Consultation

Initial Project Assessment of the Offshore Hybrid Asset Pilot Projects

Publication date:	1 March 2024 (revised 16 April 2024)
Response deadline:	31 May 2024
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This consultation provides our minded-to position on the Initial Project Assessment (IPA) of the two eligible projects which applied to the Offshore Hybrid Asset (OHA) pilot scheme for a regulatory regime, both of which are Non-Standard Interconnectors (NSIs). The IPA considers the needs case for GB consumers of the applicant projects. We welcome views from all interested stakeholders and aim to take a final decision in summer 2024.

We will publish non-confidential responses we receive alongside a decision, including next steps, on our website at ofgem.gov.uk/consultations. If you want your response – in whole or in part – to be considered confidential, please tell us in your response and explain why. Please clearly mark the parts of your response that you consider to be confidential, and if possible, put the confidential material in separate appendices to your response.

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Executive Summary

Offshore Hybrid Assets (OHAs) are a novel asset type combining interconnection with the transmission of electricity from offshore wind generation. They provide the potential for increased coordination and the more efficient use of transmission assets in comparison to standalone point-to-point interconnectors and radial offshore wind connections, and can provide a first step towards a more strategic and integrated electricity grid in the North Sea.

By combining interconnection with offshore transmission, OHAs can:

- reduce the impact on coastal communities and the marine environment by reducing the number of individual cables and onshore converter stations required.
- increase efficiency in the construction and use of the infrastructure, allowing the same cable to be used for wind energy transmission and cross-border trade, potentially reducing overall construction and operational costs.
- Maximise the use of renewable energy that might otherwise be curtailed by providing routes to export at times of excess generation, offering a route to market for wind developers that maximises output, reduces asset costs, and minimises delays.

Ofgem conducted the Interconnector Policy Review[1] (ICPR) in 2020-21, which committed to opening a pilot scheme for OHAs, at the time referred to as 'Multi-Purpose Interconnectors' (MPIs). The ICPR explained the benefits they may provide to the coordination of offshore assets and the integration of offshore renewables. We subsequently launched the OHA pilot scheme in 2022.

About the pilot NSI projects

The OHA pilot scheme closed for applications on 31 October 2022, after which two of the project applications were found to be eligible for assessment at the Initial Project

[1] Interconnector Policy Review - Decision | Ofgem

Assessment (IPA) stage.[2] Both of these projects in the OHA pilot scheme are Non-Standard Interconnectors (NSIs[3]) developed by National Grid Ventures[4]:

- **LionLink**, to the Netherlands, a proposed 1.8GW connection to an offshore converter station on a Dutch offshore transmission 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.

At the IPA stage, Ofgem assesses the projects' suitability for a regulatory regime, and this document outlines our minded-to position on which Pilot NSIs to grant regulatory regime in principle based on that assessment. The Pilot NSIs comprise the assets that connect GB to the offshore converter station in the connecting jurisdiction. The offshore converter station is then connected to the shore of the connecting jurisdiction. This entire shore-to-shore asset is known as an OHA, meaning that the Pilot NSIs each form part of an OHA but are not themselves an entire OHA. [5]

Our Minded-to Positions

We have assessed the OHA pilot 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 assessed applications in line with our OHA pilot regulatory framework document,[6] and needs case assessment framework[7], which included detail on the different parts of our assessment framework, including:

- project maturity to become operational by the end of 2032
- socio-economic welfare (SEW) impacts
- system operability and balancing market impacts
- decarbonisation
- security of supply, and

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[2] For details of Ofgem's decision on project eligibility, please see: Decision on Multi-Purpose Interconnector pilot project Selection | Ofgem
[3] For the purpose of the OHA pilot scheme, an NSI is an electricity interconnector which is connected to an offshore converter station in the connecting jurisdiction and which does not undertake offshore wind transmission activities in Great Britain. See page 17 Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme | Ofgem
[4] Nautilus was initially submitted as a Multi-Purpose Interconnector project, (i.e. an OHA connecting to offshore wind generation in GB jurisdiction). However, significant project developments have taken place since then, requiring the Nautilus project to carry on in our processes as an NSI.
[5] Further detail on the configuration of NSIs and OHAs can be found on page 11 and 14.
[6] Multi-purpose Interconnectors Pilot Regulatory Framework | Ofgem
[7] Cap and Floor Third Application Window and MPI Pilot Regulatory Framework- Guidance on our Needs Case Assessment Framework | Ofgem

- hard to monetise impacts.

The table below shows a summary of our minded-to positions for both Pilot NSI projects.

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

Project	**Our minded-to position**	**High-level reasons**
LionLink	Approve	No material concerns identified. This minded-to approval is conditional. To grant a regulatory regime in principle to LionLink, pursuant to the IPA decision, Ofgem must 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.
Nautilus	Reject	Reservations surrounding high constraint costs, and uncertainty regarding the project's total welfare to GB owing to its configuration.

The analysis undertaken for the OHA pilot scheme has confirmed the expectations in our Interconnector Policy Review (ICPR) that GB will likely become a net electricity exporter. This means that while we expect GB prices overall to be much lower than today's levels in most scenarios,[8] exports will slightly increase GB wholesale prices, which shifts the balance of consumer and producer benefit. Our study shows that the Pilot NSIs are beneficial to GB overall, when accounting for total SEW. However, this is driven by strong producer welfare, which offsets decreases in consumer and interconnector welfare.[9]

Through the export of renewable energy, both Pilot NSI projects contribute to carbon savings across Europe and contribute to balancing supply and demand in GB in an increasingly intermittent system by providing a route to market for surplus wind energy

[8] The Future Energy Scenarios represent a range of different, credible ways to decarbonise our energy system to reach the 2050 target. Further detail can be found in Arup's market modelling report published alongside this consultation.
[9] Interconnector welfare is primarily affected by the change in revenue earned because of the variation in price differentials between the countries an interconnector connects to.

that would otherwise be curtailed. However, as the bulk of GB's wind resources are located in the north, the proposed location of the Pilot NSIs in the south means that the Pilot NSIs will increase transmission system costs because of network bottlenecks. The positive decarbonisation and security of supply findings need to be weighed against the high constraint costs and other factors in determining whether to approve an applicant project.

Our analysis has found that the configuration and market arrangements of the two wider OHAs, of which the Pilot NSIs form the line from the GB shore to the offshore converter station in the connecting jurisdiction, have a significant impact on their needs case and commercial viability.

In the market modelling analysis, the Pilot NSIs are projected to predominantly export from GB. However, the output of the offshore wind farm also reduces the capacity on the wider OHA that can be used for cross-border trade, reducing interconnector welfare. This means that the Pilot NSIs are projected to rely more heavily on consumer support to top up the floor.[10]

For OHAs that operate under Offshore Bidding Zone (OBZ) market arrangements (which have been assumed in our analysis), the presence of the OBZ means that congestion revenue accrues asymmetrically on each side of the OBZ depending on the direction of flow. This feature is a complication that is not present for point-to-point interconnectors but has important consequences for the financial viability of these projects (including under a cap and floor regulatory regime). Discussions are ongoing with the relevant authorities in the connecting countries over appropriate cross-border cost, revenue and benefit sharing arrangements for the two OHAs, of which the two Pilot NSIs form respective parts (see more detail in Section 4).

To grant a regulatory regime in principle to the Pilot NSIs, pursuant to the IPA decision, Ofgem must 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.

It is anticipated that the learnings from and outcomes of the OHA pilot scheme, and the further development in GB and overseas of an enduring OHA regime, will contribute to the development of future projects of this type.

[10] Here we mean the floor of the cap and floor regime.

Next steps

We are now seeking views on our minded-to position, and welcome responses from all interested stakeholders. Stakeholders should submit responses to Cap.Floor@ofgem.gov.uk by **30 April** 2024.

We expect that a final decision will follow in summer 2024, and any regulatory regime offered in principle will be subject to our IPA conditions.

1. Introduction

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. 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 a way of providing flexibility and enhancing security of supply in a renewables-dominated energy system.

1.2 OHAs combine interconnection with the transmission of offshore wind, providing the potential for coordination and transmission asset efficiency benefits compared to standalone point-to-point interconnectors and radial offshore wind connections. Additionally, a meshed grid in the North Sea 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 extensive offshore wind ambitions for 2050. Development of the technical, regulatory and commercial structures of OHAs will assist in meeting this goal.

1.3 A wider OHA combines network-to-network cross-border interconnection with (in GB and/or the connecting state) offshore transmission. These assets are referred to in recital 66 of the EU Electricity Regulation[11] and described as "offshore electricity infrastructure with dual functionality (so-called 'offshore hybrid assets') combining transport of offshore wind energy to shore and interconnectors". The Pilot NSIs, which will conduct only interconnection activities in GB, each form part of an OHA. OHAs and interconnectors allow electricity to be generated in one market and used in another. Ofgem has decided that a form of cap and floor regime should apply to the Pilot NSIs.[12]

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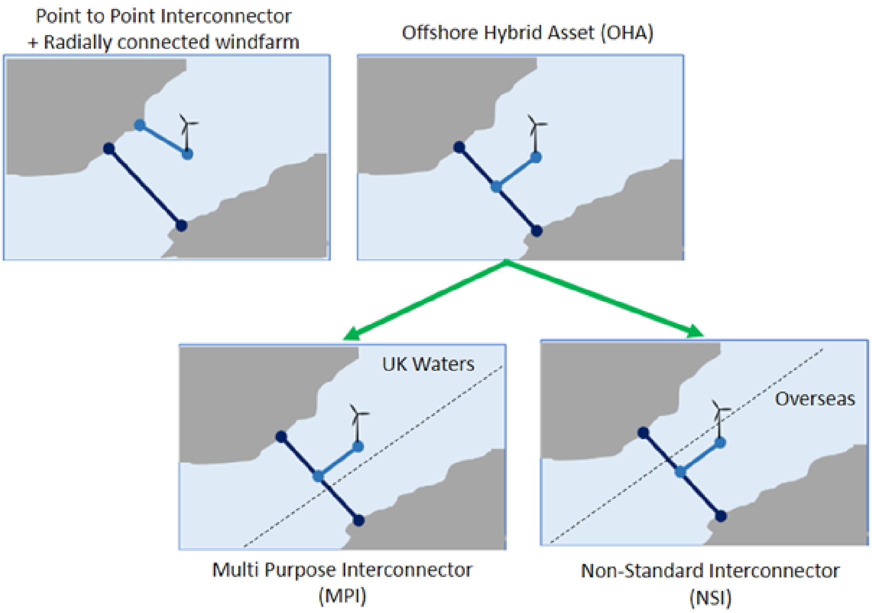
[11] Recital 66 of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast). : REGULATION (EU) 2019/ 943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 5 June 2019 - on the internal market for electricity (europa.eu)

[12] For more information, please see: Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme | Ofgem

Figure 1: Schematics demonstrating the configuration of cross-border assets



Background to the cap and floor regime and the Initial Project Assessment of the OHA pilot scheme

1.4 The cap and floor regime is the 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.

1.5 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.

1.6 The cap and floor regime is awarded through investment windows rather than in response to ad hoc applications. Following the cap and floor 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 the ICPR in 2020-21,[13] to determine the effectiveness of the cap

[13] Open letter: Notification to interested stakeholders of our interconnector policy review | Ofgem

and floor regime and to consider changes to the assessment process and to the regime for future projects.

1.7 The ICPR also committed to opening 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. It was considered that the cap and floor regime would be suitable for OHA development, and while the details of the regulatory regime for OHAs is evolving, Ofgem's assessment structure and delivery of such a regime matches that of the standard cap and floor process. Following the ICPR, the OHA pilot scheme was open for applications between September and October 2022.

1.8 The Pilot NSIs are being assessed considering 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 also consider the unique risks carried by OHAs in their development compared to point-to-point interconnectors.

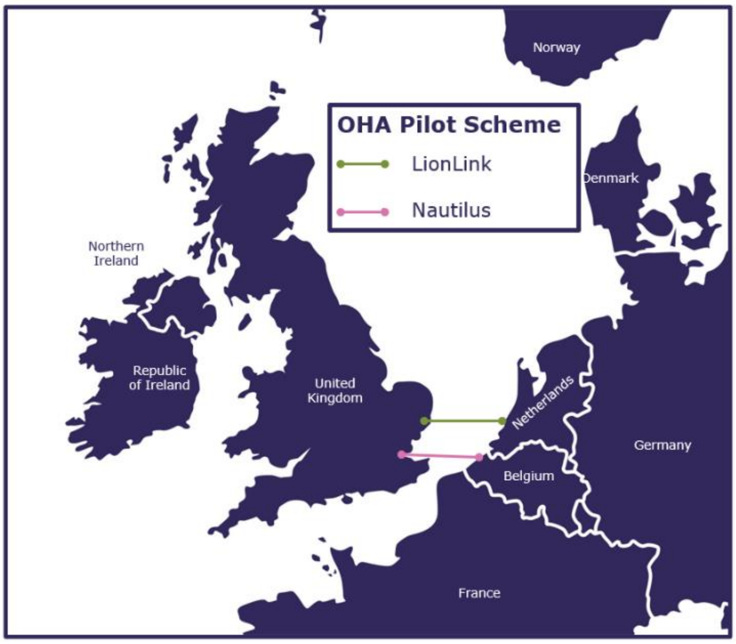
Non-standard interconnectors

1.9 We determined that the following applicant projects were eligible for assessment at the IPA stage in December 2022:[14]

- LionLink, to the Netherlands, a proposed 1.8GW connection to an offshore converter station on a Dutch offshore transmission 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.

[14] Decision on Multi-Purpose Interconnector pilot project Selection | Ofgem

Figure 2: Map showing indicative connection points for the OHA pilot scheme applicants

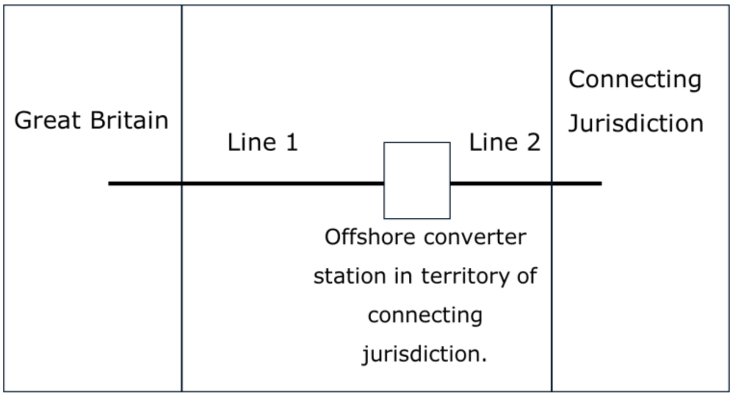


1.10 Both of the applicant projects are NSIs, and we refer to them as the Pilot NSIs. For the purposes of the OHA pilot scheme the regulatory description of an NSI is as follows: "an electricity interconnector which is connected to an offshore converter station in the connecting jurisdiction and which does not subsist for the purposes of offshore transmission activities in Great Britian".[15]

1.11 This means that the two Pilot NSIs comprise the assets that connect GB to the offshore converter platforms in the connecting states. We call this Line 1, as shown in Figure 3 below.

