increase in wholesale prices in GB.

Revenue expectations

4.28 We now anticipate LionLink making payments above the cap in the early years of the modelled period in LW. In CT, LionLink's revenues are also now projected to go above the cap in the early years and from 2043 to 2045, with no anticipated floor payments across the modelled period. However, even though LionLink's revenues have considerably increased across all three scenarios since our last run, the project is now projected to require floor payments in the early years in FS and the later years in LW.

4.29 These new floor payment projections are largely driven by an increase to the assumed floor level against which the project revenues are assessed. The assumed floor level is based on the regime parameters for the projects of the OHA pilot scheme that we published for consultation on 20 September 2024.

4.30 We note that the increase of the floor level is mainly driven by updating the cost of debt parameter with the current market figures. The result of such update is a higher cost of debt than the one against which the project was assessed in our minded-to IPA consultation.

4.31 We recognise that the project may require support from consumers in some years. However, we highlight that the project remains positive for GB as a whole in terms of socio-economic welfare. In addition, we also consider that this project could bring other benefits to consumers which our quantitative analysis does not account for, including enabling the development of a meshed grid in the North Sea as well as other benefits previously discussed.

4.32 We are aware of the uncertainties affecting the revenues of this type of project. Therefore, we remain attentive to any material changes that may be detrimental to consumers and reserve the right to re-assess the case for this project.

Decarbonisation

4.33 Results from our re-run analysis suggest that LionLink continues to cause an increase in projected CO2 emissions in GB, but contributes to a net decrease in the Netherlands and across Europe. A cross-border approach to decarbonisation is important for progressing global climate ambitions because the impact of these emissions is not restricted to their local region or country.

Security of Supply

4.34 The results for this indicator remain largely the same as well as its RAG Rating. As at the consultation stage, no unserved energy (USE) hours are observed in the CT and FS scenarios. Overall, there remain benefits in the LW scenario and thus this project continues to deliver benefits to consumers in this indicator.

Constraint costs (balancing market impacts)

4.35 NESO has undertaken further analysis on constraint costs impacts of LionLink. This takes into account all the changes to the modelling which have taken place since the publication of the minded-to consultation. Additionally, the constraint reduction factor has been applied from 2035 onwards to account for predicted future network reinforcements.

4.36 NESO results further suggest that the project continues to have positive and negative impacts across different boundaries of the system, although the negative impacts outweigh the positive impacts. On balance, the project continues to increase constraint costs under most scenarios but to a lower extent mainly because of the application of the reduction factor.

4.37 NESO's analysis suggests that the introduction of LionLink into the system would represent between 0.1% to 1.7% of the increase in the total constraint costs if they were to materialise. We note that LionLink's share in the projected installed capacity in GB would range from 0.5% to 1.1% when looking at the 2030 and 2050 installed capacity projections.

4.38 The RAG rating for this indicator has stayed amber. The range of constraint costs has decreased since consultation. The upper bound has reduced from £1.2bn to £0.9bn. The lower bound has also reduced slightly. This is driven by a decrease in all scenarios. Based on this information, the range of constraint costs are manageable and would not pose considerable risk to consumers.

System Operability indicators

4.39 The system operability indicators were not re-run by NESO as changes were expected to be too marginal for the time and effort that it would have taken to

re-run the model. We have carried over the results from the consultation stage, so the RAG ratings have not changed for these indicators. More details on this can be found in NESO's report published alongside this decision.

RES curtailment

4.40 The updated curtailment analysis from the NESO shows that the expected RES curtailment saving as a result of LionLink being added to the system is a substantial 6.2 to 27.2 TWh over the 25-year lifetime of the regime. This is a very small reduction from the previous analysis.

Network costs

4.41 Network costs have been assessed by Ofgem and are not considered to be an obstacle for this project. The details of onshore works are not disclosed in this decision due to the commercially sensitive nature of this data.

Hard to monetise impacts

4.42 Hard to monetise impacts were not affected by the updates to modelling conducted since the consultation. These indicators have not been reassessed and therefore our RAG ratings have not changed.

Our Decision

4.43 In our March 2024 minded-to consultation, we outlined that we were minded-to grant the regulatory regime to LionLink, in principle. However, this was contingent on Ofgem being reasonably satisfied that the outcomes of the negotiations on cost and revenue sharing will result in arrangements that are in the interests of GB consumers.

4.44 As set out above within Section 2, the cost and revenue sharing arrangements have been agreed for LionLink. Having carefully considered the consultation responses received, as well as the changes in results across the IPA, we have decided to approve LionLink's application for a regulatory regime, subject to the IPA conditions as set out within Section 5.

5. Conditions relating to our decision

IPA Conditions

5.1 Our IPA conditions are an important tool to protect consumers by providing Ofgem with the ability to intervene if a project has materially deviated from the basis upon which it was awarded a regulatory regime in principle.

5.2 Our minded-to position to award each of LionLink and Nautilus a Pilot OHA regulatory regime in principle is contingent upon the following Initial Project Assessment conditions (the 'IPA Conditions'):

1. **Operations prior to the end of 2032**: If there is a change in circumstances before the Final Project Assessment (**FPA**) decision that means a project is no longer able to become operational by the end of 2032, we may choose to conduct an IPA review of the project. This would include Ofgem undertaking a reassessment of the IPA in order to confirm whether or not the project continues to be in consumers' interests and should continue to hold a regime in principle.
2. **Material change**: If any information given to us before FPA decision leads us to consider that the project no longer meets the basis upon which it was granted a regime in principle, then we may choose to require an IPA review of the project. This information includes changes to project parameters such as timelines, connection date, project configuration, commercial arrangements (including cost and revenue sharing arrangements), regulatory support or grid connection in the connecting country, and costs.
3. The developer must submit detailed information on costs for our FPA to start within three years of an IPA decision. This information will need to be informed by detailed discussions with the supply chain and tender returns.
4. The developer must give to Ofgem formal written notice of any material changes to the project. Following any such change, the developer must explain the rationale for the change and the implications on project cost and delivery.
5. The developer must submit quarterly written reports on progress against a number of key development milestones, including (but not limited to) development work, consenting and permitting, procurement, financing, operational management plans and costs, project management and other factors that had an impact on the IPA assessment under which the project was granted a regulatory regime.
6. The developer must confirm the timing of FPA submission in writing to Ofgem at least two months before the expected submission date.

