ARUP

Ofgem

Multi-Criteria Assessment framework report for Cap and Floor W3 and Offshore Hybrid assets Pilot Projects

MCA report

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Executive Summary

Background

In July 2022, Ofgem published a new Multicriteria Assessment (MCA) framework to assess the impacts of new interconnector (IC) and multiple-purpose interconnector (MPI)[1] projects applying for regulatory approval under the Cap and Floor (C&F) regime.[2]

Electricity ICs are physical links which allow electricity to flow across borders. This can enable more efficient use of generation assets, bringing significant benefits to electricity systems. Offshore Hybrid Assets (OHAs) are a novel type of transmission infrastructure that combines cross-border trade of electricity and the transmission to shore of electricity produced by generation assets connecting along its route.

In Great Britain (GB), ICs are regulated under the C&F regime. This regulatory framework was developed by Ofgem in 2014 to support investment in this type of infrastructure. In 2022, Ofgem launched a new application window for new IC (Window 3, or W3) as well as a new pilot regulatory framework for OHAs, largely based on the C&F regime.

The C&F regime is intended to ensure that ICs are financially safeguarded by setting a minimum agreed floor level for revenue. If the earned revenue falls below the floor, there will be a transfer of funds from consumers to IC owners. Conversely, if IC owners earn revenue above the agreed cap, the excess amount is transferred back to consumers through network tariffs.

Ofgem assess the impacts of each new candidate project to determine whether or not to award a C&F in principle at the Initial Project Assessment (IPA) stage of the regime. The assessment is made across a range of modelled socio-economic and environmental factors captured by the MCA. The MCA framework consists of seven categories measuring impacts on Socio-Economic Welfare (SEW), Network Costs, System Operability (SO), Flexibility (i.e., impacts under the Balancing Market mechanism), Decarbonisation, Security of Supply (SoS), and hard-to-monetise impacts.

Ofgem has commissioned Arup to provide the market modelling analysis required to calculate the impacts described by the SEW, Decarbonisation and SoS impact categories. Arup was also required to provide a qualitative review of the hard-to-monetise impacts identified by the developers. National Grid Energy System Operator (NGESO) was required to provide the analysis required to describe the SO and Flexibility impacts.

The W3 assessment considers more candidates and a more complex set of design and arrangements than in the previous ones. Ofgem progressed seven projects to the IPA stage W3. These projects are listed below.

Table 1 - W3 IC candidate projects applying to a C&F regime

Project Name	Developer	Type of Asset	Capacity (MW)	Connecting country	Operation date
Aquind	AQUIND	IC	2,000	France	2027
Aminth	Copenhagen Infrastructure Partner (CIP)	IC	1,400	Denmark	2031

[1] Since the publication of MCA framework, the terminology to describe MPI projects has changed to Offshore Hybrid Assets (OHA). The new terminology will be used throughout this document.

[2] For more details, please visit: https://www.ofgem.gov.uk/publications/cap-and-floor-third-application-window-and-mpi-pilot-regulatory-framework-guidance-our-needs-case-assessment-framework

Project Name	Developer	Type of Asset	Capacity (MW)	Connecting country	Operation date
Cronos	CIP	IC	1,400	Belgium	2029
Tarchon	CIP	IC	1,400	Germany	2030
NU-Link	Consortium	IC	1,200	Netherlands	2031
MaresConnect	MaresConnect Limited (MCL)	IC	750	I-SEM	2030
LirIC	Transmission Investment (TINV)	IC	700	I-SEM[3]	2030

In addition, two OHAs projects were considered eligible to apply for a dedicated OHA pilot regulatory scheme. These projects are listed below.

Table 2 - OHA projects applying to Ofgem's pilot regulatory scheme

Project Name	Developer	Type of Asset	Capacity (MW)	Connecting country	Operation date
LionLink	National Grid Venture (NGV)	OHA	1,800	Netherlands	2030
Nautilus	NGV	OHA	1,400	Belgium	2030

Summary of the analysis underpinning the MCA framework results

In order to measure the impact of each project, Arup and NGESO have compared impacts on a Net Present Value (NPV) basis in a scenario without the assessed project (the counterfactual) and with the assessed project (the target case). All other factors in the analysis have been kept constant. The approach is consistent with HMT Greenbook accounting.

A key driver in IC and OHAs value is the existence and future development of other cross-border infrastructure in GB. To take account of this effect, Arup have assessed the eligible IC and OHA projects using two different approaches: 'first additional' (FA) and 'marginal additional' (MA) approaches.