[15] See page 17 Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme (ofgem.gov.uk)

Figure 3: A schematic demonstrating the configuration of a shore-to-shore Offshore Hybrid Asset, of which each Pilot NSI comprises Line 1



1.12 For each wider OHA, the lines from the offshore converter stations in the connecting states to the onshore electricity systems of these states is referred to by Ofgem as Line 2, and is outside the scope of the LionLink and Nautilus Pilot NSI projects.

Cost and revenue sharing

1.13 For OHAs that will operate under the OBZ market arrangements, the presence of the OBZ and its pricing principles (that it adopts the lower of the two connecting countries' market prices) has the effect of placing congestion revenues, on either one of the lines from the offshore converter station to the connected countries' onshore networks, but not both. This is in contrast to the position on a point-to-point interconnector where congestion revenues arise across one line and can be shared, in agreed proportions, between the operators of this interconnector in the two connecting states.

1.14 Depending on the scale of price differences between the two connected markets, congestion revenue can be a very significant element of the total socio-economic welfare generated by the project.

1.15 Consequently, a fair sharing of the costs and revenues of an OHA is a significant issue for the commercial parties to these projects and the relevant national authorities.

1.16 The impact of an OBZ is a new feature of electricity market regulation. Discussions between project developers and relevant authorities are ongoing to establish a suitable approach to cross-border cost and revenue/benefit sharing.

1.17 The modelling for the IPA has been undertaken on the conservative assumption that Line 2 costs and revenues are not shared between the GB owner/operator of the relevant Pilot NSI and the owner/operator of the wider OHA in the connecting state. Accordingly, Line 2 in the case of both Pilot NSI projects has been excluded from our assessment for the IPA.

1.18 Following the IPA decision, each project is held to IPA conditions, which are part of the IPA decision and are intended to incentivise timely delivery of projects and to ensure that consumers realise the anticipated benefits that informed our decision on the needs case for the project at IPA stage.

What are we consulting on?

1.19 This consultation contains our minded-to position on our IPA of the Pilot NSIs (i.e. LionLink and Nautilus), along with supporting analysis and reasoning for our position. We have assessed the projects that were successful in passing the eligibility criteria.[16] Alongside this consultation, we have published the detailed results and methodology of components of the analysis conducted for the IPA: the Market Modelling report, prepared by our consultants at Ove Arup and Partners ("Arup"); and the system operability report, prepared by National Grid Electricity System Operator (NGESO).[17] This consultation covers only the needs case assessment of the Pilot NSIs to consider their suitability for the relevant form of OHA regulatory regime. If successful in the IPA, projects will receive a regulatory regime in principle. The details for the regulatory regime that will apply to the Pilot NSIs are contained in a separate publication[18] and we will later be consulting on the detailed regime parameters for the Pilot NSI(s).

Related publications

Context for the introduction of Window 3 and OHA pilot scheme

Interconnector Policy Review: Decision (ofgem.gov.uk)

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

[16] Ofgem received four applications to the OHA pilot scheme. In April 2023 we announced that we would not progress two of the projects, both connecting to Norway, due to the incompatibility of GB's OHA development timeline and that of Norway. For further information, please see the announcement letter on this subject: An updated decision on Multi-Purpose Interconnectors Pilot project selection | Ofgem

[17] Please note that 'NGESO' and 'ESO' are used interchangeably across the consultation and accompanying reports to refer to GB's Electricity System Operator.

[18] Decision on the Regulatory Framework for the Non-Standard Interconnectors of the Offshore Hybrid Asset pilot scheme | Ofgem

Multi-purpose Interconnectors Pilot Regulatory Framework | Ofgem

Cap and Floor Third Window and MPI Pilot Needs Case Framework (ofgem.gov.uk)

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 Non-Standard Interconnectors | Ofgem

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

Accompanying Publications:

1.20 This minded-to consultation is published alongside reports supporting our IPA, based on analysis undertaken by Arup and NGESO. These reports are as follows:

- Market Modelling Analysis for Cap and Floor Window 3 and Offshore Hybrid Assets Pilot Projects – Arup;
- Multi-Criteria Assessment framework report for Cap and Floor Window 3 and Offshore Hybrid Assets Pilot Projects – Arup; and
- ESO Modelling Report: Cap and Floor Window 3 and Offshore Hybrid Asset pilot scheme Needs Case Assessment – NGESO.

Consultation stages

1.21 The consultation will remain open for eight weeks for written response until 30 April 2024, following which we anticipate publishing our decision in summer 2024.

Stage 1	Stage 2	Stage 3	Stage 4
Consultation open	Consultation closes (awaiting decision). Deadline for responses	Responses reviewed and published	Consultation decision/policy statement
01/03/2024	30/04/2024	Q2 2024	Summer 2024

How to respond

1.22 We want to hear from anyone interested in this consultation. Please send your response to the person or team named on this document’s front page.

1.23 We've asked for your feedback in each of the questions throughout. Please respond to each one as fully as you can.

1.24 We will publish non-confidential responses on our website at www.ofgem.gov.uk/consultations.

Your response, data and confidentiality

1.25 You can ask us to keep your response, or parts of your response, confidential. We'll respect this, subject to obligations to disclose information, for example, under the Freedom of Information Act 2000, the Environmental Information Regulations 2004, statutory directions, court orders, government regulations or where you give us explicit permission to disclose. If you do want us to keep your response confidential, please clearly mark this on your response and explain why.

1.26 If you wish us to keep part of your response confidential, please clearly mark those parts of your response that you *do* wish to be kept confidential and those that you *do not* wish to be kept confidential. Please put the confidential material in a separate appendix to your response. If necessary, we'll get in touch with you to discuss which parts of the information in your response should be kept confidential, and which can be published. We might ask for reasons why.

1.27 If the information you give in your response contains personal data under the General Data Protection Regulation (Regulation (EU) 2016/679) as retained in domestic law following the UK's withdrawal from the European Union ("UK GDPR"), the Gas and Electricity Markets Authority will be the data controller for the purposes of GDPR. Ofgem uses the information in responses in performing its statutory functions and in accordance with section 105 of the Utilities Act 2000. Please refer to our Privacy Notice on consultations, see Appendix 4.

1.28 If you wish to respond confidentially, we'll keep your response itself confidential, but we will publish the number (but not the names) of confidential responses we receive. We won't link responses to respondents if we publish a summary of responses, and we will evaluate each response on its own merits without undermining your right to confidentiality.

General feedback

1.29 We believe that consultation is at the heart of good policy development. We welcome any comments about how we've run this consultation. We'd also like to get your answers to these questions:

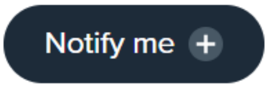
- Do you have any comments about the overall process of this consultation?

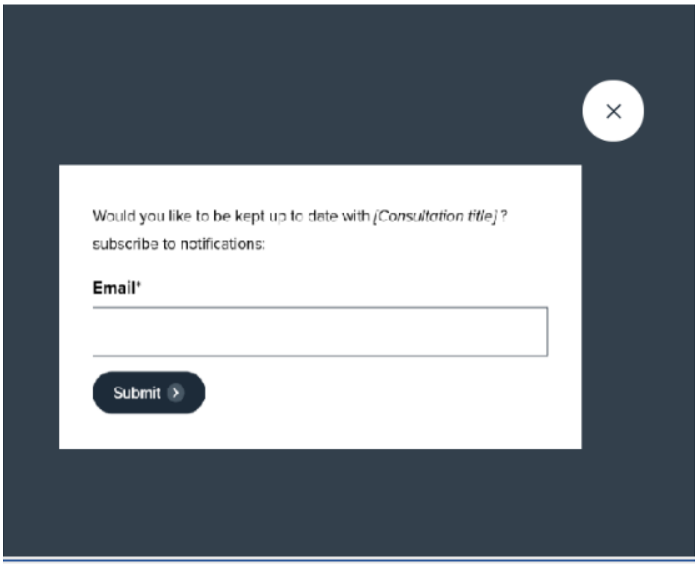
- Do you have any comments about its tone and content?
- Was it easy to read and understand? Or could it have been better written?
- Were its conclusions balanced?
- Did it make reasoned recommendations for improvement?
- Any further comments?

1.30 Please send any general feedback comments to stakeholders@ofgem.gov.uk

How to track the progress of the consultation

1.31 You can track the progress of a consultation from upcoming to decision status using the 'notify me' function on a consultation page when published on our website. Ofgem.gov.uk/consultations.





Once subscribed to the notifications for a particular consultation, you will receive an email to notify you when it has changed status. Our consultation stages are:

Upcoming > Open > Closed (awaiting decision) **> Closed** (with decision)

2. The strategic case for OHAs

Section summary

In a decarbonised future electricity system, we expect that further interconnectors - including OHAs - will likely be net exporters, resulting in lower consumer welfare and a marginal rise in the wholesale price in GB.

Despite this, some future interconnection would likely remain in the consumer interest, as it is likely that there are additional benefits to be gained from interconnectors and OHAs in meeting national and international policy goals related to decarbonisation, flexibility and renewable energy integration.

OHAs could potentially deliver significant benefits above point-to-point interconnectors, such as that of coordination and efficiency in the development of offshore transmission infrastructure. It is expected that OHAs could play an important role in enabling the development of offshore renewables in the context of increasingly crowded seas and supply chain constraints, reducing the number of assets required to connect generation, and consequently reducing investment costs and adverse societal impacts.

The energy landscape is changing due to the rapid transition to low-carbon energy sources and the related implementation of market reforms. Some policy reforms may change the strategic case for future interconnection. We are alert to this and have taken into account known changes and reforms where possible, and further discuss uncertainties in policy and market frameworks where some options might be particularly relevant to our assessment.

We also acknowledge that the expectations for an adjusted cap and floor framework and legal structure for OHAs have changed between the conclusion of the ICPR, opening of the pilot scheme, and this minded-to position.[19]

Benefits of interconnection

2.1 The economics of interconnectors are changing. At the time of the introduction of the cap and floor regime, interconnectors were considered beneficial to GB consumers, primarily by increasing wholesale market competition and enabling imports of cheaper electricity from Europe. However, GB's renewables rollout

[19] Page 8 demonstrates the change in terminology of the, then, 'multi-purpose interconnector' pilot scheme, to the, now, OHA pilot scheme to reflect the description of an MPI asset as contained in the Energy Bill: Consultation on the Regulatory Framework, including Market Arrangements, for Offshore Hybrid Assets: Multi-Purpose Interconnectors and Non-Standard Interconnectors | Ofgem

means that under most future scenarios we anticipate that our wholesale price will likely move from being one of the highest to one of the lowest in Europe. This means that it is expected that interconnectors (in this context also including the interconnection function of OHAs) will serve a different purpose, as a way of providing flexibility to our renewables-dominated energy system. In principle, the interconnection function of OHAs and point-to-point interconnectors can provide the following benefits to GB:

2.2 **Lower prices for consumers**. Electricity trading through interconnectors allows access to cheaper electricity from neighbouring countries, and more efficient generation dispatch, reducing the overall cost of energy across markets. This has been the main historic driver for new interconnection. However, whilst there will remain a general efficiency benefit, we expect that the GB consumer benefit is likely to change as GB becomes a net exporter of electricity.

2.3 **Diversification of GB's energy sources**. Interconnectors provide access to a wider range of generation. This diversification can enhance energy security by reducing dependence on a more limited range of domestic sources. Interconnectors can facilitate the integration of other renewable sources into the grid through imports, or export excess wind energy to another country with high demand. This helps in optimising the use of renewables, enabling regional specialisation (by locating different types of renewables in areas where they are most efficient) and unlocking a more sustainable energy mix.

2.4 **Ability to balance supply and demand, including providing a route to export renewable energy that would otherwise be curtailed**. Interconnectors can help manage fluctuations in renewables output, by importing or exporting as needed. This can contribute to a more stable and reliable electricity grid if they are located in the right place. In practice, the current operation of interconnectors is proving challenging given limited price signals in the wholesale market, and complex cross-border balancing arrangements.

2.5 **Enabling countries to share excess capacity during peak demand periods**. This could be more cost-effective than building additional domestic infrastructure to meet occasional high demand.

2.6 **Enhancing grid resilience by providing backup options**. We have seen numerous examples where the system operator has used interconnectors, sometimes under emergency instruction, to alleviate incidents that would otherwise have led to major demand outages. Between July 2022 and March 2023 interconnectors played a significant role on six occasions responding to

Capacity Market Notices, price spikes driven by low wind, and NGESO's Demand Flexibility Service.[20]

2.7 **International collaboration towards strategic energy policy goals**. In future we expect OHAs to increasingly become part of a meshed North Sea grid, coordinating the connection of offshore wind farms and enabling cross border flows in tandem. This has already been highlighted as a priority approach for countries with limited coastlines. There will be significant strategic value in coordinated development internationally to reach offshore wind ambitions for 2050.

2.8 It should be noted that some of the above benefits relating to security of supply and flexibility are sometimes not realised in the operation of interconnectors under the current landscape. This is expected to be mitigated through the participation of OHAs and interconnectors in ancillary services, which is currently voluntary, as well as through either more centralised network planning and/or wholesale market reforms detailed below.

2.9 In addition to the benefits of interconnection as a whole, by combining interconnection with wind, offshore hybrid assets also offer further benefits:

- **More efficient use of the infrastructure.** In high wind yield areas, wind may blow approximately 50% of the time, meaning the infrastructure associated with radial offshore wind connections is only used half of the time. By combining offshore transmission with interconnection, when the wind is not blowing, the same assets can be used for cross border trade.
- **Smaller onshore footprint.** Offshore platforms connecting the wind infrastructure and the interconnection mean that the requirement to locate converter stations on land is halved compared to a separate radially connected windfarm and a standalone point-to-point interconnector.