Next steps

5.3 Following the award of the Pilot OHA regulatory regime in principle to LionLink and Nautilus, the developer of these two projects will have three years to submit detailed cost information for the FPA stage. The provisional cap and floor levels will be set on a project-by-project basis at the FPA stage following our cost assessment. A decision on the detailed regime parameters for the NSI Pilot projects is due to be published by Ofgem in due course.

5.4 We will confirm our thinking on the need for, and timing of, of a fourth window within the next few months.

Market Modelling Annex

Methodology of the changes to the I-SEM assumptions

In 2022, ENTSO-E and ENTSOG (ENSTO-E/G) published a joint report with a set of energy system scenarios to develop their TYNDP.[35] This report presents three scenarios: National Trends (NT), Global Ambitions (GA) and Distributed Energy (DE). These scenarios set out different pathways to reach carbon neutrality by 2050 and contain assumptions across different European bidding zones.

In this re-run, Arup used the three scenarios that ENSTO-E/G published in their TYNDP 2022 report for the bidding zone in Northen Ireland and the Republic of Ireland to obtain the new supply and demand assumptions for I-SEM.

Arup paired the FES scenarios and ENSTO-E/G scenarios based on the scale of RES deployment and speed of decarbonation. FES LW and FES CT were paired with ENSTO-E/G DE. FES FS was paired with ENSTO-E/G GA.

The DE and GA scenarios start from 2030 and run until 2050. On the other hand, the NT scenario starts in 2025. As our analysis starts in 2027, for the period 2027-2029, Arup interpolated the NT inputs to the DE/GA inputs to obtain a complete set of assumption from 2027 to 2050.

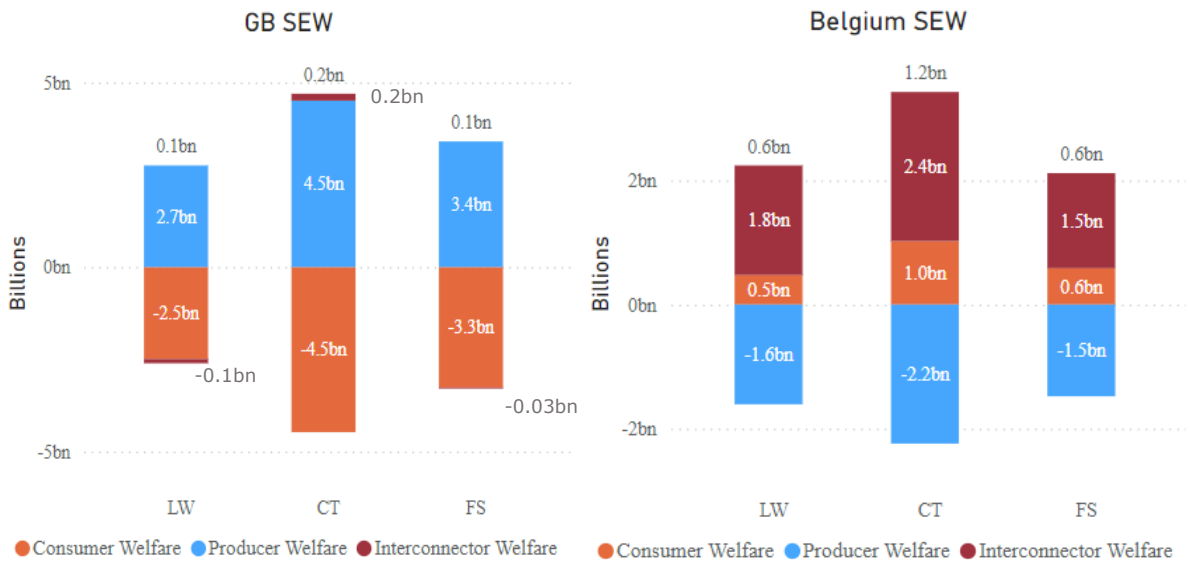
[35] TYNDP 2022 Scenario Report – Introduction and Executive Summary (entsos-tyndp-scenarios.eu)

Nautilus

Overview and SEW impacts

The Nautilus project has been modelled as a 1.4 GW line between GB and MOG II (L1), the energy island under development in Belgian national waters. L1 is assumed to connect to a 1.4 GW windfarm on the energy island. This windfarm is assumed to connect to Belgium via a 1.4 GW line (L2). The island is assumed to operate as an OBZ.[36] The project was modelled from 2030.

Figure 1.1 – SEW impacts of Nautilus in GB and Belgium (£bn, real 2022, NPV)



Stacked column charts presenting the total SEW figures and breakdown by Consumer, Producer and Interconnector welfare, for GB and Belgium.

In GB, the total SEW impacts are marginally positive in all scenarios. This is driven by positive producer SEW in all scenarios. Nautilus delivers negative consumer SEW across all scenarios. Interconnector SEW is marginally negative in LW and FS, but marginally positive in CT.

Nautilus is predominantly used to export electricity from GB across the three scenarios. This increases wholesale prices in GB compared to the counterfactual[37]. This in turn increases producer SEW and reduces consumer welfare.

In Belgium, Nautilus delivers positive total SEW in all scenarios. This is largely driven by strong interconnector and consumer SEW. Producer SEW is negative in all scenarios.

Price differentials and flows

[36] Offshore bidding zones: key to efficient market integration (tennet.eu): 'Offshore bidding zones are separate price regions for offshore hubs, within the European electricity market.'
[37] The counterfactual indicates the impacts in a scenario without the project being modelled.