Under the FA approach, each project is assessed assuming it is the sole new project to be constructed. This approach allows to explore the highest potential value of a new project. Under the MA approach, each project is assessed assuming that all candidate projects were built according to the connection date submitted in the W3 of the C&F regime and the OHA pilot programme.

In order to measure the impacts that new ICs and OHAs can have under different market circumstances, Arup conducted the analysis using three different scenarios taken from the Future Energy Scenarios (FES) 2022 developed by NGESO: Leading the Way (LW), Consumer Transformation (CT), and Falling Short (FS).

This document brings together the results of the analysis conducted by Arup and NGESO to inform the indicators of the MCA framework.

[3] Since 2018, the Integrated Single Energy Market (I-SEM) is the wholesale electricity market for Ireland and Northern Ireland. It brings together these two markets into an all-island arrangement.

It is meant to be used as an overarching document combining the metrics for each W3 IC and OHA project under the MCA framework using a Red-Amber-Green (RAG) rating system. This document should be read alongside the Arup and NGESO reports, which give a more detailed description of the analytical approach and methodology used to derive the indicators of the MCA framework.

1. Introduction

1.1 Interconnectors and Offshore Hybrid Assets

A traditional point-to-point (P2P) IC is an electricity cable that physically connects by sea or land the networks of two different countries, allowing for the trade of electricity across their markets. ICs can help to balance the demand and supply of electricity, providing additional flexibility to better manage the intermittency of renewable energy generation. This in turn may also help the efficient integration of renewables by providing them with more market routes and hopefully reducing the amount of curtailed wind.

Additionally, they can improve overall security of supply by connecting a country to a wider pool of generation, improving energy supply, diversity and resilience. Allowing for trading across different markets, they can also help lowering consumers' energy bills or increase generator revenues.

An OHAs is a novel asset type that connects the electricity networks of two countries as well as generation assets along its route. Hence, an OHA combines cross-border electricity trade with other activities such as the transmission of electricity generated, for example, by an offshore wind farm (OWF).

OHAs can provide other benefits in addition to those of traditional ICs. By allowing the same cable to be used for cross-border trade and offshore transmission, these assets can reduce the impact on coastal communities, the marine environment, as well as the overall infrastructure costs required to deliver the same output.

ICs have long been considered a facilitator of the energy transitions and, alongside OHAs, they can greatly contribute to the UK Government's Net Zero targets.

1.2 The Cap and Floor regime

The C&F regime is the regulatory framework developed in 2014 by Ofgem, the GB energy regulator, to incentivise investment in ICs. Under the regime, ICs are subject to a revenue cap whilst benefitting from guaranteed revenues at the floor. If revenues exceed the cap, payments are made by the IC owner to electricity consumers in GB. If revenues fall below the floor, payments are made by GB consumers to the IC owner.

Considering the potential liability onto consumers under the regime to top up revenues if required, Ofgem conducts a cost-benefit analysis (CBA) to assess the economic needs case of new eligible projects. The results of the CBA inform the IPA decision of which projects to grant a C&F regime in principle.

Since the launch of the C&F regime through the pilot project Nemo Link in 2011, Ofgem opened two application windows in 2014 (W1) and 2016 (W2), assessing and awarding a C&F regime to nine IC projects with a total capacity of 8.35 GW, bringing the total GB IC capacity to 14.35 GW once completed.[4] These projects are listed in Table 3 below.

Table 3 - IC projects approved under the C&F regime

Project name	Connecting country	Nominal capacity (MW)	Regulatory regime	Delivery date
Nemo Link	Belgium	1000	C&F Pilot	2019
IFA2	France	1000	C&F W1	2021
NSL	Norway	1400	C&F W1	2021

[4] These figures do not include NorthConnect, for which regulatory approval was withdrawn by Ofgem in December 2022 due significant delays and lack of realistic prospect of it being delivered.

Project name	Connecting country	Nominal capacity (MW)	Regulatory regime	Delivery date
Viking Link	Denmark	1400	C&F W1	End of 2023
Greenlink	Ireland	500	C&F W1	End of 2024
FAB Link	France	1250	C&F W1	Q1 2031
GridLink	France	1400	C&F W2	Q1 2031
NeuConnect	Germany	1400	C&F W2	2028
NorthConnect	Norway	1400	C&F W2	Discontinued

Third application window under the C&F regime

Due to the significant increased appetite to invest in IC capacity and the substantial changes in the UK's energy landscape over the last decade, in August 2020 Ofgem decided to review its IC policy [5], regulatory framework and approach ahead of any further C&F application windows. This was to ensure that further cross-border projects and the regulatory framework for their delivery remain in consumers' best interest.