Outcomes of our Interconnector Policy Review and our expectations for the OHA pilot scheme

2.10 In August 2020, Ofgem launched the ICPR to investigate its approach to further interconnection and to evaluate the effectiveness of the cap and floor regime. The

[20] For more information regarding data sources behind this, please see Elexon's BMRS portal for generation data including interconnector flows; NGESO's capacity market notices available at GB Electricity Capacity Market Notices - National Grid (nationalgrideso.com), and price data from Nord Pool available at: Nord Pool (nordpoolgroup.com).

decision, published in December 2021, signalled our intention to run a pilot scheme for OHAs alongside Window 3 for interconnectors.

2.11 The ICPR concluded that going forward, as GB is predicted to become a net exporter of renewable energy, further interconnection capacity could result in higher wholesale prices than would otherwise be the case. In such cases we would expect the allocation of welfare between consumers and producers to change, with further interconnection (including that from OHAs) potentially resulting in lower consumer welfare and higher producer welfare due to the export of electricity increasing GB wholesale prices. Nonetheless, it was identified that the total welfare impact of projects could remain positive, as modelled through a 2020 AFRY study that constituted part of the ICPR analysis.[21]

2.12 Therefore, the decision to open an OHA pilot scheme and Window 3 for point-to-point interconnectors was on the basis that future interconnection would likely remain in the consumer interest due to the role OHAs and interconnectors could play in delivering a decarbonised energy system, and it was decided to expand the needs case assessment to further explore these wider impacts of OHAs and interconnectors beyond welfare, such as carbon savings and system flexibility and operability.

Interaction with other market reforms

2.13 The ICPR took place alongside wider reviews of network planning and delivery in GB. In January 2021, Ofgem published the **review of GB energy system operation**.[22] This recommended to Government that the system operators are given additional responsibilities and that the system operator for electricity is made fully independent from the transmission network owner. Subsequently, a joint consultation with the Department for Energy Security and Net Zero (then the Department for Business, Energy & Industrial Strategy (**BEIS**)), [23] proposed the creation of an independent system operator, known as the **future System Operator** (now called the National Energy System Operator (NESO)). [24]

2.14 The introduction of the NESO will enable a more strategically planned transmission network by taking on an increasingly significant role in strategic

[21] Interconnector policy review: Working paper for Workstream 2 – socio-economic modelling | Ofgem
[22] Review of GB energy system operation | Ofgem
[23] Consultation on proposals for a Future System Operator role | Ofgem
[24] Previously denoted as the Future System Operator (or FSO), the new National Energy System Operator (NESO) will be the independent, public corporation responsible for planning Britain's electricity and gas networks and operating the electricity system

network planning and in facilitating competition. This includes responsibility for the new **Centralised Strategic Network Plan (CSNP)**[25]**.**

2.15 In the CSNP, the NESO will initially focus on the GB electricity transmission network – onshore, offshore and interconnectors, as well as gas transmission and the proposed hydrogen network. The NESO will also make recommendations on how the system should develop to decarbonise the electricity system by 2035, which is critical for meeting the UK's overall 2050 Net Zero target.

2.16 In addition to the change towards centralised network planning, plans were developed in 2022 to accelerate and coordinate the construction of specific network infrastructure projects that would become operational in the 2030s. These plans consist of the **Holistic Network Design (HND)**[26] for offshore developments, and the **Accelerated Strategic Transmission Investments (ASTI)**[27] programme onshore. **The Holistic Network Design Follow Up Exercise (HNDFUE)** is in development for additional offshore wind to be published in Spring 2024.[28]

2.17 Finally, the UK Government's **Review of Electricity Market Arrangements** (REMA)[29] aims to identify and implement reforms to GB electricity markets to unlock the necessary investment and drive efficient operation of a secure, low carbon, electricity system. As part of this, in April 2022 Ofgem began an assessment of the potential impacts of implementing locational pricing in GB.[30] In theory, locational pricing has the potential to significantly change the behaviour of operational interconnectors or OHAs and the needs case for future interconnectors and OHAs. The resulting analysis, published in October 2023, showed that alternative price differentials in a zonal GB market[31] would mean interconnectors could flow more efficiently and reduce constraints alongside the associated costs to balance the system. We have not considered the potential impacts of locational pricing in our assessment of projects as it remains uncertain whether locational pricing will be implemented, and if so, which design option

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[25] Centralised Strategic Network Plan: Consultation on framework for identifying and assessing transmission investment options | Ofgem
[26] The Pathway to 2030 Holistic Network Design | ESO (nationalgrideso.com)
[27] Decision on accelerating onshore electricity transmission investment | Ofgem
[28] Holistic Network Design Follow-Up Exercise | ESO (nationalgrideso.com)
[29] Review of electricity market arrangements | GOV.UK (www.gov.uk)
[30] Under locational pricing, wholesale prices reflect the locational value of energy at different points across the network. For more information, please see: Assessment of locational wholesale pricing for Great Britain | Ofgem
[31] Instead of having one wholesale electricity price, GB could be split into a few zones with their individual zonal prices.

might be taken forward and on what timeline. However, the work to date demonstrates that any change in wholesale market arrangements could have a material impact on interconnector flows and operation.

2.18 Early development of the above policies was concurrent with the ICPR and the launch of the OHA pilot scheme. The ICPR decision in December 2021 announced the long-term intention to target future windows with particular attention to desired location, timing, and capacity, whilst continuing to work with the relevant programmes to ensure that interconnector regulatory needs are considered as strategic network planning frameworks are developed. This is also relevant for OHAs.

2.19 As stated in the ICPR, the initial intention was to launch the OHA pilot scheme with locational targeting[32] pending analysis from NGESO. However, in our targeting document published in August 2022[33], Ofgem communicated that we would not restrict applications to the OHA pilot scheme or Window 3 based on location. We noted that a project's location and support from the relevant authorities of the connecting country/jurisdiction would be considered closely throughout the needs case assessment. The impact of an OHA or interconnector on network constraints is dependent not only on its location in GB, but also on supply and demand assumptions, expected flows, wholesale price dynamics, and the other interconnectors in the baseline. Given this variability, it was considered more appropriate to analyse and assess the system impacts of applicant OHAs or interconnectors knowing the full picture of specific projects, as opposed to using high-level analysis to exclude certain interconnectors from applying for the pilot scheme. Nonetheless, the NGESO targeting analysis provides important context which we encouraged developers to take into account for their submissions. NGESO's modelling analysis highlights that additional interconnection may have a significant impact on nationwide constraint costs, however this is highly dependent upon location and import/export status of the interconnector.

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[32] Locational targeting would mean we would invite interconnectors proposing to connect to specific locations to apply for the window and exclude other proposals. By launching a locationally-targeted window we would seek to ensure that our application window brings forward the right projects in the right locations, at the right time for consumers when thinking about the GB energy system.

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

3. Structure of the IPA

Section summary

The IPA consists of three components: the maturity and deliverability analysis, market modelling, and system impacts. Decision making is not weighted across these three components.

The Pilot NSIs are assessed based on their ability to become operational prior to the end 2032, to ensure they can contribute to the timely delivery of offshore wind infrastructure in GB and the North Sea. However, reflecting the novelty of the assets and the timing of the ongoing development of the regulatory regime, Ofgem recognised that aspects of the submissions in respect of the Pilot NSIs may have been at an earlier stage of development in comparison to point-to-point interconnectors.

We note that our modelling is limited in how it can capture the theoretical benefits unique to the Pilot NSIs outlined in the strategic case chapter, such as coordination of assets. The modelling for the Pilot NSIs compares only to a counterfactual of the energy island in the connecting country going ahead without the Line 1 cable to GB. As the assessed Pilot NSIs do not have connected offshore generation located in GB, this also means that the counterfactual does not compare Pilot NSI development with the development of radial wind connections in GB.

3.1 The IPA for the OHA pilot scheme is informed by analyses from Ofgem, NGESO, and Arup. Specifically, NGESO provide the system impacts analysis; and Arup provide market modelling analysis and a 'Red-Amber-Green' (RAG) rating for the hard to monetise impacts.[34] [35] These analyses are presented together in the multi-criteria assessment (MCA) framework report published by Arup alongside this consultation. Alongside this, we have assessed the maturity and deliverability of the projects. We also provide a final assessment of the hard to monetise impacts identified by Arup. The component parts of our assessment are presented in the table below and explored in more detail in this section.

[34] For more information on RAG ratings, please see page 31.
[35] Please note that the term 'hard to monetise costs' has been used elsewhere by Ofgem, such as within the Window 3 application guidance, but is otherwise known as 'hard to monetise impacts'.

The components of Ofgem's IPA

Multicriteria assessment (MCA) Framework Report

System impacts analysis

The indicators for this analysis are as follows. This is provided by NGESO.

1. Frequency stability
2. Frequency response savings
3. Voltage stability
4. Reactive response savings
5. Restoration (black start)
6. Constraint costs
7. RES integration (avoided RES curtailment/spillage)[36]

Electricity market modelling analysis[37]

The indicators for this analysis are as follows. This is provided by Arup.

1. RES integration (additional RES capacity)
2. CO2 reduction (SEW)
3. CO2 reduction (societal value)
4. Overall decarbonisation
5. Consumer SEW
6. Producer SEW
7. Interconnector SEW
8. Total SEW[38]
9. Security of supply; cost of expected energy not served

Hard to monetise impacts

Arup also provide an assessment of hard to monetise impacts within the MCA report. An additional assessment on HtM impacts is also provided in Ofgem's deliverability and maturity analysis below. The indicators for this analysis are as follows:

[36] This refers to the level of RES curtailment that would be avoided due to the addition of an interconnector or OHA, and was calculated by NGESO as they were deemed the most appropriate party to do so given that they are the monopoly owner of the full scale of data on the GB network.
[37] The market modelling, although conducted by Arup, is informed by select data submitted by developers. The figures for onshore costs included in a developer's CION and the indicative capex costs submitted by developers are inputs which inform the SEW outputs. More information on onshore costs is explained on page 45.
[38] Total SEW is composed of GB consumer, GB producer and GB interconnector SEW. 'Total SEW' and 'total welfare' are used interchangeably in this consultation.

1. Environmental
2. Local community
3. Noise/disturbance
4. Landscape
5. Other impacts

Ofgem deliverability and maturity analysis

The indicators for this analysis are as follows. This is provided by Ofgem.

1. Qualitative assessment of risks and dependencies
2. Hard to monetise impacts
3. Project plans
4. Plans for grid connection in connecting country
5. Plans for obtaining regulatory approval in the connecting country
6. Justification of connection location, cable route, capacity and technical design
7. System operability
8. Financing plans
9. Supply chain plans

Ofgem's decision making

3.2 It is important to note that the OHA pilot scheme and Window 3 for point-to-point interconnectors are two separate investment windows which offer separate regimes and have separate criteria. These two separate IPA processes are being run concurrently and the projects were assessed in the same market modelling and system impact modelling, as the projects are being built to the same timelines and will have tangible impacts on each other that need to be accounted for. Not doing so would have provided less rigorous results.

3.3 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 regard 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.

3.4 The market modelling analysis and system impact analysis are considered as distinct pieces of the IPA, which are presented together within the MCA provided by Arup. The MCA does not calculate an aggregate SEW for each project by collating these inputs due to the inherent differences in the analyses owed to the different modelling software used.

3.5 During the IPA, 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.

Changes between the OHA pilot scheme and previous windows for interconnectors

3.6 The Pilot NSIs were expected to provide similar submission material to Window 3 applicants, including on the obligation for developers to provide 'plans for grid connection in the connecting country' and 'plans for regulatory approval in the connecting country' as standalone criteria.[39]

3.7 Maturity to connect prior to the end of 2032 was considered important for the development of OHAs, as well as point-to-point interconnectors, to ensure they can contribute to the timely delivery of offshore wind infrastructure in and around GB. However, acknowledging the novelty of the assets and the potential slower speed of development of the regulatory regime, when assessing the OHA application material, Ofgem recognised that aspects of the Pilot NSI project submissions may have been less developed in parts than the submissions in respect of the Window 3 point-to-point interconnectors.

3.8 As part of the application guidance for the OHA pilot, Ofgem provides examples of material we would wish to see included in the submissions as evidence to give us sufficient confidence that the projects could be delivered by the end of 2032.[40]

System impacts

3.9 Window 3 and the OHA pilot scheme take a closer step towards aligning interconnector windows with strategic network planning. In our targeting analysis from August 2022, we decided not to exclude projects connecting to specific locations from applying for Window 3 and the OHA pilot scheme. However, we

[39] For more information on the changes for W3 compared to Window 2, please see the W3 IPA consultation. In addition, for more information on the criteria for the OHA pilot scheme, please see appendix 1 of the OHA regulatory framework guidance: Multiple Purpose Interconnectors Pilot Scheme | Ofgem

[40] Please see Appendix 1 for information on the submission material for the OHA pilot: Multiple Purpose Interconnectors Pilot Scheme | Ofgem

have sought to provide more transparency on NGESO's constraint costs (balancing market impacts) analysis for the OHA pilot scheme in comparison to previous interconnector windows.

Wider impacts quantification

3.10 In previous interconnector windows, the market modelling consisted primarily of the SEW. For Window 3 and the OHA pilot scheme the market modelling has been expanded to account for wider impacts. Indicators measuring carbon savings and reduction of unserved energy (USE) hours are new to this application window. It should be noted that the calculation of the headline SEW in previous windows includes the local constraint costs and costs of onshore works. Onshore costs have not been included in the OHA pilot scheme results; however, we are working with NGESO to source robust and up-to-date estimates for these inputs. This is expanded upon later in this section.

Modelling study submitted by applicants

3.11 In previous interconnector windows, Ofgem compared its own modelling study to studies submitted by developers. Developer submission of a modelling study was made optional in Window 3 and OHA pilot scheme. Developer-submitted modelling studies serve as complementary to Ofgem's own market modelling, however they are not used as a replacement. The purpose of the developer-submitted modelling studies was to enable Ofgem to consider different modelling approaches, assumptions and scenarios for use in Ofgem's modelling, at the stage of the modelling workshops and finalisation of the methodology. Beyond the finalisation of the methodology, the developer modelling studies are not used further in the assessment process of the IPA.

Deliverability and maturity analysis

3.12 This section of the IPA captures all qualitative data submitted to Ofgem that cannot be captured within the MCA framework,[41] and helps us to understand a project's maturity to deliver prior to the end of 2032.