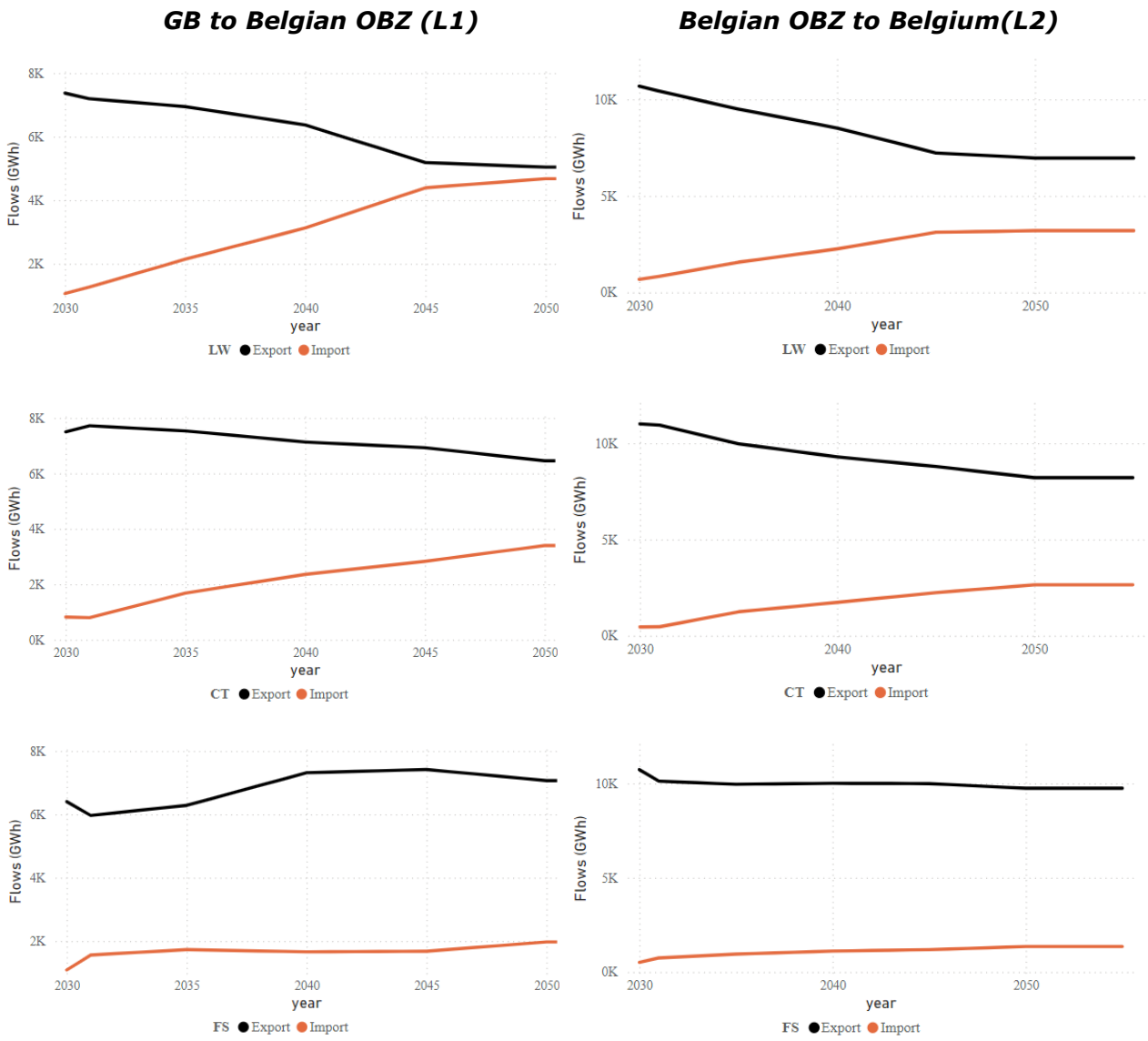
Figure 1.2 – Price differentials between GB, Belgium and the Belgian OBZ (£/MWh)

Line charts representing the wholesale price in GB, Belgium and the Belgian energy island.

Prices in Belgium are constantly higher than in the Belgian OBZ and GB. In the early years in LW, prices in the Belgian OBZ are marginally higher than in GB but this trend changes from 2033. In CT and FS, prices in GB are constantly higher than in the Belgian OBZ.

The price differentials described above are the main drivers of the direction of electricity flows across the project. As the below line charts show, the project is mostly used for exporting electricity from GB. In LW, the project is forecast to import more than in other scenarios. L2 is used to export electricity from the windfarm to Belgium in all scenarios.

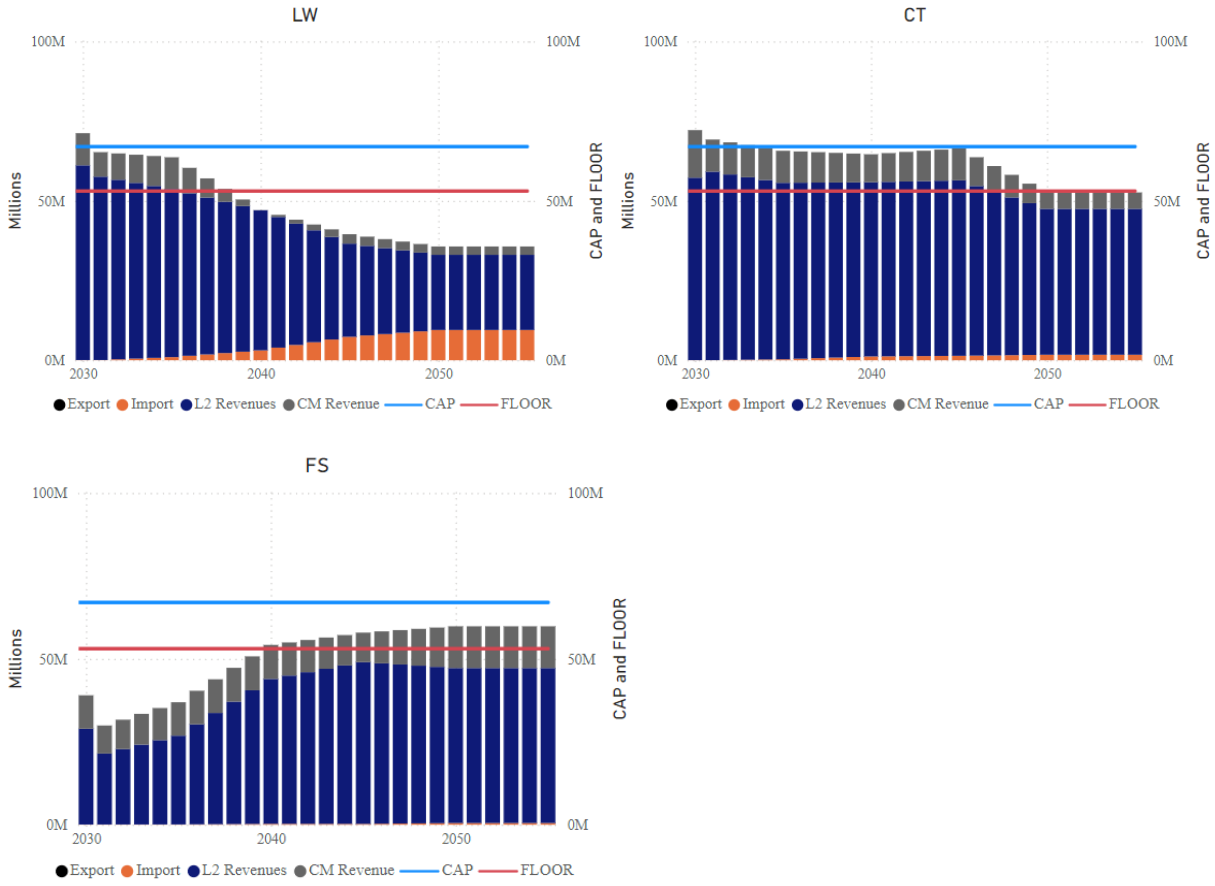
Figure 1.3 – Electricity flows across Nautilus and L2 (GWh)