In December 2021,[6] Ofgem published its decision setting out the next steps for IC regulation. The decisions relevant to this document included:

- the opening of a third C&F application window (W3) for ICs;
- the launch in parallel of a pilot C&F scheme for OHAs, inviting OHA developers to apply for C&F regime; and
- the review of the CBA framework used to assess new IC and OHA projects.

Following the assessment of eligibility criteria, Ofgem progressed a total of seven eligible applications under W3, from IC project developers and two from OHA project developers under the pilot regulatory scheme for OHAs. These are listed in Table 4 and Table 5 below.

Table 4 - W3 IC candidate projects applying to a C&F regime

Project Name	Developer	Type of Asset	Capacity (MW)	Connecting country	Operation date
Aquind	AQUIND	IC	2,000	France	2027
Aminth	CIP	IC	1,400	Denmark	2031
Cronos	CIP	IC	1,400	Belgium	2029
Tarchon	CIP	IC	1,400	Germany	2030
NU-Link	Consortium	IC	1,200	Netherlands	2031
MaresConnect	MCL	IC	750	I-SEM	2030
LirIC	TINV	IC	700	I-SEM	2030

[5] Open letter: Notification to interested stakeholders of our interconnector policy review, Ofgem, August 2020.

[6] Interconnector Policy Review: Decision, Ofgem, December 2021.

Table 5 - OHA projects applying to Ofgem's pilot regulatory scheme

Project Name	Developer	Type of Asset	Capacity (MW)	Connecting country	Operation date
LionLink	NGV	OHA	1,800	Netherlands	2030
Nautilus	NGV	OHA	1,400	Belgium	2030

1.3 Ofgem's new MCA framework

In 2022, Ofgem commissioned Arup to conduct a review of its previous CBA framework and of the feedback provided by key stakeholders throughout the years. Based on Arup recommendations,[7] Ofgem published an updated Multicriteria Assessment (MCA) framework composed of seven standalone impact categories describing the potential impacts of new IC and OHA projects applying for regulatory approval, summarised in Table 6 below.[8]

Table 6 - Impact categories and indicators under the updated MCA framework for the C&F regime

Impact category	Indicator	Unit	Party responsible for the analysis
SEW	Consumers SEW	£m	Ofgem's consultant
SEW	Producers SEW	£m	Ofgem's consultant
SEW	Interconnectors SEW	£m	Ofgem's consultant
SEW	Total SEW	£m	Ofgem's consultant
Network costs	Onshore works	£m	Relevant TO
System operability	Frequency stability	MW/h	NGESO
System operability	Frequency response savings	£m/ MWh	NGESO
System operability	Voltage stability	MVar	NGESO
System operability	Reactive response savings [9]	£m/MVar	NGESO
System operability	Black start [9]	£m	NGESO
Flexibility	Balancing Market impacts [9]	£m	NGESO
Decarbonisation	CO_2 reduction (SEW)	£m	Ofgem's consultant
Decarbonisation	CO_2 reduction (Societal value)	£m	Ofgem's consultant
Decarbonisation	RES integration (avoided RES spillage) [10]	MWh/y	Ofgem's consultant
Decarbonisation	RES integration (additional RES capacity)	MW	Ofgem's consultant
Decarbonisation	Overall decarbonisation	t	Ofgem's consultant
Security of Supply	Cost of EENS	£m/MWh	Ofgem's consultant

[7] For more detail, please see: Cap and Floor Third Application Window and MPI Pilot Regulatory Framework – Guidance on our Needs Case Assessment Framework, Ofgem, July 2022.

[8] For more details on each indicator and the methodology used to calculate them, please refer to: Future Interconnectors Assessment Framework, Arup, July 2022.

[9] We note that, in its report, the NGESO refers to the indicator 'Reactive response savings' as Reactive Power Savings, to the indicator 'Black start 'as Restoration, and to the indicator 'Balancing Market impacts' as Constraint costs.

[10] Following consultation with Ofgem, it was agreed that the best party to calculate this sub-indicator would NGESO considering the in-house expertise and technical capabilities. Please note that NGSO refers to this indicator as 'avoided RES curtailment'.