3.13 It is important to note that the timelines and incentives framework for the Window 3, which may also be implemented for the Pilot NSIs subject to forthcoming policy work and consultation, means that if a project faces material

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[41] This is with the exception of the qualitative assessment of hard to monetise impacts which are included within Arup's MCA.

changes to their project's timelines, designs, or costs, they may face penalties, and Ofgem, in any event, reserves the right to undertake a review of an IPA decision. The maturity assessment helps Ofgem avoid as far as possible awarding a cap and floor regime in principle to a project that may face such material changes to its circumstances, by assessing with higher scrutiny the plans it has made prior to applying for a cap and floor regime.

3.14 In the 'Multi-Purpose Interconnectors Pilot Regulatory Framework' document,[42] we detailed the submission requirements, which included a project plan, financing strategy, assessment of risks and dependencies, assessment of hard to monetise impacts, supply chain plans, justification of the cable route, capacity and technical design, and written evidence of positive engagement with the connecting country Transmission System Operator (TSO), and National Regulatory Authority (NRA) and/or government, as appropriate, in the connecting country.

Scoring of projects

3.15 We apply a Red-Amber-Green (RAG) rating[43] to each submission material area that was requested in our Application Guidance for the OHA pilot scheme, based upon how well-prepared a developer is to become operational prior to the end of 2032.[44] This includes how strong a developer's understanding is of the milestones required in their project's development to reach final investment date and to commence construction; how well a developer is sighted of potential risks, with details of mitigations, and whether the views of decision-making parties such as the connecting country NRA and TSO on milestones, approach and timings are aligned with that of the developer. This helps Ofgem identify if there are significant obstacles to a project's development which could be likely to lead to delays to the connection date as proposed by the developer in their application that would threaten the project's capability to become operational by 2032.

3.16 Our RAG rating is defined as follows:

[42] Multi-purpose Interconnectors Pilot Regulatory Framework | Ofgem

[43] RAG ratings, also known as a 'traffic light ratings' are used to demonstrate performance. In general, green is used to denote 'good' performance, amber is used to demonstrate concern of moderate severity, and red indicates that there is significant cause for concern. Further detail of Ofgem's specific adoption of this can be found below.

[44] Please note that the submission material included a 'project overview'. This is not discussed in this consultation given that this was for informative purposes to provide the project background. Projects received a green in this area for providing the information, and a red would indicate the material was absent.

- **Green:** we do not have material concerns on this criterion based on the information received.
- **Amber:** we have concerns of moderate severity around the project's maturity, but our current view is that these concerns could be managed by the developer.
- **Red:** we have serious concerns about the project's maturity and ability to connect prior to the end of 2032, based upon the evidence submitted for this criterion, or material changes to the project that have occurred since submission of which the developer has notified us.

3.17 The maturity analysis is designed to assess a project's likelihood of connecting prior to the end of 2032, based on preparations and work that the developer had conducted at the point of submitting the OHA pilot application, alongside taking into account any material developments since this time (notified by the developer to Ofgem or noticed by Ofgem and later explained by the developer upon Ofgem's request).

3.18 We recognise that the following factors vary from project to project:

1. There is scope for projects to change and develop in the time between now and 2032.
2. The differing legislative frameworks and modes of engagement that NSIs are subject to depending on their chosen connecting country.

3.19 The IPA criteria are designed to take these factors into account and treat projects fairly and objectively. For example, as a measure of plans for regulatory approval in the connecting country, we consider the alignment between the understanding of the NRA, Government or TSO and the understanding of the developer, as opposed to prescribing the submission of standardised evidence of engagement, such as a letter of support. Additionally, maturity should not be viewed as being equal to time or money invested in a project to date – neither of which brings certainty of delivery within the required timeframe. Rather, maturity is evidenced by the developer's consideration of obstacles to project development and how the developer (and other relevant authorities) envisions these can be overcome.

Scoring of justification of location and technical design

3.20 The 'justification of connection location, capacity and design' section of the maturity analysis is derived both from a developer's application and the Connections and Infrastructure Options Note (CION) completed by NGESO and submitted as part of the developer's application. Ofgem considers that the CION for every project applying under the OHA pilot is likely to be outdated to some extent due to rapid changes to connections and system planning processes and the contracted background. This affects how we can use this information for our assessment. The CIONs for OHA pilot projects were concluded in 2017 and 2019 with a generation background that predates the large strategic investment programme of the Holistic Network Design (HND). With this in mind, we have assessed the developer's justification of its chosen technical designs and locations based on how thorough a developer has been in its engagement with NGESO in considering the optimal connection locations and designs to reduce costs and/or maximise benefit, and how well each developer has accounted for risk. Otherwise, we have discounted evidence derived from the CION which the developer would not have been able to obtain, and only assessed applications for this criterion in aspects that go as far as developers can control.

Scoring of hard-to monetise impacts

3.21 As part of the submission material for the OHA pilot scheme, developers were asked to submit details of the project's hard-to-monetise (HtM) impacts (also known as HtM 'costs'), covering environmental, landscape, noise and local community impacts. These are important to capture because they can provide a more holistic understanding of the potential impact of a project on the surrounding area in GB to which it proposes a connection. This also serves to make Ofgem aware of any risks to project construction and connection and how the developer is handling any such risks.

3.22 These hard to monetise indicators are included within the MCA we commissioned Arup to lead. Arup's Multi-Criteria Assessment (MCA) report considers these impacts by providing a RAG rating against each of them. We expand on the interpretation of these results in the individual project results sections. Arup only assessed the content of the project submissions. Ofgem have subsequently added to Arup's view accounting for material developments which have taken place after a project's submission, either notified to us by a developer, or that Ofgem has noticed and then requested a developer to comment on. The RAG ratings displayed in this document for this criterion is Ofgem's final scoring, accounting for Arup's view.

MCA framework and report

3.23 Following our ICPR decision, Ofgem procured advisors from Arup in 2022 to develop an updated methodology for our IPA. Arup provided suggestions on how to account for impacts of interconnectors from a whole-system perspective through a new multicriteria assessment (MCA) framework.[45] Their work draws upon best practice across other sectors.[46] It also identifies roles and responsibilities, identifying which organisation is best placed to undertake analysis or provide data, between Ofgem, Arup, NGESO, and applicants.

3.24 Ofgem took on board Arup's proposed methodology, alongside feedback from two developer workshops between May and June 2023, and the MCA framework has been used for the OHA pilot scheme. The MCA quantifies indicators that were deemed hard-to-monetise in previous point-to-point interconnector windows, and indicators are grouped in seven categories: socioeconomic welfare, onshore costs, system operability impacts, flexibility impacts, decarbonisation, security of supply and hard to monetise impacts (defined for the OHA pilot scheme as noise, environment and local community impacts).[47]

3.25 We procured Arup to lead the MCA framework exercise and conduct the market modelling analysis required for it. In addition, Ofgem requested NGESO to undertake a system impact analysis to obtain various indicators that would later be included in the MCA.

3.26 Ofgem, in collaboration with Arup and NGESO, held two workshops with developers in respect of the OHA pilot and Window 3 projects between May and June 2023 to consult developers on the methodology and key assumptions of the MCA and market modelling. Stakeholder feedback was duly considered by Ofgem alongside the views of Arup and NGESO in reaching a final position on the methodology and assumptions. A 'methodology note' explaining the final methodology was circulated among applicants in August 2023, and this has been published along with Arup's report.[48]

Ofgem's considerations on the MCA framework

3.27 The main purpose of the MCA framework is to facilitate Ofgem's interpretation of a project's results by bringing together information that is collected from different sources. Through the MCA framework, Arup have provided a RAG rating for each

[45] The MCA report produced by Arup can be found in the documents accompanying this consultation on Ofgem's website.
[46] Needs Case Assessment Framework Arup Report (ofgem.gov.uk)
[47] For detail of the indicators used and the party conducting the analysis, please see Table 1 on Page 13 of Ofgem's guidance: Cap and Floor Third Window and MPI Pilot Needs Case Framework | Ofgem.
[48] For further detail please refer to Arup's and NGESO's reports, which are published alongside this document.

indicator, wherein the rating reflects the number of scenarios where a project demonstrates a positive result against a particular indicator.[49]

3.28 The RAG ratings assist Ofgem's understanding of how projects perform across the range of indicators and selected scenarios. We note this approach is an update from our initial approach where we intended to rate indicators based on a high, base, low case categorisation of the selected FES scenarios. We introduced this change in response to developers' feedback that the FES scenarios were not specifically designed to represent different values of interconnector projects.[50]

3.29 We have chosen not to weight results from any particular scenario or indicator in a mechanistic manner. This is to ensure sufficient discretion in reaching a final decision on whether to award a cap and floor regime in principle with regard to the Application Guidance for the OHA pilot scheme and the Authority's principal objective of protecting the interests of existing and future consumers.

3.30 We have individually considered all indicators in the MCA in our decision-making as opposed to aggregating them into a single figure. The stated intention prior to the analysis was to bring the quantifiable indicators as calculated by Arup and NGESO together into an aggregate SEW figure. However, after undertaking the analysis, Ofgem reflected that bundling a range of indicators into a single figure could compromise the quality and integrity of the results. The results across Arup and NGESO's modelling differ slightly due to the inherent differences of the modelling software used. Further detail on this reasoning can be found in Arup's MCA report published alongside this document.

3.31 We also stated prior to our analysis that we intended to use the aggregate SEW figure to shortlist projects, but since the calculation of this was no longer possible, we decided not to use this measure to shortlist projects in our assessment. The existence of an aggregate SEW indicator, encompassing all monetisable indicators, was fundamental to the shortlisting approach and it may have been detrimental to exclude a project from the full MCA process based on one or just a few indicators.

3.32 We summarise the assumptions, methodologies and our high-level approach to interpret results of the analyses and indicators that encompass the MCA report in

[49] Please note that this excludes 'hard to monetise impacts' whereby the RAG ratings are not dependent on the scenarios.
[50] More information can be found in Arup's MCA report published alongside this report.

the following sections. Our interpretation of results for individual projects is covered in the following chapter.

Market modelling analysis

3.33 The purpose of the market modelling analysis is to calculate the impact of a new interconnector or OHA on the market in GB and its connecting country. It quantifies a range of socio-economic and environmental factors, including impacts on consumers, producers and interconnectors SEW; decarbonisation; and security of supply. These indicators form part of the MCA framework report.

3.34 To assess a project's performance under a wide range of outcomes, Arup have analysed the impacts of each project under a set of three scenarios, using two different modelling approaches as described below.

Modelling approaches

3.35 To assess project impacts under different levels of interconnection, and to understand the impacts which are attributable to a single Window 3 or OHA project under various market conditions, Arup undertook its assessment using the following approaches below. This is in line with the methodology used for previous interconnector windows and is broadly equivalent to the TOOT (Take One Out at a Time) and PINT (Put One In at a Time) methodologies used by ENTSO-E for European-level studies.

1. **First Additional (FA) approach:** this approach assesses the impact of each project against a baseline of interconnectors, including those currently operational, under construction or under development with regulatory approval. It assumes the assessed project is the only new project to connect to GB and no other project is built beyond the connection date of the assessed project. This therefore represents an estimate where the interconnector landscape is most optimistic from the perspective of the assessed project, meaning that results for the assessed interconnector are not impacted by, nor do they impact, other Window 3 or OHA pilot projects.
2. **Marginal Additional (MA) approach:** this approach assesses the impact of each project against the baseline of interconnectors, including those currently operational, under construction or under development with regulatory approval, as well as all the other Window 3 and OHA applicant projects. This represents an estimate where the interconnector landscape is the most pessimistic from the perspective of the assessed project as it assumes all other projects in the window are constructed.

Scenarios

3.36 To assess project impacts under different market conditions, we confirmed the approach of using FES 2022 as the modelling scenarios.[51] We deem it important that the underlying scenarios were based on publicly available information to ensure the transparency, auditability, and replicability of Arup's analysis, as well as ensuring analytical compatibility with NGESO's system impacts analysis and other comparable analyses used elsewhere.

3.37 The FES 2022 represent credible decarbonisation pathways for the future of energy between now and 2050. Each scenario, detailed below, considers how much energy we would need and where it would come from:

1. **Leading the Way (LW):** describes the fastest credible decarbonisation journey achieved through a combination of consumer-led and system-led solutions. This scenario includes high levels of cross-border capacity between GB and connected countries.
2. **Consumer Transformation (CT):** this pathway reaches net zero by 2050 driven by consumer-led solutions. It includes lower levels of cross-border capacity than LW.
3. **Falling Short (FS):** represents the slowest credible speed of decarbonisation and does not reach net zero by 2050. It includes relatively low levels of cross-border capacity.

Ofgem's considerations on market modelling results

3.38 We outline below our main considerations when interpreting the market modelling report:

3.39 While Arup have provided us with results for the three scenarios and two approaches outlined above, in reaching our decision, **we have opted to focus our attention on the MA results across all three scenarios**. We have chosen to follow this approach because we consider that the MA approach depicts a more probable view of the world than the FA approach. The FA approach assumes that only one additional cross-border project will be built in GB to 2050 while the MA approach assumes that all the candidate W3 interconnectors and OHA pilot projects will be built in GB by the same date. Whilst not all projects might be successful in this application window, considering the expected increase in

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[51] For more information on the FES scenarios, please see NGESO's report: Future Energy Scenarios | ESO (nationalgrideso.com)

electricity demand and the deployment of more RES capacity required to meet Net Zero, it is reasonable to assume that additional assets such as interconnectors or OHA projects will be built in response to the needs of an increasingly electrified system.

3.40 Arup's analysis is based on day ahead trading and does not account for the impacts of intraday trading. Although we said we were going to calculate the impacts of intraday trading in our modelling workshops, we have concluded that intraday trading would likely only result in marginal changes to the analysis compared to the practical burden of including this analysis. The reasons for this conclusion are further explored in Arup's market modelling report.

3.41 For completeness, Arup have assessed the impact of a project in both GB and the connecting country. Ofgem is aware of the projected impacts of the projects in connecting jurisdictions. However, for our decision making, Ofgem only considers the impact on GB, as a cap and floor regime is underpinned by GB consumers.

3.42 It should be noted that a positive result in the market modelling analysis does not overrule or outweigh the deliverability or system operability assessment. A project rated green in the market modelling may still not pass the IPA overall if there are serious concerns with its ability to deliver prior to the end of 2032 or with its impact on constraint costs.

System impacts

3.43 This section summarises the modelling approach undertaken by NGESO to produce the system impact analysis, and how this approach has been factored into Ofgem's decision making. The report is published alongside this consultation together with further details of the methodology, assumptions and results.