Line charts presenting the electricity flows (export/import) across the project (black line – export, orange line – import).

Revenues and impacts on consumers

Figure 1.4 –GB share of revenues earned by Nautilus from L1 (export, import and CM) and L2 (£m, real 2022)

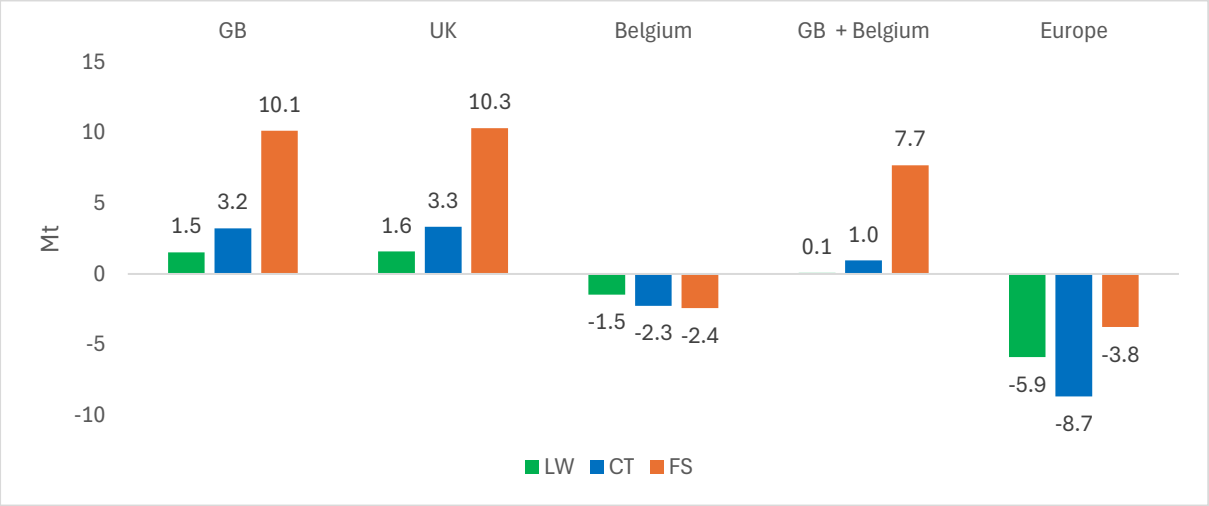


Combined stacked column and line charts comparing revenue sources against the cap and floor levels from 2030 to 2055. Stacked columns represent revenues from export, import, L2 and CM. Lines show cap and floor levels.

Nautilus is forecast to earn most of its revenue through revenues from L2. Most of the L1 revenues are generated from imports, especially towards the end of the modelled period. In LW, Nautilus' revenues are above the cap level in 2030, between the cap and floor from 2031 to 2038 and below the floor after 2038. In CT, Nautilus' revenues fall between the cap and floor levels, except for the four first years when the revenues are above the cap and the last five years when floor support is likely to be required. In FS, Nautilus' revenues are forecast to fall below the floor over the first 10 years of the modelled period, and from 2040, they are likely to fall between the cap and floor levels.

Decarbonisation impacts

Figure 1.5 – Decarbonisation impact in GB, Belgium and Europe



Column chart representing the impact of Nautilus on CO_2 emissions in GB, Belgium and Europe.

The introduction of the Nautilus project is likely to increase CO_2 emissions in GB across all scenarios. This is because the project increases the dispatch of thermal generation in GB by increasing GB wholesale prices. The project is likely to reduce emissions in Belgium and across Europe in all scenarios.