Hard to monetise impacts	Environmental impact	qualitative	Developers
Hard to monetise impacts	Local community impacts	qualitative	Developers
Hard to monetise impacts	Noise/Disturbance	qualitative	Developers
Hard to monetise impacts	Landscape	qualitative	Developers
Hard to monetise impacts	Other impacts	qual/quant	Developers

The new MCA framework allows Ofgem to assess a broader range of quantitative and qualitative impacts to previous windows, and to consider the trade-offs that each project presents. Under W1 and W2, the analysis was primarily focused on the assessment of Socio-Economic Welfare (SEW) impacts, whilst decarbonisation and SoS impacts were treated only qualitatively. The MCA framework aims at quantifying and monetising as many indicators as possible to estimate the overall monetary impacts that a project can deliver across multiple categories.

Overall, this framework allows Ofgem to consider multiple indicators in the round in a simple way to support its decision making, without using pre-determined weighted scores. In this way, the framework will support Ofgem in reaching a final decision in a clear and transparent way, rather than determining it automatically on its behalf.

1.3.1 Conventions

We used the following conventions throughout this report:

- Each indicator shows the performance of a project over the duration of the C&F regime, i.e., a 25-year period specific to that project.
- The price base is real 2022 (calendar year average) money in British Pounds unless otherwise specified. NPV calculations are based on a 3.5% discount rate as per HM Treasury Green Book guidance.[11]
- Unless specified, for each project, we present the results under each indicator for GB only.
- All charts and tables have been adapted to meet Ofgem's publication standards.

1.3.2 Report structure

The reminder of the report is structured as follows:

- Chapter 2 provides a brief summary of the indicators informing each impact category of the MCA framework and how they are considered under the framework.
- Chapter 3 presents the performance of each W3 IC and OHA project assessed under the MCA framework.

We have also included a number of Appendixes in the report:

- Appendix A includes tables capturing the performance of all the projects assessed under the MCA framework
- Appendix B contains a brief summary of the hard-to-monetise impacts of each project.

[11] For more details, please see the guidance here.

2. Ofgem MCA framework

2.1 Aim of the framework

Historically, significant price differentials with Europe and limited interconnection capacity to GB translated into a strong positive correlation between incentives for developers and benefits for GB consumers, as new interconnections would increase the import of cheaper electricity.

However, as interconnection capacity increases and more renewable generation is deployed both domestically and in Europe, structural price differentials are likely to decrease in the long-term, whilst short-term price volatility would increase.

This in turn could change the case for the traditional correlation between additional interconnection and increased consumer welfare in GB. Nonetheless, interconnectors have the potential to deliver other significant wider benefits such as flexibility, system operability, security of supply and decarbonisation, which were not fully captured by the previous assessment framework.

The MCA framework aims at:

- Measuring a wide range of both quantitative and qualitative indicators, and where possible, monetising them. This allows developers to demonstrate how their projects meet GB consumers' interests beyond the traditional assessment of SEW impacts.
- Supporting Ofgem in identifying and understanding the positive and negative impacts of the projects assessed in order to select those that best serve consumers' interest.
- Providing clarity on Ofgem's assessment process informing the decision on whether to award a C&F regime in principle at the IPA stage.

It is important to note that the MCA framework was not designed to replace Ofgem's decision making process. The framework does not calculate a final aggregate score for each project. Instead, the intention is that the MCA analysis provides a broad range of information for Ofgem to make the most informed judgement on which projects should be taken forward.

It is important to note that there are other elements not captured by the MCA that have a significant bearing in Ofgem's final decision. These are, for example, the ability of a project to progress within the timelines indicated by the developers, regulatory approval in the relevant connecting country, etc.

2.2 Underlying analysis

This section provides a brief summary of the analytical approach and methodology used by Arup and NGESO to calculate the indicators of the MCA framework. For more detailed information, please refer to the respective reports published alongside this document.

2.2.1 Arup market modelling

Arup was commissioned by Ofgem to provide the modelling and analysis required to calculate the impacts described by the SEW, decarbonisation and SoS impact categories for each of the seven W3 IC and two OHA projects.

In order to do so, Arup have compared impacts on a NPV basis in a scenario without the assessed project (the counterfactual) and with the assessed project (the target case). All other factors in the analysis have been kept constant. The approach is consistent with HMT Greenbrook accounting.

A key driver in IC and OHAs value is the existence and future development of other cross-border infrastructure in GB. To take account of this effect, Arup have assessed the eligible IC and OHA projects using two different approaches: 'first additional' (FA) and 'marginal' (MA) approaches.