3.44 The purpose of the NGESO analysis is to calculate the impact of a new interconnector or OHA on GB's electricity system. It quantifies the following indicators, which feed into our MCA framework report:

3.45 **Constraint costs (balancing market impacts):** this quantifies the impact of a project on constraint costs for GB, managed by the NGESO through the Balancing Mechanism.

3.46 **System operability**: This assesses the potential savings that a project may provide to the grid through the provision of ancillary services. The services considered are:

1. **Frequency response** – the potential impact of the projects on system frequency.

2. **Reactive power** – the potential impact of the projects on system voltage.
3. **Restoration** – the potential impact of the projects on restoring power to the system in the unlikely event of a power outage.

3.47 **Avoided Renewable Energy Supply (RES) curtailment:** This is an assessment of the level of RES curtailment that would be avoided due to the addition of an interconnector or OHA.

3.48 As part of the submission material for the OHA pilot scheme, Ofgem required developers to detail any alignment with Grid Code 0137: Grid Forming Capability (GC0137). This aims to enhance the capability of conventional power electronic converter plant (e.g. wind farms, HVDC interconnectors and solar parks), so that the plant responds more like a traditional synchronous plant and is able to offer an additional grid stability service. The NGESO analysis was based on the assumption of projects conforming to GC0137 and participating in system operability services as applicants stated in their submissions.

Modelling methodology

3.49 To assess a project's performance under a wide range of outcomes, NGESO, in line with Arup's market modelling approach, analysed the impacts of each project under the same three scenarios and two modelling approaches. This means that NGESO assessed projects as follows:

1. To provide a theoretical upper and lower limit of constraint costs and system operability benefits, NGESO used both an FA and MA approach. We note that, in general, for constraint costs, the MA results represent the lowest possible estimation of a project's attributable costs, and the FA the highest. This occurs because, in the MA approach, the inclusion of all the other Window 3 and OHA pilot projects reduces the impact of any one project on constraint costs.
2. To assess impacts of projects under different market conditions, NGESO used LW, CT, FS scenarios from FES 2022, following the same approach as Arup for the interconnector baseline.
3. NGESO used the HND1/ NOA 2021/22 Refresh for assumptions of the optimal network. [52]

[52] The Holistic Network Design (HND) gives a recommended offshore and onshore design for a 2030 electricity network that facilitates the Government's ambition for 50GW of offshore wind by 2030. The Network Options Assessment (NOA) 2021/22 Refresh is an update to the NOA 2021/22, published in January 2022. This integrates the HND's offshore network and confirms the wider onshore network requirements.

3.50 This analysis models the years from 2027 to 2042, using 2013 as the base weather year. NGESO can only model as far as 2042 as this is the last year in FES22 that provides a detailed zonal supply-demand match. Without this, constraint cost analysis cannot be undertaken. This is an unavoidable practical constraint.

Ofgem's considerations on system impact analysis results

3.51 There are five aspects to the constraint cost (balancing market impacts) analysis that we have considered:

A. The network reinforcements already factored into the background network topography by NGESO to accommodate Window 3 projects as a result of project connection agreements;
B. The remaining costs that continue, despite these mitigations in A and signal a need for further reinforcement (this is NGESO's analysis);
C. The additional network reinforcements that would be required to mitigate these remaining constraint costs (the costs of which we expect in general terms to be less than NGESO's analysis in B);
D. The time it would take to complete the signalled reinforcements in C; and
E. The residual constraint costs that would still remain even after the signalled reinforcements in C have been completed.

3.52 NGESO has explained to Ofgem that system impacts from all applicant projects have been factored in when running the HND1/ NOA 2021/22 Refresh and previous network design exercises based on the information contained in their connection agreements. This suggests that the addition of the applicant projects to previous network design exercises would have already triggered some reinforcement works for the system. We note that any costs that may arise from these reinforcement activities would need to be covered by consumers. We are unable to quantify the costs of these specific works from the data provided by NGESO to date.

3.53 We note NGESO's clarification that the constraint costs presented in its analysis are a view of future constraint costs and are sensitive to the assumptions used. The estimated constraint costs calculated in NGESO's analysis across the system provide a signal for the need for further network reinforcements or non-network solutions. We are concerned by the high level of these costs, especially for projects connecting in southern areas of the country. We are additionally concerned that such high costs are still present in NGESO's analysis even though

Window 3 and OHA pilot projects are assumed to be in the assessed network background as stated above.

3.54 In subsequent network planning processes, NGESO will likely identify the optimal selection of additional network mitigations that would deliver economic benefit, whilst considering the impact on community, the environment and system operability. NGESO has also clarified through its report that the cost of reinforcing the network would be expected to be lower than the additional constraint costs shown in the report, but estimating the required reinforcement costs to mitigate the additional constraint costs attributable to the Window 3 and OHA projects is not possible at this stage, and each reinforcement is unique in terms of cost, network capability and timing.

3.55 Network reinforcements can take time, especially if they involve new onshore transmission lines and substations. The planning and consenting process may take many years to resolve and it is possible that new interconnectors or OHAs may be operational before the complete suite of onshore mitigating network reinforcements is completed.

3.56 We note that even after these reinforcement works are carried out, some remaining constraint costs would likely still be attributable to the assessed projects. We do not have estimates of these residual constraint costs, this data is not currently available for each project.

3.57 The MA approach is the basis of Ofgem's decision making as it presents a more probable picture of the interconnector landscape in comparison to the FA approach. This is in line with our considerations for the market modelling results.

3.58 Prior to undertaking our analysis, we indicated our intention to quantify the Window 3 project revenues from the provision of ancillary services.[53] However, after undertaking the analysis, Ofgem decided not to proceed with their quantification given the limited impacts those would have had on final results. Instead, we decided to factor them into our assessment in a qualitative manner. We note that the results provided by the NGESO for the system operability indicators are the potential savings that an interconnector or OHA may provide to the grid through the provision of ancillary services. This is not to the same as the revenues that projects could make out of the provision of those services. We

[53] These are services that an interconnector or OHA may provide to the grid to balance the system such as the provision of frequency response, restoration, or reactive power services.

have considered the results from NGESO's analysis on system operability as an indicator of the scale of ancillary services revenues.

Limitations of quantitative modelling

3.59 Following the conclusions of the ICPR, we endeavoured to incorporate as wide a range of interconnector impacts as possible to our quantified assessment of projects. Further, in the interests of transparency, we adjusted our approach and consulted developers on our key methodologies and assumptions prior to undertaking the different analyses that make up each part of the MCA framework. However, it is important to stress that any modelling exercise has limitations and necessarily makes simplifications through its various assumptions. When reaching our decision, we need to find the right balance between the information that is available to us and the uncertainty that surrounds this information. We outline below some key considerations for both the market modelling and the system impact analysis:

Modelling assumptions

3.60 Both analyses use FES 2022 which was the most up to date data possible at the time of undertaking the analysis from early 2023. It would not have been feasible to use FES 2023 data for this analysis, as the network reinforcement requirements would only have been available from early 2024, and thus NGESO would have been unable to determine the system impacts of new projects prior to the availability of this data. To ensure the alignment of analysis, both Arup and NGESO used FES 2022.

3.61 We note that during our modelling workshops, we indicated our intention to set the baseline for EU interconnectors by including all projects built and under construction and those with regulatory approval. However, during the modelling period, we instead decided to use the FES EU interconnector baseline. We followed this approach to align Arup's and NGESO's assumptions. We note that NGESO's FES scenarios are publicly consulted upon, and we have made available the underlying data for EU interconnector baseline.

3.62 We also note that both analyses use a different approach to weather years in their calculation. Arup uses three weather years (1990, 2007, 2010) to obtain an average of the results, whereas NGESO uses only on year (2013).

3.63 Using the FES 2022 and its EU market assumptions for our modelling is a choice that is analytically robust and transparent. However, we recognise that there are challenges owing to the practicalities of collecting data from different European sources and data on GB by NGESO. For example, to create the FES 2022, NGESO had to draw from ENTSO-E data conducted in 2020.

3.64 We sought to align assumptions as much as possible for both reports. However, given unavoidable differences such as the modelling tools used, the approach to modelling spot years after 2042 and the use of different weather years, Arup's and NGESO's results are not directly comparable. Therefore, we consider results from both reports as standalone indicators. It is important to note however, that the underlying trends in the results, such as flows and wholesale prices, from both modelling exercises broadly align. This gives us confidence that although both modelling results are not directly comparable, they are robust and internally consistent.

Security of supply impacts

3.65 Security of supply impacts are characterised in the analysis only by 1) the project's contribution to reducing unserved energy hours in GB, and 2) the project's contribution through providing ancillary services. The analysis does not account for other impacts that could come under the definition of security of supply.

Interactions between projects

3.66 Both modelling exercises use the FA and MA approach to understand a project's performance on its own or against all other projects. There is no guarantee that all projects will be accepted for a cap and floor regime, and removal of projects is likely to lead to differing results than those provided by the individual MA results for each project. To have an exact estimate of the combination of successful projects of our IPA, we would need to model all possible permutations of project, which is impractical. The range provided by the FA-MA results already encompasses these permutations so we could expect that any combination of successful Window 3 and OHA pilot projects would fall within that range.

Wider market reforms

3.67 As stated in Section 2, the analysis does not take into account the potential effects of locational pricing. This is due to the high uncertainty over the likelihood and timing of implementation of locational pricing, and indeed uncertainty over the nature of any locational pricing regime itself, which outweighed the practical burden of including this market reform in the analysis.

Use of confidential information

3.68 The analysis conducted by NGESO is derived from market sensitive data that cannot be publicly disclosed. However, NGESO have provided information to enable interpretation of their analysis and understanding of their conclusions and have provided higher transparency than in previous windows. Ofgem consider that NGESO possess the most appropriate expertise to model constraint costs and is best placed to conduct this analysis as GB's System Operator.

Onshore costs

3.69 Part of the calculation of costs for the market modelling and MCA are the costs of onshore grid reinforcement ('onshore costs') to accommodate a given project's connection point. The stated intention prior to our analysis was for Arup to extract these costs from the submitted CIONs for each project and provide a RAG rating in the MCA for onshore costs. While assessing project submissions, Ofgem concluded that the CIONs are all materially out of date, as they were conducted against a 2018 or earlier generation landscape which predates the HND. Therefore, in addition to the discounting of CION data from the 'justification of connection location' criterion in the maturity assessment, as referred to previously in this section, Ofgem have not included the onshore costs within the MCA framework, as including these figures would have impacted the quality of the assessment. Throughout the consultation period Ofgem will continue to engage with NGESO to source up-to-date onshore costs for each NSI Pilot project.

4. The IPA for the OHA pilot scheme

Section summary

On the basis of the analysis from the three distinct pieces of the IPA- the maturity and deliverability assessment, market modelling, and system impacts- **we are minded to grant an OHA regulatory regime in principle to LionLink**, connecting GB to the Netherlands. However, this approval is conditional. To grant the regulatory regime in principle to LionLink, pursuant to the IPA decision, Ofgem must 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.

Our market modelling indicates that the project would provide a total welfare benefit to GB, and the project has demonstrated that it is mature and likely to be operational prior to the end of 2032. We note the moderate constraint cost impact of the project.

We are minded not to offer an OHA regulatory regime in principle to Nautilus, based upon the high constraint cost impact of the project and the uncertainty regarding the project's total welfare benefit to GB owing to its configuration.

Further detail on our analysis for each of the projects and how we reached this position is covered in subsequent sections dedicated to each project.

Questions

Q1. Do you agree with our minded-to positions on the two projects considered in this consultation?

Q2. Is there any additional information that you think we should take into account when reaching our decision on the IPA of the projects?

Table 3: Summary of OHA pilot project performance across the IPA

	Maturity	**Total SEW for GB £bn** (real 2022 GBP, NPV 3.5% discount rate)	**Total European carbon savings** (EU + GB & Norway) **mtCO2**	**Balancing market impacts (constraint costs) £bn**	**System operability savings (frequency, voltage, restoration) £bn**
Nautilus	Configuration TBC	£0.4 to £1	4.9 to 10.7	£1.3 to £3.3	£0.21
LionLink		-£0.2 to £1.6	4.5 to 10.9	£0 to £1.2	£0.31

Numbers expressed in ranges for total SEW, carbon savings and constraint costs show the range of results between all scenarios for the MA approach. The system operability column takes an average of the benefits across all the ancillary services listed. Each indicator shows the total result for the project over a 25-year period.

4.1 Overall, the results for the Pilot NSIs match the high-level expectation stated in the ICPR that interconnectors operational from the 2030s onwards would be primarily exporting, and this feature has a range of associated impacts, all present in this analysis. As anticipated in the ICPR, both projects show a total welfare benefit to GB (as a sum of consumer, producer and interconnector welfare), although LionLink does have negative total welfare in one scenario only in the MA approach. The positive welfare impact of these projects is characterised primarily by producer welfare, as the main activity of the Pilot NSIs is to export excess GB wind energy. However, this also means that the Pilot NSIs contribute to a rise in GB wholesale prices, which leads to negative consumer welfare. Consumer welfare rises into the late 2030s and 2040s for both projects as they contribute to reducing unserved energy hours, allowing for imports to GB in times of system stress, and therefore enhancing security of supply. The welfare calculations account for indicative producer/consumer transfers such as CfD and cap and floor payments. Beyond CfDs there are no current regulatory mechanisms for sharing the strong benefit for producers from these projects with consumers.

4.2 Market modelling indicators outside of welfare- decarbonisation and security of supply- were positive among both projects and have been considered alongside SEW projections. Both Pilot NSIs contribute to overall carbon savings across Europe, however, the modelling demonstrates that they would increase emissions in GB specifically in all scenarios.

4.3 The system impacts analysis is less favourable, and shows high constraint costs, of up to £3.3bn. The constraint costs can overshadow the system operability benefits of the NSIs, such as the more modest benefit from NSIs providing ancillary services, or the savings from avoided wind curtailment. When assessed alongside the market modelling, this shows that the Pilot NSIs often are valuable to GB as a whole as exporting interconnectors for projected future excess wind energy. However, in doing so, they are projected to incur high constraint costs across various system boundaries and in the local areas to which they are connected, implying that they are not in the most suitable locations in GB to maximise overall value. We are concerned that such high constraint costs are present in NGESO’s analysis despite Window 3 and OHA pilot projects being assumed to be in the network background for this analysis, and that the analysis already includes works accounted for in the CION analysis and connection agreements of the projects.