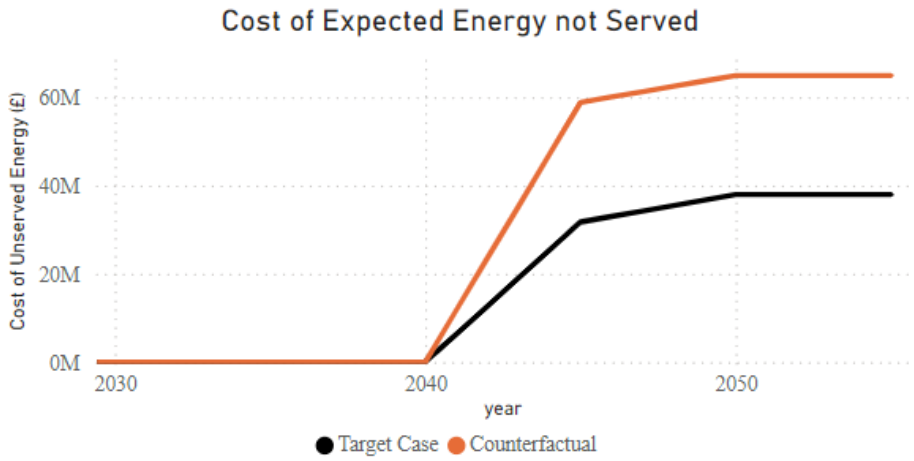
Table 1.1 – Decarbonisation indicators for Nautilus

Indicator	Applies to	Unit	LW	CT	FS
CO_2 reduction (SEW)	GB	£m real 2022 NPV	116.3	262.3	688.6
CO_2 reduction (societal value)	GB	£m real 2022 NPV	530.0	724.6	1,042.3
Overall decarbonisation	Europe	Mt	-5.9	-8.7	-3.8

As shown in Table 1.1 above, the increase in CO_2 emissions in GB leads to energy consumers paying electricity at a higher cost compared to the counterfactual. The additional CO_2 also leads to higher societal costs in GB.

Security of supply impact

Figure 1.6 – Cost of Expected Energy Not Served (EENS) in the counterfactual and target case in LW (£, real 2022)



Line chart comparing the impact of Nautilus' introduction (target case) on the cost of expected energy not served (EENS) against the counterfactual (project not being introduced)

The introduction of Nautilus leads to a reduction in the number of USE (unserved energy) hours in GB compared to the counterfactual in LW. The project helps to reduce the costs of EENS by importing electricity in periods of system stress. The reduction is predicted to be £324.1m.

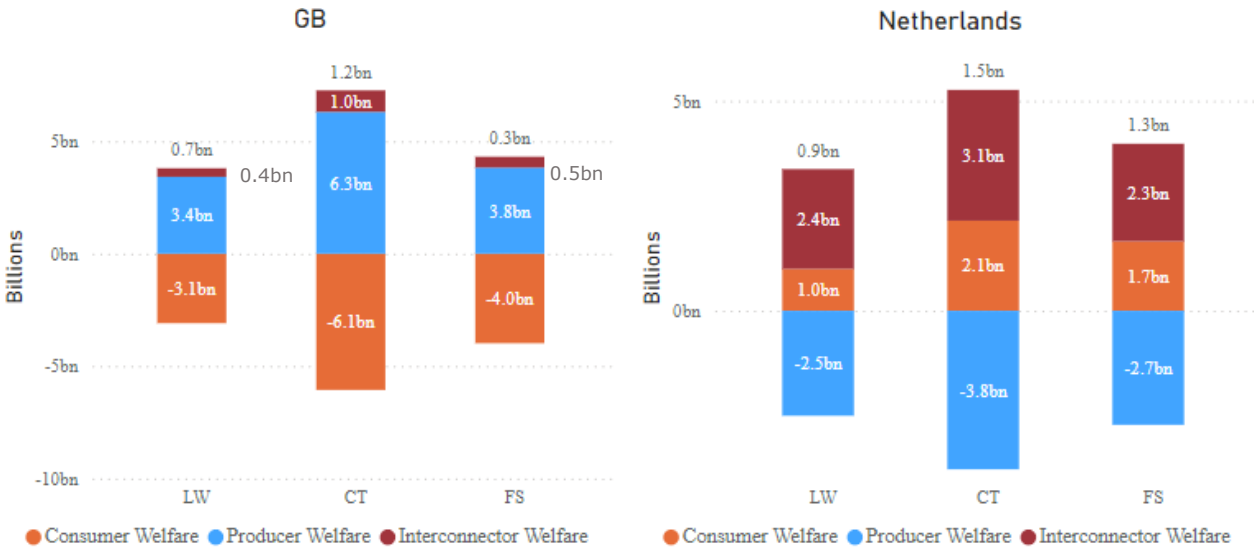
In CT and FS, no USE hours are observed before and after the introduction of the project, meaning that Nautilus does not have positive nor negative impacts on SoS (security of supply) in GB.

LionLink

Overview and SEW impacts

The LionLink project has been modelled as a 1.8 GW interconnector between GB and an energy island in Dutch national waters (L1). The energy island, assumed to operate as an OBZ[38], connects to a 2 GW windfarm to the Netherlands via a 2 GW line (L2). The project is modelled from 2030.

Figure 2.1 – SEW impacts of LionLink in GB and the Netherlands (£bn, real 2022, NPV)



Stacked column charts presenting the total SEW figures and breakdown by Consumer, Producer and Interconnector welfare, for GB and the Netherlands.

In GB, the total SEW impacts are positive in all scenarios. This is due to strong producer SEW and positive IC welfare. LionLink delivers negative consumer SEW in all scenarios.

LionLink is predominantly used to export electricity from GB across the three scenarios. This increases wholesale prices in GB compared to the counterfactual. This in turn increases producer SEW and reduces consumer welfare.

In the Netherlands, LionLink delivers positive total SEW in all scenarios. This is largely driven by strong interconnector and consumer SEW. Producer SEW is negative in all scenarios.

Price differentials and flows

Figure 2.2 – Price differentials between GB and the Netherlands (£/MWh)