4.4 The wholesale price impact and therefore consumer welfare impact should not be viewed in isolation. In the modelling, we expect the Pilot NSIs and new interconnectors to contribute to an incremental rise in wholesale prices. However, in the 2030s and 2040s, we expect wholesale prices to be lower overall for GB compared to today, owing to the decarbonisation of our energy system and the decreasing reliance on international gas markets. Additionally, in our modelling we can quantify the wholesale price impact of projects individually.

4.5 For the Pilot NSIs it was also found that two further issues have a significant impact on these projects' expected benefits to GB: the specific project configurations; and the OBZ[54] market arrangements.

4.6 For the project configurations, the capacity of the Line 2 cable (i.e. cable from the offshore converter station to the connecting country's electricity system) relative to the capacity of the connected offshore wind farm may limit the potential for the Pilot NSI (i.e. Line 1) to be used for cross-border trade in the export (GB to connecting country) direction. This may limit the congestion revenue that can be earned by the NSI from cross border trade. Ofgem expected that less capacity is available for cross border trade when the windfarms are generating, but it is less clear how both Line 1 and Line 2 cable sizes are being identified to maximise the operational efficiency of the total OHA.

4.7 The OBZ market arrangements anticipated for the projects also have an important impact. For OHAs that operate under OBZ market arrangements (which have been assumed in our analysis), the presence of the OBZ means that congestion revenue accrues asymmetrically on each side of the OBZ depending on the direction of flow. This arises because the OBZ will adopt the lower price of the two connecting onshore power markets and therefore either Line 1 or Line 2 will capture the international price differential at any one time. The market modelling assumes a 50:50 cost and revenue split between GB and the connecting country on the Pilot NSIs - meaning for 'Line 1' only. However, congestion revenue as a result of international trade also accrues on Line 2 and it is Ofgem's view that the costs and revenue sharing arrangements for the whole OHA should be considered as part of the regulatory alignment with the connecting country.

[54] See pages 26-29 Market Arrangements for Multi-Purpose Interconnectors | Ofgem for information about Offshore Bidding Zone market arrangements.

4.8 Under the existing proposals it would be possible for the Pilot NSIs to export to the connecting country and for all the congestion revenue to accrue predominantly on Line 2. Notwithstanding the wider SEW analysis, we do not believe this is an appropriate approach.

4.9 International discussions, between the relevant authorities, regarding appropriate cross-border sharing of costs and revenues/benefits, in respect of the whole OHA assets, are ongoing. At the time of publication of this document we do not believe that the current set-up is in the best interests of GB consumers and we look forward to working with our partners in the relevant states to achieve a fair and sustainable agreement before a final decision is made on these projects.

4.10 It is important to consider the evolution of Ofgem's expectations for the OHA pilot scheme, that were first outlined in the conclusions of the ICPR, when interpreting these results for the Pilot NSIs. Our decision to grant a regulatory regime is based on the expected benefit to GB of projects to justify the support from GB consumers. In addition, as the applicant OHA pilot projects are NSIs rather than MPIs, some of the expected benefits to GB that were noted in the conclusions of the ICPR are not present in the results for the Pilot NSIs. For example, as the Pilot NSIs will not be connected to offshore generation assets in GB waters, GB will not capture the benefit of coordination compared to the counterfactual of building radial wind farm connections and interconnectors.

4.11 The expected welfare benefits of Pilot NSIs to GB, in the modelling, are broadly similar to those deriving from point-to-point interconnectors. Ofgem is confident that although our modelling could assess the benefits derived from the coordination of offshore wind assets in GB, the Pilot NSIs remain beneficial to GB consumers and there is potential for the learnings from the development of the Pilot NSIs to inform the construction, operational, regulatory and commercial frameworks for future projects. We believe that development of this technology type is strategically important to GB consumers as we seek to exploit the rich wind resources especially in the North Sea.

4.12 As we already stated, we have chosen not to weight results from any particular scenario or indicator in a mechanistic manner. This is to ensure sufficient discretion in reaching a final decision on whether to award a regulatory regime in principle with regard to the Application Guidance for the OHA pilot scheme and GEMA's principal objective of protecting the interests of existing and future consumers.

4.13 In the sections below we summarise our reasoning for our minded-to position on each of the applicant projects. The detail of each project's evaluation is provided in the following sections dedicated to each specific project.

Our minded-to position on the IPA of LionLink

4.14 We are minded to offer an OHA regulatory regime to LionLink, as the project demonstrates a total welfare 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. As a Pilot NSI, LionLink will be strategically beneficial to GB in further developing the technology of OHAs and shaping regulatory arrangements for these new types of assets.

4.15 We remain concerned about the potential impact of OBZ arrangements in the Netherlands on the accrual of congestion revenue on Line 1 of the OHA. If the accrual 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 is difficult to forecast).

4.16 Therefore, to grant the regulatory regime in principle to LionLink, pursuant to the IPA decision, Ofgem must 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.

Our minded-to position on the IPA of Nautilus

4.17 We are minded not to offer an OHA regulatory regime to Nautilus, based upon the high constraint cost impact of the project, and uncertainty over the project configuration on the Belgian side which makes it difficult to assess the project's total welfare benefit to GB.

4.18 Nautilus' constraint costs are considerably high. The project demonstrates elsewhere in the analysis that consumers would incur significant costs, shown through negative consumer welfare in all scenarios of the market modelling,[55] and so we are particularly concerned about the additional costs to consumers that the constraint impact would suggest.

[55] The modelling demonstrates that Nautilus is projected to incur negative consumer SEW in all scenarios, except LW in the FA approach.

4.19 In addition, the capacity of the connection from the Belgian Energy Island to the Belgian shore remains unclear, as outlined in Elia's recent consultation.[56]

4.20 The lack of certainty as to whether the energy island will operate in "Single" or "Split" Node configuration means that it is difficult to assess how to model the capacity of the cables from the Belgian energy island to the Belgian shore, which has a substantial bearing on the economics of Nautilus. We have modelled 3.5GW in our analysis, however other capacities remain possible, and this would have an impact on the wider SEW calculations, interconnector revenues, and the NGESO analysis.

[56] Elia is the Belgian transmission System Operator. The recent consultation can be found at the following link: Public consultation Task Force Princess Elisabeth Zone (elia.be)

5. Lion Link

Maturity and deliverability assessment

Stage	Requirement	RAG rating
Eligibility to be considered for IPA	A GB connection agreement for connection prior to the end of 2032	
IPA	Project overview	
	Qualitative assessment of risks and dependencies	
	Hard to monetise impacts	
	Project plans	
	Plans for grid connection in connecting country	
	Plans for obtaining approval in connecting country	
	Justification of chosen connection location, capacity and design	
	System operability (GC0137)	
	Financing strategy	
	Supply chain plans	

Qualitative assessment of risks and dependencies

5.1 The developer provided a high-level overview of risks and mitigations across six key areas, with procurement constituting the most considerable risk. Ofgem deemed the submission as indicative of the effective monitoring and management of risks. However, the submission lacks an assessment of project-specific risks as opposed to those applicable to the wider interconnector landscape and the developer's other project in the OHA pilot. Given the novelty of NSIs and the developing political and regulatory landscape, a greater exploration of risks in this area would also have been beneficial.

Hard to monetise impacts

5.2 LionLink's submission demonstrated a high-level consideration of some of the project's HtM impacts, an example being the upheld consideration of environmental and community impacts through their assessment of connection locations. The submission in respective of LionLink would have benefitted from the inclusion of an assessment of wider impacts such as landscape, noise, and others. These impacts were scored red in Arup's RAG rating in the MCA, due to the minimal consideration of these impacts. In addition, more bespoke and project specific analysis would have been welcomed by Ofgem.

5.3 The overall RAG rating for the HtM indicator is assigned by Ofgem drawing upon Arup's RAG ratings for the individual HtM components alongside Ofgem's further considerations. Taking into account the above, Ofgem gives LionLink an amber rating overall for this criterion.

Project plans

5.4 The project plans submitted provide key milestones ranging from early-stage development to mid-2026, following which the plan for the construction phase is unclear. This, alongside the high-level nature of the plan contribute to the amber rating. Despite this, Ofgem deemed the plans provided to be reasonable given the novelty of OHAs and therefore the plans do not cause for concern for the project's deliverability.

Plans for grid connection in connecting country

5.5 LionLink's grid connection in the Netherlands is to TenneT's (the Netherlands' Transmission System Operator) 2GW Program in Dutch waters. The submission explains at a high level that there are two platform options to facilitate LionLink's connection ashore to the Dutch transmission network. Minimal detail was provided at this stage, but Ofgem was satisfied in the progress to date, alongside the advanced progress of the 2GW Program in line with the OHA pilot scheme timelines.

Plans for obtaining regulatory approval in the connecting country

5.6 At the time of application, LionLink presented positive engagement with the Netherlands authorities, with a cooperation agreement in place between NGIHL and TenneT, with a Joint Development Agreement (JDA) to follow. This demonstrated support for the project, yet the degree of regulatory alignment and the process for regulatory approval were ambiguous at the point of application. Nevertheless, the information provided, alongside the inclusion of LionLink in the Ten-Year Network Development Plan (TYNDP), was indicative of the project's regulatory support in the Netherlands.

5.7 We also note that LionLink was included in the regional Project Mutual Interest (PMI) list[57] and appears on the PMI list adopted on 28 November 2023 pursuant

[57] ACER_Opinion_10-2023 draft_regional_list_proposed_PCI_list_annex.pdf (europa.eu)

to the Commission's Delegated Regulation on the first Union list of projects of Common and Mutual Interest.[58]

5.8 Given the novelty of OHAs, early and ongoing engagement has been undertaken by Ofgem with the Netherlands' Authority for Consumers and Markets (ACM) to develop the regulatory framework and cost and revenue sharing arrangements. In order to grant the regulatory regime in principle to LionLink, pursuant to IPA decision, Ofgem must 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.

Justification of connection location, cable route, capacity and technical design

5.9 LionLink's submission material provided detailed evidence of their decision-making process and assessment of connection locations in GB to determine its proposed connection at Friston 400kV substation at the time of application submission. The information provided demonstrated a robust optioneering process and an attempt where possible to align with system needs.

System operability (GC0137)

5.10 LionLink's application confirms that the project will be designed with Grid Forming Capability, enabling National Grid Interconnectors Holdings Limited (NGIHL) to offer the associated stability service. The benefits of this are not captured in the application but rather in NGESO's analysis.

Financing strategy

5.11 Ofgem has assessed and is satisfied with the financing plan as detailed at this stage of the project development, by NGV in its submission in respect of Nautilus. The IPA submission states that it is anticipated that the Final Investment Decision (FID) will take place at the end of Q1 2026.

Supply chain plans

5.12 The developer submitted a strong supply chain plan that presents a robust consideration of suppliers, technology choices and risks. This is suggestive of a thorough understanding of the process, however additional project-specific information would have been beneficial.

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[58] The link to the Commission's delegated regulation establishing the *first Union list of projects of common interest and projects of mutual interest* EUR-Lex - C(2023)7930 - EN - EUR-Lex (europa.eu). The link to the *first Union list of projects of common interest and projects of mutual interest:* Annex on the first Union list of Projects of Common and Mutual Interest - European Commission (europa.eu)

Market Modelling

5.13 The LionLink project has been modelled as a 1.8GW non-standard interconnector between GB and the energy island in Netherlands' waters (i.e. Line 1). The energy island is assumed to be operated as an OBZ which is connected to a 2GW windfarm and to the Netherlands via a 2GW line (i.e. Line 2).

5.14 It is important to note that a 50:50 revenue split has been assumed on Line 1 from the GB shore to be Dutch energy island. More information on the modelling assumptions, methodology, and results can be found in Arup's Market Modelling report published alongside this document.

5.15 The following results refer to the MA approach only. This is because the MA approach is the basis of Ofgem's decision making as it presents the more realistic picture of the interconnector landscape.

Welfare

5.16 According to the modelling, under the MA approach, the total SEW impacts of LionLink in GB are expected to be positive in LW, approximately neutral in CT and marginally negative in FS.

5.17 The positive total SEW in LW is predominantly comprised of positive consumer SEW. This is because the project is anticipated to predominantly import from 2040 under this scenario, which drives down GB wholesale price in comparison to the counterfactual. In contrast, under CT and FS LionLink is anticipated to produce negative consumer SEW due to predominant export flows which raises GB wholesale prices.

5.18 Ofgem is not considerably concerned by the marginally negative or neutral total SEW projected under CT and FS in the MA as suggested by Arup's modelling. This is because the MA approach assumes the commissioning of all projects that are assessed under the IPA for Window 3 or the OHA pilot scheme, and therefore likely demonstrates the minimum potential value of a new project within each of the three market scenarios. In reality, it is anticipated that total SEW of LionLink would likely be higher than the MA values and that LionLink is anticipated to deliver total SEW benefits within the range provided by the MA and FA approaches.

Revenue expectations

5.19 LionLink (Line 1) is expected to earn considerably less revenue than the line from the Dutch offshore platform to the Dutch shore (Line 2). This is due to the anticipated predominant export flows from GB to the Netherlands and the narrow price differential between GB and the OBZ in the Netherlands. Alongside the IPA process, Ofgem has been engaging closely with the Netherlands authorities to further regulatory alignment and to seek to agree an appropriate cost and revenue sharing arrangement. These discussions are ongoing. The revenue expectations as depicted in this modelling may vary, in line with any alternative mutually agreed revenue sharing arrangements.

5.20 Due to the low anticipated income on LionLink for the MA approach, the total revenue earned by the project does not meet the floor throughout the modelled period in LW, even when capacity market revenues are considered. In FS, marginal floor payments are required in the early years, after which LionLink earns comfortably within the cap and floor range. For CT, LionLink is anticipated to earn revenue approximately equivalent to the floor in the early years, requiring very marginal top ups, after which revenue increases from 2041 and approaches near the cap in the latter years.

5.21 Ofgem is not considerably concerned about the projected floor payments in MA given that this represents a likely conservative estimate of the project's impacts, and given that LionLink was modelled based on a 50:50 revenue sharing arrangement with the Netherlands for Line 1 only. Discussions are ongoing on this matter.

Decarbonisation

5.22 The modelling suggests that LionLink leads to a net increase in CO2 emissions in GB across all scenarios, and a net decrease in the Netherlands and across Europe (including GB) in all scenarios. This increase in GB, which is netted off when considering the impact on Europe as a whole, is due to LionLink's expected predominant export flows which leads to higher wholesale prices in GB and the dispatch of more expensive gas-fuelled generation. A cross-border approach to decarbonisation is important for progressing global climate ambitions.

Security of supply

5.23 In LW from 2040 onwards, energy supply in GB fails to meet demand in periods of system stress. This leads to high wholesale prices to cover costs associated with the amount of USE hours observed. LionLink is expected to reduce these USE hours with associated savings of £223.6m compared to the counterfactual. In CT and FS, no USE hours are anticipated before or after the introduction of the project, therefore LionLink does not result in a positive nor negative impact in this regard.

Conclusion

5.24 Ofgem is satisfied with LionLink's results as suggested by the market modelling. The MA run represents a conservative estimate of the project's SEW benefits, and Ofgem recognises that LionLink's actual impacts may likely sit between the MA and FA results. As such, the results explored above provide Ofgem with sufficient confidence that LionLink is expected to provide positive total SEW for GB, alongside offering wider decarbonisation benefits for Europe.

5.25 Ofgem recognises that the modelling does not account for any changes that may arise from the ongoing discussions with Netherlands authorities regarding cost and revenue sharing arrangements.

5.26 The approval of LionLink is subject to the outcome of these discussions. For LionLink to receive the regulatory regime in principle, pursuant to the IPA decision, Ofgem must 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.

System impacts analysis

5.27 NGESO has undertaken analysis on the system operability and balancing market (constraint costs) impacts of LionLink. Further information can also be found in NGESO's report published alongside this document.

Constraint costs (balancing market impacts)

5.28 The connection of LionLink is anticipated to result in an increase in constraint costs, with a range between £0.04bn to £1.2bn, comparing the lowest (FS) and highest (LW) scenarios of the MA case. The marginally positive constraint costs of £0.04bn, are a result of the FS scenario which assumes that GB does not reach net zero. The CT and LW cases, both estimate constraint costs above £1.1bn for LionLink.

5.29 The analysis shows that in general, LionLink increases constraint costs on several midland and northern boundaries but relieves congestion on a range of other boundaries. However, this relief is not large enough to offset the total constraint costs projected over the 25 years of the project.

Frequency response

5.30 The modelling shows that LionLink could be expected to facilitate frequency response savings of approximately £170mn across the expected 25-year life of the project in the MA approach. There is minimal variation across the three scenarios, with CT representing the highest impact and LW the lowest. Ofgem recognises that the frequency response landscape will change considerably over the coming decades and therefore there is inherent uncertainty in quantifying the benefits of LionLink in providing frequency response services. However, reform of NGESO's ancillary service and balancing markets are designed to make markets more efficient, accessible and liquid which may potentially lead to even greater levels of participation of LionLink than that assumed in this analysis.

Reactive power

5.31 NGESO's analysis suggests that LionLink is anticipated to lead to reactive power savings of approximately £140mn in the MA approach across the 25 years. This figure is constant across all scenarios, and there is minimal to no variation across the MA approach, due to the little variation in reactive power benefit from an interconnector whether it is importing, exporting, or float.[59] Ofgem contends that this figure likely represents an upper estimate of the potential savings, given that the analysis assumes that all reactive power benefits that could be provided by LionLink is actually required, which may not be the case.

Restoration

5.32 According to the modelling, LionLink could be expected to facilitate savings for restoration services of between approximately £40mn and £50mn in the MA approach across the 25 years, with the potential savings being greatest under LW, followed by CT and FS. Ofgem note the uncertainty of this analysis owed to the difficulty in forecasting future cost assumptions and also due to the fundamental changes anticipated in the restoration services landscape over the coming decades.

Avoided RES curtailment

5.33 The NGESO analysis suggests that the addition of LionLink is estimated to result in between approximately 5TWh and 28TWh avoided RES curtailment for the expected 25-year life of the project under the MA approach. These savings are lowest in the FS scenario and highest in the CT scenario. This is because CT has high levels of renewable generation combined with low hydrogen production from electrolysis which leads to the highest levels of RES curtailment across the three scenarios, providing LionLink with the greatest opportunity to reduce this curtailment. Ofgem recognises the uncertainty around forecasting potential

[59] Float refers to the time at which an interconnector is neither importing nor exporting.

system operability benefits over a 25-year time horizon but is satisfied with the projected potential of LionLink to contribute to avoiding RES curtailment.

6. Nautilus

Maturity and deliverability assessment

Stage	Requirement	RAG rating
Eligibility to be considered for IPA	A GB connection agreement for connection prior to the end of 2032	
IPA	Project Overview	
	Qualitative assessment of risks and dependencies	
	Hard to monetise impacts	
	Project plans	
	Plans for grid connection in the connecting country	
	Plans for regulatory approval in the connecting country	
	Justification of connection location, route and technical design	
	System operability (GC0137)	
	Financing strategy	
	Supply chain plans	

Qualitative assessment of risks and dependencies

6.1 Nautilus' assessment of risks and dependencies provided a high-level overview of risks and mitigations across six key areas, including planning and consents, and procurement. The submission lacked sensitivity to project-specific risks and mitigations as opposed to those applicable to the wider interconnector landscape and the developer's other project in the OHA pilot scheme. A greater acknowledgement of project-specific risks would have been beneficial, particularly given the novelty of NSIs and the developing regulatory landscape. Nautilus was given an amber RAG rating for this criterion.

Hard to monetise impacts

6.2 Nautilus' application demonstrated a high-level understanding of some of the project's HtM impacts. This included the clear consideration of environmental and community impacts throughout their narrative regarding the assessment of connection locations. The submission would have benefitted from bespoke impacts, distinguishing Nautilus from the other NSI pilot applicant project submitted by the same developer, and addressing wider impacts such as landscape, noise, and others. These indicators were scored red in Arup's RAG rating in the MCA, due to the minimal consideration of these impacts.

6.3 The overall RAG rating for the HtM indicator is assigned by Ofgem drawing upon Arup's RAG ratings for the individual HtM components alongside Ofgem's further considerations. Taking into account the above, Ofgem gives Nautilus an amber rating overall for this criterion.

Project plans

6.4 Nautilus' submission provides high-level milestones prior to commercial operations at the start of 2030. This includes overarching cable procurement timelines and regulatory processes. However, the submission does not detail any indication of construction timelines. This would have been advantageous, though Ofgem appreciates the difficulties in predicting the construction schedule at the time of project application.

Plans for grid connection in the connecting country

6.5 Nautilus' grid connection in the connecting country is concerned with its connection to the MOG2 energy island located in Belgian waters, which is being developed by Elia (the Belgian system operator). The submission provided very high-level plans to obtain this grid connection, to which Ofgem would have welcomed additional information to further evidence and contextualise the developer's plan to gain this connection.

6.6 It is important to note that the configuration of the energy island, specifically the capacity of the line connecting the Belgian energy island to the Belgian shore, is yet to be determined. Ofgem and the developer of Nautilus were both made aware at a meeting with Elia and the Belgian Commission for Electricity and Gas Regulation (CREG) on 9 November 2023, that the capacity of the line is not likely to be decided upon until 2025. Further detail was subsequently published by Elia in a consultation on 20 November 2023.[60]

6.7 This uncertainty on the configuration of the energy island is of material concern to Nautilus' needs case. This is because any change to the cable capacity of Line 2 will impact the flows of the NSI, the overall SEW, interconnector revenues, and the NGESO analysis.

6.8 The uncertainty around the capacity of Line 2 and the material impacts on the needs case assessment, presents a considerable challenge to Ofgem's IPA. Ofgem

[60] Public consultation Task Force Princess Elisabeth Zone (elia.be)

cannot be confident of the project's projected impacts on GB consumers, and therefore we are minded-to reject Nautilus from being awarded a cap and floor regime in principle on this basis.

Plans for obtaining regulatory approval in the connecting country

6.9 Nautilus features in the TYNDP and the Belgium Federal Development Plan[61], which demonstrates support for the project in Belgium. We also note that Nautilus was included in the regional PMI list[62] and appears on the PMI list adopted on 28 November 2023 pursuant to the Commission's Delegated Regulation on the first Union list of projects of Common and Mutual Interest.[63]

6.10 Ofgem have continued to engage with Elia and the CREG, regarding Nautilus' pathway for regulatory approval. Given the novelty of OHAs, early and ongoing engagement has been undertaken with the relevant authorities to assess the cost and revenue sharing arrangements across the OHA asset. To grant the regulatory regime in principle to Nautilus, pursuant to the IPA decision, Ofgem must 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.

Justification of connection location, cable route, capacity and technical design

6.11 The developer of Nautilus provided detailed evidence of their decision-making process and assessment of connection locations in GB which demonstrated a robust optioneering process.

System operability (GC0137)

6.12 Nautilus' application confirms that the project will be designed with Grid Forming Capability, enabling NGIHL to offer the associated stability service. The benefits of this are not captured in the application but rather in NGESO's analysis.

Financing strategy

6.13 Ofgem has assessed and is satisfied with the financing plan as detailed at this stage of the project development, by NGV in its in submission in respect of Nautilus. The IPA submission states that it is anticipated that FID will take place at the end of Q1 2025.

Supply chain plans

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[61] Federal Development Plan of the Belgian transmission system 2024-2034
[62] ACER_Opinion_10-2023_draft_regional_list_proposed_PCI_list_annex.pdf (europa.eu)
[63] Delegated Regulation on the first Union list of Projects of Common and Mutual Interest (europa.eu)

6.14 Nautilus' application provided a clear breakdown of the procurement process alongside analysis of suppliers' availability and experience. This supports an appropriate consideration of supply chain pressures in the current market and consequent risk mitigations.

Market modelling

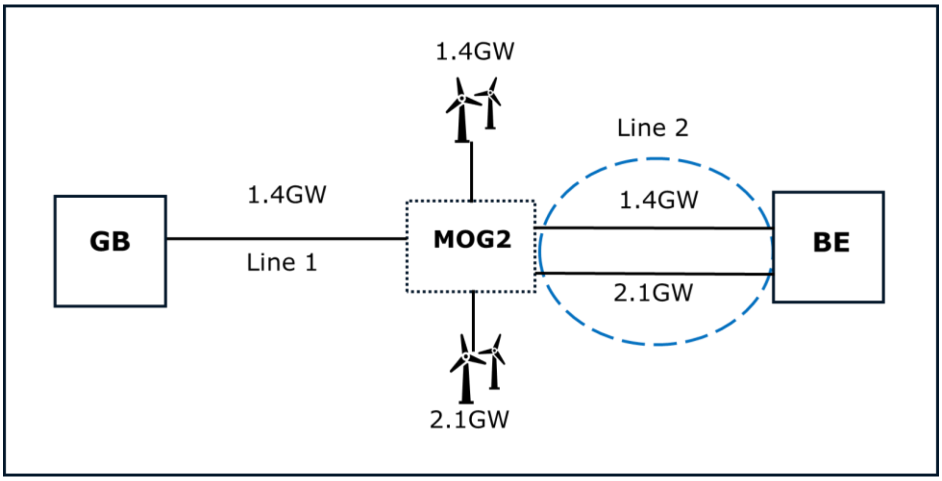
6.15 Nautilus has been modelled as a 1.4GW interconnector between GB and the Belgian energy island. As seen in Figure 4, the Nautilus interconnector constitutes Line 1 of the wider OHA. Two offshore wind farms of 1.4GW and 2.1GW generation capacity are modelled to connect to this energy island, all of which are assumed to operate under OBZ arrangements. The modelling then assumes that the energy island is connected to Belgium via a 3.5GW total connection. However, the configuration of the connection from the energy island to the Belgian shore is unclear at this stage. For the purpose of the IPA, Ofgem call this connection from the energy island to the Belgian shore 'Line 2', which constitutes both the 2.1GW and 1.4GW lines from MOG2 to the Belgian Shore.[64]

6.16 A 50:50 revenue split has been assumed on Nautilus for the purpose of the market modelling analysis undertaken by Arup.

6.17 The following results refer to the MA approach only. This is because the MA approach is the basis of Ofgem's decision making as we consider that it presents a more probable long-term picture of the interconnector landscape.

[64] This terminology is used by Ofgem to remain consistent with that used in relation to LionLink, and to NSIs in general. However, please note that this terminology differs in Arup's report wherein they differentiate between the two lines connecting MOG2 to the Belgian shore, calling them Line 2 and Line 3 specifically.

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



Welfare

6.18 Under the MA approach, the modelling suggests that Nautilus produces positive SEW impacts in GB across all scenarios. This is driven by strong producer SEW which offsets a decrease in consumer SEW, due to Nautilus being expected to increase the GB wholesale price as a result of its predominant export flows. In addition, interconnector welfare is anticipated to be marginally negative in LW and FS, and marginally positive in CT.

Revenue expectations

6.19 Nautilus is likely to earn most of its revenue through exports across all scenarios due to being primarily used to export from GB towards the OBZ and Belgium. Similarly, although outside of the scope of Nautilus, Line 2 is also expected to earn significant congestion income through transmitting electricity from the OBZ to Belgium.

6.20 Under the MA approach, Nautilus is anticipated to earn revenues above the floor in all scenarios, including above the cap for the whole duration of CT, in the early years of operation for LW, and in the later years for FS. Under the configuration modelled (3.5GW capacity from the energy island to the Belgian shore), Ofgem is satisfied that Nautilus would not be reliant on consumer support in the form of floor payments.

6.21 However, we remain concerned over the potential for significant asymmetry between Line 1 and Line 2 congestion revenue.

Decarbonisation

6.22 Nautilus leads to a net increase in CO2 emissions in GB in all scenarios, and a net decrease in Belgium. The reduction in emissions in Belgium do not fully offset the increase of CO2 in GB, leading to a net increase in emissions between the two countries. However, Nautilus contributes to a net decrease in emissions across Europe as a whole (including GB), of up 10.7Mt under CT.

6.23 Ofgem recognises that this increase in emissions in GB is a result of Nautilus' expected predominant export to Belgium which leads to the dispatch of more expensive thermal generation. Ofgem recognises that a cross-border approach to decarbonisation is important for the progression of global climate ambitions.

Security of supply

6.24 In LW from 2040, energy supply in GB fails to meet demand in periods of system stress. In this scenario, the introduction of Nautilus helps reduce the number of USE hours in GB compared to the counterfactual, resulting in a cost saving of £233.7mn.

6.25 Under CT and FS, no USE hours are observed before or after the introduction of the project, meaning that Nautilus does not have the opportunity to provide an impact on security of supply in GB in terms of USE hours.