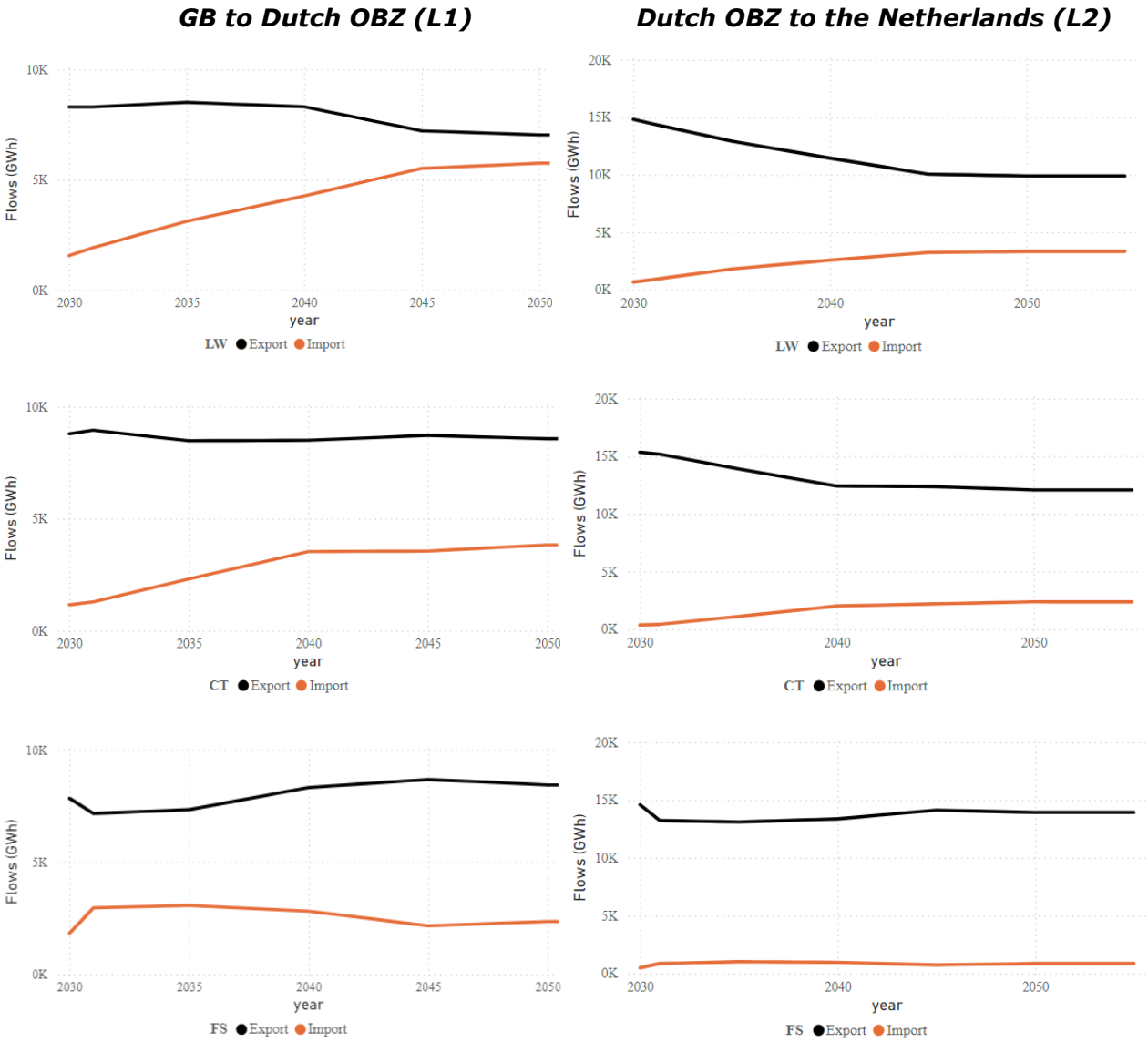
[38] Offshore bidding zones: key to efficient market integration (tennet.eu): 'Offshore bidding zones are separate price regions for offshore hubs, within the European electricity market.'

Line charts representing the wholesale price in GB, the Netherlands and the Dutch energy island.

Prices in the Netherlands are constantly higher than in the Dutch OBZ and GB. In LW, prices in the Dutch OBZ are marginally higher than in GB but this trend changes from the early 2040s. The opposite trend can be observed in FS. In CT, prices in the Dutch OBZ are higher than in GB in all modelled years.

The price differentials described above are the main drivers of the direction of electricity flows across the project. As the below line charts show, the project is mostly used for exporting electricity from GB. In LW, the share of imports is higher than in other modelled scenarios.

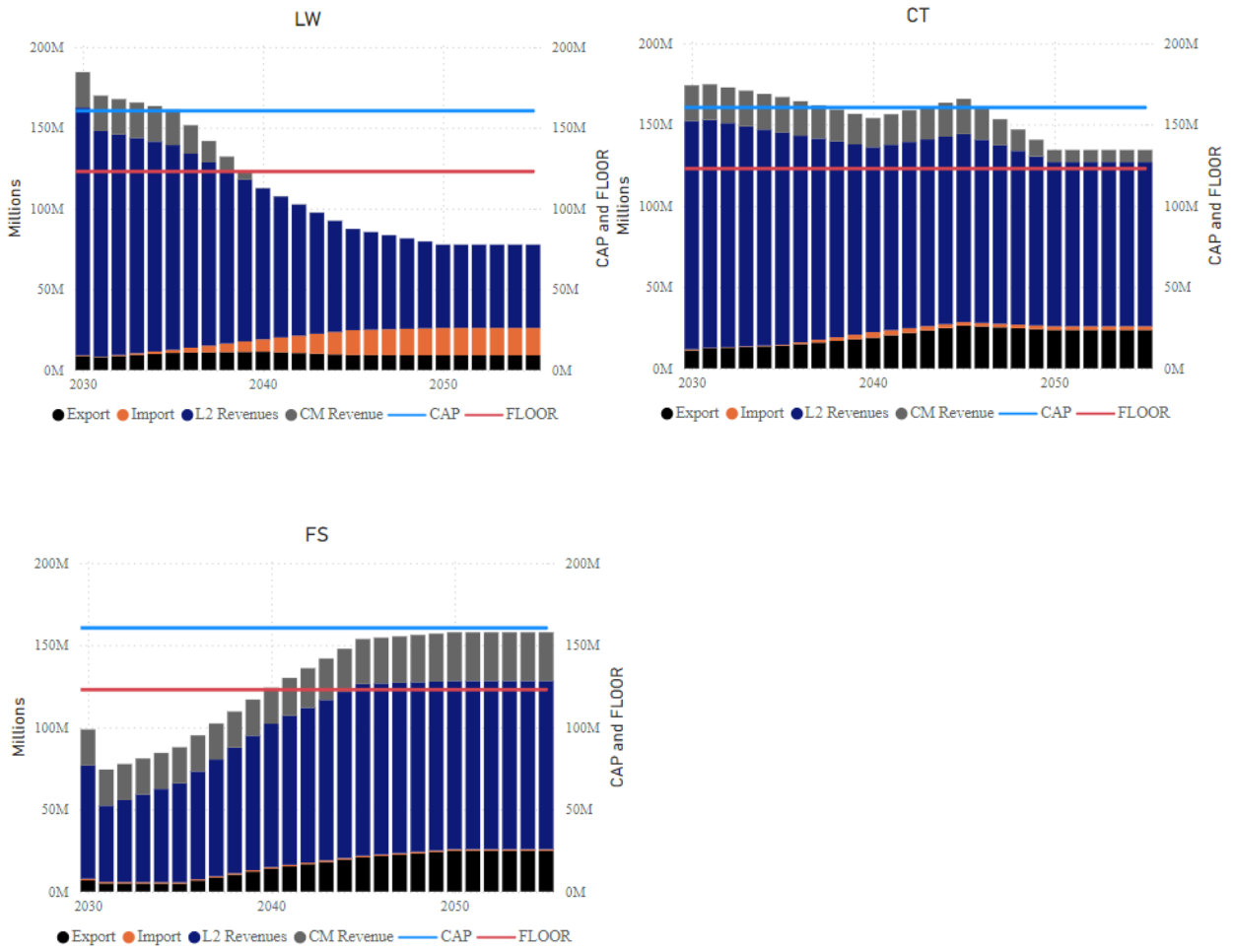
Figure 2.3 – Electricity flows across LionLink (L1) and L2 (GWh)