6.26 Ofgem is satisfied that Nautilus offers security of supply benefits under LW with associated cost savings that offer benefit to GB consumers.

Conclusion

6.27 Nautilus' results provide Ofgem with sufficient confidence that Nautilus could be expected to provide positive SEW for GB, alongside offering wider decarbonisation benefits for Europe.

6.28 Ofgem recognises that this modelling does not account for ongoing discussions with the relevant authorities on the cost and revenue sharing arrangements for the wider OHA asset.

System Impacts analysis

6.29 NGESO has undertaken analysis on the system operability and balancing market (constraint costs) impacts of Nautilus. Further information can also be found in NGESO's report published alongside this document.

Constraint costs (balancing market impacts)

6.30 The connection of Nautilus is anticipated to result in an increase in constraint costs, with a range between £1.3bn to £3.3bn, comparing the lowest (FS) and highest (CT) scenarios of the MA case.

6.31 The analysis shows that in general, Nautilus increases constraint costs on several midland and southern boundaries but relieves congestion on other southern boundaries, but not to a large enough extent to negate the total constraint costs projected over the 25 years of the project.

6.32 As noted in the overview of NGESO's methodology, if a project were to be approved for a regulatory regime, grid reinforcement work would likely need to be undertaken by NGESO to alleviate the constraint impact of the interconnector on the system. We cannot be certain of the exact costs and timelines of grid reinforcement that are necessary to accommodate a specific interconnector at this time. Nautilus's constraint costs are considerably high in two out of three scenarios, with an upper boundary of £3.3bn in the MA approach. We can anticipate these substantial costs could trigger network reinforcements. NGESO and consumers would have to bear these costs until the works are complete, which is a timing yet undefined. To minimise the impact on the electricity system, we deem it appropriate to only consider projects for a cap and floor regime with low constraint costs or constraint savings, specifically considering the upper boundary of the range of costs which could be incurred. Based on the information we have available, Nautilus's constraint cost projections currently pose a significant risk for consumers.

Frequency response

6.33 The modelling suggests that Nautilus could be expected to facilitate response savings of between approximately £95mn-£100mn in the MA approach. The results across the scenarios are relatively consistent, with LW representing the lowest projected savings, and CT the highest. Ofgem recognises that the frequency response landscape will change considerably over the coming decades and therefore there is inherent uncertainty in quantifying the benefits of Nautilus in providing frequency response services. However, reform of NGESO's ancillary service and balancing markets are designed to make markets more efficient, accessible and liquid which may potentially lead to even greater levels of participation of Nautilus than that assumed in this analysis.

Reactive power

6.34 The NGESO analysis demonstrates that the addition of Nautilus is anticipated to lead to reactive power savings of approximately £110mn in the MA approach. This figure is constant across all scenarios, and there is minimal to no variation across the MA approach, due to the little variation in reactive power benefit from an interconnector whether it is importing, exporting, or float. Ofgem contends that this figure likely represents an upper estimate of the potential savings, given that the analysis assumes that all reactive power benefits that could be provided by Nautilus is actually required, which may not be the case.

Restoration

6.35 According to the NGESO analysis, Nautilus could be expected to facilitate savings for restoration services of between approximately £40mn and £50mn in the MA approach, with the potential savings being greatest under LW, followed by CT and FS. Ofgem notes the uncertainty of this analysis owed to the difficulty in forecasting future cost assumptions and also due to the fundamental changes anticipated in the restoration services landscape over the coming decades.

Avoided RES curtailment

6.36 The modelling suggests that the addition of Nautilus is estimated to result in 2TWh to 5TWh avoided RES curtailment for the expected 25-year life of the project under the MA approach. There is minimal variation across the scenarios, with the highest RES curtailment avoided being seen in the CT scenario. This is because CT has high levels of renewable generation combined with low hydrogen production from electrolysis which leads to the highest levels of RES curtailment across the three scenarios and provides the greatest opportunity for Nautilus to reduce this curtailment.

7. IPA conditions

7.1 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 cap and floor regime in principle.

7.2 Our minded-to position to award LionLink a cap and floor regime in principle is contingent upon the following 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 be 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, 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 cap and floor regime.
6. The developer must confirm the timing of FPA submission in writing to Ofgem at least two months before the expected submission date.

8. Next steps

8.1 It is important to note this is a minded-to consultation, and we remain open to feedback from any interested stakeholders and any relevant additional evidence from applicants before communicating our final decision on any of the applicant projects. We also remain open to additional evidence from applicant projects.

8.2 When the consultation closes, we will review responses and publish a final decision in summer 2024 to either:

(a) confirm our minded-to position as set out in this consultation; or

(b) appropriately amend our position if the amendments are justified as a result of the consultation process.

8.3 Developers which pass the IPA will then 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.

8.4 We cannot comment on the opening of a future OHA window at this time.

Appendix 1 - Glossary

A

AC

Alternating Current.

ACM

Authority for Consumers and Markets. The national regulatory authority in the Netherlands

Ancillary services

Contracted services (such as frequency response and black start) available to the System Operator in order to maintain balance and to ensure the security and quality of electricity supply across the system.

ARUP

Ove Arup and Partners.

ASTI

Accelerated Strategic Transmission Investment.

Avoided RES Curtailment

Avoided Renewable Energy Supply Curtailment. Curtailment refers to the reduction of power reduction when there is too much electricity in the grid or when there is not enough power in the grid. Curtailments aims at lessening the stress on the grid.

B

BEIS

Department of Business, Energy and Industrial Strategy. The former name for the HM Government department which as of February 2023 is now the Department for Energy Security and Net Zero.

Bidding zone

An area in Europe (i.e. within EU and EEA) in which a single wholesale electricity market price applies.

Black Start

An alternative name for 'Restoration', see below.

C

Capacity Market Notices

A signal four hours in advance that there may be less generation available than National Grid, acting as System Operator, expects to need to meet national electricity demand on the transmission system.

Cap and floor regime

The regulated route for interconnector development in GB. It sets a minimum and maximum return that interconnector developers can earn over 25 years.

CBA

Cost-benefit analysis. An evaluation of project costs against the monetisable benefits that such a project could provide.

CFD

The Contracts for Difference scheme - the Government's main mechanism for supporting new low-carbon electricity generation projects in GB. Generators compete in auctions to receive CfD support, and if granted a CfD, the prices received by generators are fixed at the 'strike price' over a number of years. When the market price falls below the strike price, a project is compensated, and when the market price sits above, the generator pays the excess back.

CION

Connections Infrastructure Options Note.

CM

Capacity Market. The CM ensures security of electricity supply by providing a payment for reliable sources of electricity alongside their electricity revenues, to ensure they deliver energy when needed.

Constraint costs

A constraint occurs when the capacity of transmission assets is exceeded so that not all of the required generation can be transmitted to other parts of the network, or an area of demand cannot be supplied with all of the required generation. The associated cost are the actions to re-dispatch generators to correct these system issues. Also known as balancing market impacts.

Consumer Welfare

Is the economic wellbeing (welfare) of consumers as measured by Cost Benefit Analysis.

Cost assessment

A process which enables Ofgem to determine the efficient levels of project capital expenditure.

CREG

Belgian Commission for Electricity and Gas Regulation.

CSNP

Centralised Strategic Network Plan. This is a concept being developed by Ofgem, for implementation by the Future System Operator, to create a new transmission network planning output to inform future network investment.

CT

Consumer Transformation. One of the four FES22 scenarios.

CUSC

Connection and Use of System Code. The CUSC is the contractual framework for connecting to and using the National Electricity Transmission System

D

Demand Flexibility Service

The Demand Flexibility Service allows consumers to earn rewards for shifting electricity usage outside of peak demand hours. This allows the ESO to manage supply through periods when margins are tight.

DSR

Demand Side Response. DSR involves businesses increasing, decreasing, or shifting their electricity use – in response to a signal – to help balance GB's electricity system. In return they receive strong financial incentives, lower their bills, and reduce their carbon footprint.

E

Elia

Belgium System Operator.

ENTSO-E

European Network of Transmission System Operators for Electricity.

EU

European Union.

F

FA

First Additional approach. This approach is used by Arup to analyse the value of each interconnector individually, assuming that it is the sole new project to be constructed. It does not consider the addition of any other interconnector project in GB aside from the applicant. The FA approach allows Arup to explore the value of a project without outside influence.

FS

Falling Short. One of the four FES22 scenarios. Known as Steady Progression in previous iterations of the FES.

FES22

Future Energy Scenarios 2022 developed by NGESO.

FPA

Final Project Assessment. The stage at which Ofgem examines detailed cost information for projects that applies for a cap and floor regime and has been recommended at the initial project assessment stage.

Frequency Response

Frequency Response is a continuously provided service used by NGESO to manage the normal second-by-second changes in frequency on the national transmission system. This is conducted by turning generation up and down to avoid imbalances in frequency, and comes with associated costs reflected in the network charge on consumer bills.

FSO

Future System Operator. Now known as the National Energy System Operator (NESO)

G

GB

Great Britain.

GDPR

General Data Protection Regulation.

GEMA

Gas and Electricity Markets Authority.

Grid Forming Capability

Introduced in grid code 0137. Aims to enhance the capability of conventional power electronic converter plant (e.g. wind farms, HVDC interconnectors and solar parks), so that the plant responds more like a traditional synchronous plant and is able to offer an additional grid stability service.

GW

Gigawatt.

H

HND

Holistic Network Design. A network planning output developed by NGESO in 2022 that creates a single integrated plan to connect 23GW of select offshore wind projects to the GB shore.

HVDC

High Voltage Direct Current.

I

IC

Interconnector. Physical links which allow for the transfer of electricity across international borders.

ICPR

Ofgem's Interconnector Policy Review.

IPA

Initial Project Assessment. The initial project assessment is Ofgem's first assessment for an interconnector applying to a cap and floor investment window, where we assess whether there is a needs case for the project based on projected costs and benefits.

Interconnector Welfare

The economic benefit (welfare) derived by interconnector owners as measured by Cost Benefit Analysis.

J

JDA

Joint Development Agreement.

L

LionLink

A proposed NSI pilot project with a 1.8GW connection from GB to an offshore converter station on the Dutch offshore transmission platform.

Locational Pricing

Locational pricing is a market design where wholesale prices reflect the locational value of energy at different points across the network.

LW

Leading the Way. One of the three FES22 scenarios.

M

MA

Marginal Additional approach. This approach is used by Arup and NGESO in their modelling to assess the impacts of a specific project against the base level of interconnection within FES 2022 as well as the other OHA and Window 3 applicant projects.

MCA

Multi-Criteria Assessment. In the context of this consultation this refers to a specific methodology conducted by Arup for the presentation of results in the cost-benefit analysis.

N

Nautilus

A proposed NSI pilot project with a 1.4GW connection from GB to an offshore converter station on the modular Offshore Grid 2 (MOG2) Belgian energy island.

NESO

National Energy System Operator

NETS

National Electricity Transmission System.

NGESO

National Grid Electricity System Operator. NGESO and ESO are used interchangeably in this consultation.

NGET

National Grid Electricity Transmission. NGET owns and maintains the onshore high-voltage electricity transmission system in England and Wales.

NGIHL

National Grid Interconnector Holdings Limited.

NOA

Network Options Assessment. A network planning exercise conducted by NGESO which provides a recommendation for which network reinforcement projects should receive investment and when. A separate report is created to assess interconnectors, the NOA for ICs.

NRA

National Regulatory Authority.

NSI

Non-Standard Interconnector. 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.

O

OBZ

Offshore Bidding Zone. A bidding zone is the largest geographical area within which market participants are able to exchange energy without capacity allocation.

OHA

Offshore Hybrid Assets. Offshore electricity infrastructure with dual functionality, combining transport of offshore wind energy to shore and interconnectors. In GB, there are two asset types which fall under the concept of an OHA: a multi-purpose interconnector (MPI), forming a whole OHA, and a non-standard interconnector (NSI), forming part of an OHA.

Ofgem

Office of Gas and Electricity Markets. Ofgem supports and acts on behalf of the Gas and Electricity Markets Authority (GEMA).

P

PCI

Projects of Common Interest. This is a key infrastructure project aimed at completing the European internal energy market and allowing the EU to achieve its energy and climate objectives. Unlike an PMI, this is an intra-EU project. PCIs are included in the Union list, established pursuant to the TEN-E Regulation 2022, and can benefit from accelerated permitting and consenting procedures as well as from the regulatory support at the national level.

PMI

Projects of Mutual Interest. This is a key cross-border energy infrastructure project between the EU and non-EU state, which contributes to the energy and climate policy objectives of the Union. This is a new category of projects that can be supported following the revision of the TEN-E Regulation 2022. PMIs will be included in the Union list, established pursuant to the TEN-E Regulation 2022, and will be able to benefit from accelerated permitting and consenting procedures as well as from the regulatory support at the national level.

Producers

Term used for electricity generators in the context of the Cost Benefit Analysis.

Producer Welfare

Is the economic wellbeing (welfare) of producers as measured by Cost Benefit Analysis. Also known as consumer surplus.

R

Reactive Power

The ancillary service used by NGESO to manage voltage levels locally and ensure the voltage profile of the transmission system stay within statutory limits. This is achieved by instructing generators to either absorb reactive power (decrease their voltage) or generate reactive power (increase voltage).

RAG

Red-Amber-Green.

Restoration

The procedure to recover from a total or partial shutdown of the GB transmission system. This entails isolated power stations being started individually and gradually being reconnected to each other in order to form an interconnected system again.

REMA

Review of Electricity Market Arrangements. A consultation conducted by DESNZ to explore a variety of proposals for wholesale market reform to enable a decarbonised, cost-effective and secure electricity system. Examples of options under the review include locational pricing, alternatives to marginal pricing, and splitting the wholesale market.

RES

Renewable Energy Sources

S

SEW

Socio-Economic Welfare. Also referred to as Consumer Welfare.

SO

System Operator. The entity charged with operating the GB high voltage electricity transmission system, currently NGET.

T

TCSNP

Transitional Centralised Network Plan.

TenneT

Netherlands' Transmission System Owner.

TO

Transmission Owner. An owner of a high-voltage transmission network or asset.

TSO

Transmission System Operator. Entity in charge of operating transmission assets, either for electricity or gas. In this consultation this term has been used to describe non-GB system operators.

TWh

Terawatt-Hour.

TYNDP

Belgium Federal Development Plan.

U

Unserved Energy Hours

A measure of the amount of time electricity demand exceeds supply.

V

VSC

Voltage Source Converters.