Line charts presenting electricity flows (export/import) across the project (black line – export, orange line – import).

Revenues and impacts on consumers

Figure 2.4 – GB share of revenues earned by LionLink from L1 (export, import and CM, £m, real 2022)

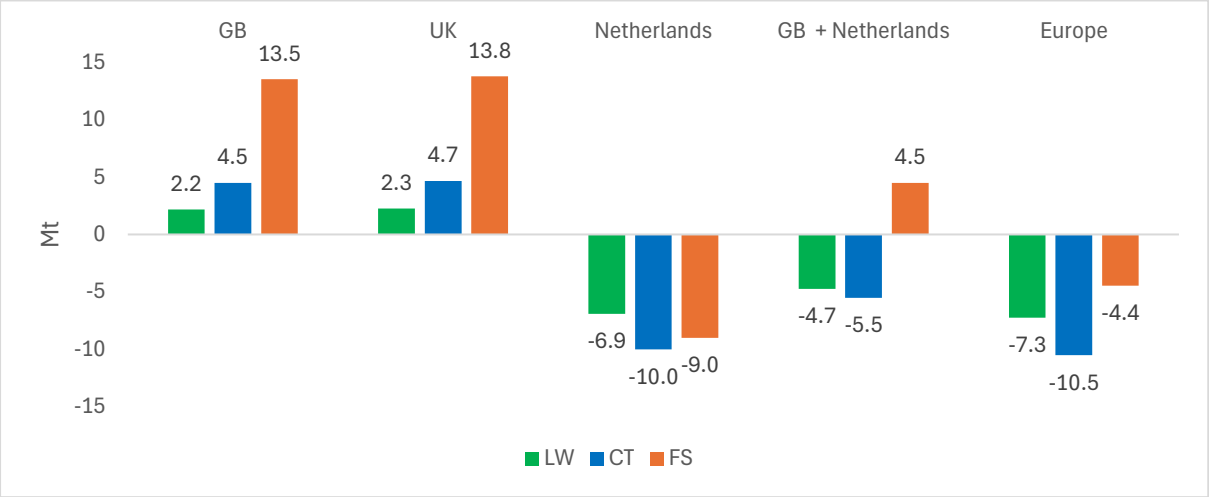


Combined stacked column and line charts comparing revenue sources against the cap and floor levels from 2030 to 2055. Stacked columns represent revenues from export, import, L2 and CM. Lines show cap and floor levels.

LionLink is forecast to earn most of its revenue through exports from GB. The share of revenues from imports in LW is higher than in other scenarios. In LW, LionLink's revenues are above the cap level from 2030 to 2035, fall between the cap and floor levels from 2036 to 2038, and fall below the floor from 2040. In CT, LionLink's revenues alternate between being above the cap level and falling between the cap and floor levels throughout the regime period, with revenues falling above the cap from 2030 to 2037 and from 2043 to 2045. In FS, LionLink's revenues are forecast to fall below the floor level from 2030 to 2039, but to fall between the cap and floor levels from 2040.

Decarbonisation impacts

Figure 2.5 – Decarbonisation impact in GB, the Netherlands and Europe



Column chart representing the impact of LionLink on CO_2 emissions in GB, the Netherlands and Europe.

The introduction of the LionLink project is likely to increase CO_2 emissions in GB across all scenarios. This is because the project increases the dispatch of thermal generation in GB by increasing GB wholesale prices. The project is likely to reduce emissions in the Netherlands and across Europe in all scenarios.

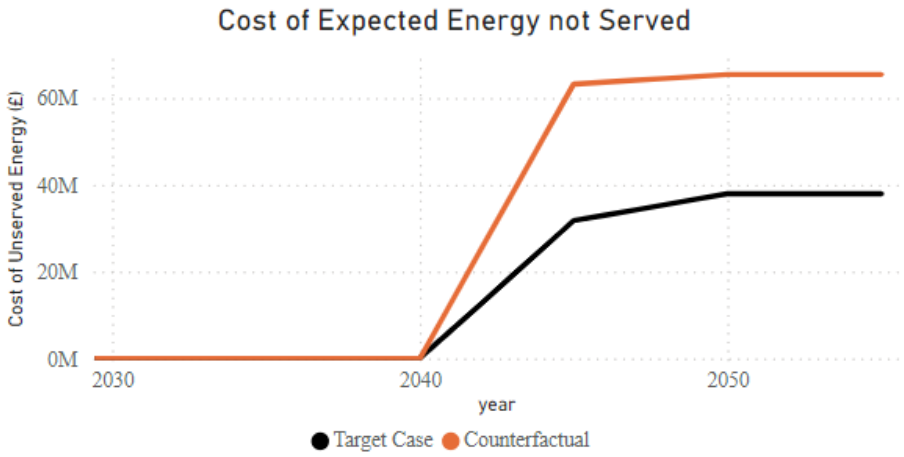
Table 2.1 – Decarbonisation indicators for LionLink

Indicator	Applies to	Unit	LW	CT	FS
CO_2 reduction (SEW)	GB	£m real 2022 NPV	185.0	352.8	909.4
CO_2 reduction (societal value)	GB	£m real 2022 NPV	748.6	1,000.5	1,384.8
Overall decarbonisation	Europe	Mt	-7.3	-10.5	-4.4

As shown in Table 2.1 above, the increase in CO_2 emissions in GB leads to energy consumers paying electricity at a higher cost compared to the counterfactual. The additional CO_2 also leads to higher societal costs in GB.

Security of supply impact

Figure 2.6 – Cost of EENS in the counterfactual and target case in LW (£, real 2022)



Line chart comparing the impact of LionLink's introduction (target case) on the cost of expected energy not served (EENS) against the counterfactual (project not being introduced).

The introduction of LionLink leads to a reduction in the number of USE hours in GB compared to the counterfactual in LW. The project helps to reduce the costs of EENS by importing electricity in periods of system stress. The reduction is predicted to be £349.6m.

In CT and FS, no USE hours are observed before and after the introduction of the project, meaning that LionLink does not have positive nor negative impacts on SoS in GB.

Multi-Criteria Assessment framework tables

For all projects:

'System operability' indicators were not re-run with the updates to modelling since consultation. Results displayed are those published in our March 2024 consultation.

We have changed the way we RAG rate the 'Security of Supply' indicator. This indicator is now being rated green whenever there is at least a positive impact in any of the modelled scenarios and there are no positive nor negative impacts on the other two scenarios.

There was no need to re-assess hard to monetise indicators. The RAG rating results here reflect those published in our March 2024 consultation.

The RAG rating for the balancing market (constraint costs) impact is as follows: green means the project reduces constraint cost in any scenario and there is only a marginal increase in the others, amber means the project increases constraint costs in any scenario to a proportional level and red means the project disproportionately increases constraint costs in any scenario. This reflects our level of concern regarding the project's constraint cost impact on the system.

LionLink

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	(44.5)	4.9	4.5	=	(3.1)	(6.1)	(4.0)	↓
SEW	Producers SEW	£bn real 2022, NPV	(32.8)	5.8	4.9	=	3.4	6.3	3.8	↑
SEW	Interconnectors SEW	£bn real 2022, NPV	(1.0)	0.9	0.7	↑	0.4	1.0	0.5	↑
SEW	Total SEW	£bn real 2022, NPV	10.7	1.8	1.2	=	0.7	1.2	0.3	↑
Network costs	Onshore works	£m, real 2022	-	-	-					
System operability	Frequency stability	Average TWh/y	1.07	1.09	1.06	=	1.11	1.12	1.13	=
System operability	Frequency response savings	£bn, NPV, real 2022	0.16	0.16	0.16	=	0.17	0.17	0.17	=
System operability	Voltage stability	Average TVar/y	4.46	4.46	4.46	=	4.46	4.46	4.46	=
System operability	Reactive response savings	£bn, NPV, real 2022	0.14	0.14	0.14	=	0.14	0.14	0.14	=
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04	=	0.04	0.05	0.05	=
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(2.1)	(1.6)	(0.2)		(0.9)	(0.8)	(0.0)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.2)	(0.4)	(1.0)	=	(0.2)	(0.4)	(0.9)	=
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.8)	(1.0)	(1.5)	=	(0.7)	(1.0)	(1.4)	=
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	4.2	7.8	4.0	=	0.3	1.1	0.5	=
Decarbonisation	RES integration (additional RES capacity)	MW	0	0	0		0	0	0	
Decarbonisation	Overall decarbonisation	Mt	(8.0)	(14.9)	(11.1)		(7.3)	(10.5)	(4.4)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	4.7	0.1	-	=	0.2	-	-	=
Hard to monetise impacts	Environmental impact, local community impacts, noise/disturbance, landscape and other.	qualitative	-	-	-		-	-	-	=

Nautilus

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	(44.9)	3.6	3.6	=	(2.5)	(4.5)	(3.3)	=
SEW	Producers SEW	£bn real 2022, NPV	(33.7)	4.1	4.0	=	2.8	4.5	3.4	=
SEW	Interconnectors SEW	£bn real 2022, NPV	(1.7)	0.2	0.1	=	(0.1)	0.2	(0.0)	=
SEW	Total SEW	£bn real 2022, NPV	9.5	0.7	0.5	=	0.1	0.2	0.1	=
Network costs	Onshore works	£m, real 2022	-	-	-					
System operability	Frequency stability	Average TWh/y	0.58	0.60	0.57		0.64	0.65	0.68	
System operability	Frequency response savings	£bn, NPV, real 2022	0.08	0.09	0.09		0.10	0.10	0.10	
System operability	Voltage stability	Average TVar/y	3.47	3.47	3.47		3.47	3.47	3.47	
System operability	Reactive response savings	£bn, NPV, real 2022	0.11	0.11	0.11		0.11	0.11	0.11	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(3.4)	(3.1)	(1.5)		(1.3)	(1.2)	(0.5)	↓
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.1)	(0.3)	(0.8)	=	(0.1)	(0.3)	(0.7)	=
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.6)	(0.7)	(1.1)	=	(0.5)	(0.7)	(1.0)	=
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	1.7	2.3	1.2	=	(0.1)	(0.1)	0.1	↓
Decarbonisation	RES integration (additional RES capacity)	MW	0	0	0		0	0	0	
Decarbonisation	Overall decarbonisation	Mt	(6.7)	(11.3)	(9.0)		(5.9)	(8.7)	(3.8)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	3.9	0.1	-	=	0.1	-	-	=
Hard to monetise impacts	Environmental impact, local community impacts, noise/disturbance, landscape and other.	qualitative	-	-	-		-	-	-	=