FA approach

Using this approach, Arup analysed the value of each IC and OHA individually, assuming that it is the sole new project to be constructed. Arup did not consider the addition of any other cross-border project in GB beyond that timeframe in any scenario.

The FA methodology allows Arup to explore the highest potential value of a new project, which is assessed across three market scenarios to determine the range of maximum values under different market conditions.

MA approach

In contrast to the above, with the MA approach Arup examined the value of each new project in turn assuming that all the W3 IC and OHA projects were built according to the connection date indicated by the developers. No other cross-border project is assumed to come online in GB after that point in any scenario.

The MA methodology demonstrates the minimum potential value of a new project within each of the three market scenarios. This analysis allows Arup to obtain the range of minimum values under various market conditions.

Scenarios and assumptions

In line with the new MCA framework, Arup used publicly available assumptions in the analysis. These were presented to and discussed with key stakeholders through two dedicated modelling workshops.

In order to measure the impacts that new ICs and OHAs can have under different market circumstances, Arup conducted the analysis using three different scenarios taken from the Future Energy Scenarios (FES) 2022 developed by NGESO: Leading the Way, Consumer Transformation, and Falling Short. These scenarios were considered to provide a broad range of outcomes to enable robust decision making.

Arup also used three different weather years to simulate the effect of different weather conditions on energy prices, generation dispatch and electricity flows.

2.2.2 NGESO modelling

The ESO has provided analysis in three main areas:

- **Flexibility.** This is quantifying the impact of an IC or OHA on constraint costs for GB, managed by the ESO through the Balancing Mechanism.
- **System Operability.** This assesses the potential benefits that an IC or OHA may provide in terms of Frequency Stability, Voltage Stability and Black Start services.
- **Avoided Renewable Energy Supply (RES) curtailment.** This is an assessment of the level of RES spillage or curtailment that would be avoided due to the addition of an IC or OHA project.

To ensure as much analytical alignment as possible, NGESO and Arup implemented the same modelling approach described above and, as far as possible, the same set of assumptions.

2.2.3 Key considerations on alignment of Arup and NGESO analysis

It is important to highlight that despite both Arup and NGESO have closely collaborated to use as far as possible the same set of input assumptions, the results of the respective analysis present some minor differences.

The key reason is the fact that Arup and NGESO utilise two different market modelling software: PLEXOS and BID3, respectively. Although the underlying logic is the same, each software presents inherently distinct characteristics in how an electricity market is simulated. This leads to a certain degree of divergence in the results that cannot be fully eliminated.

During the modelling workshops held by Arup and attended by developers and other key stakeholders, an additional indicator was introduced, i.e., 'Aggregate SEW'. This additional indicator was meant to capture the total SEW impacts of a project by combining the relevant monetised indicators for SEW, SO, Flexibility and Decarbonisation (CO_2 reduction (societal Value)).[12]

'Aggregate SEW' was to be used to quickly identify projects not beneficial as a whole, which would have then been removed from the assessment. However, considering that the results of the analysis from Arup and NGESO are not perfectly compatible, Ofgem and Arup agreed not to calculate an 'Aggregate SEW' to shortlist candidate projects.

2.3 Impact categories and indicators

This section briefly describes the impact categories and indicators that compose the MCA framework. More information on the indicators can be found in the 'Future interconnectors assessment framework' report published by Arup in July 2022 on Ofgem's website.[13]

More detailed information on the specific methodologies used to calculated them can be found in Arup's market modelling report or NGESO system modelling report, published alongside this document.

2.3.1 Socio-Economic Welfare (SEW)

The SEW impact category captures the changes in welfare following the introduction of a new project. It is described by four indicators:

- consumers SEW (monetised);
- producers SEW (monetised);
- IC SEW (monetised); and
- total SEW (monetised).

These indicators have been calculated by Arup as part of the market modelling analysis commissioned by Ofgem. The results considered under the MCA framework refer to GB only and are presented in NPV terms.

Consumer SEW includes:

- **Changes in wholesale market prices**, due to the addition of a new IC or OHA project. These changes will affect the costs of electricity for consumers in the connected countries.
- **Changes in payments from or to consumers under the C&F regime**. When the revenues earned by a given project are below the floor, these will be topped up by consumers. When revenues are above the cap, these are transferred to consumers. This represents a transfer of welfare between consumers and project developers, and it is applied to all ICs and OHAs subject to a C&F regime.
- **Changes in the costs of the Capacity Market (CM).** The CM ensures security of electricity supply by providing a payment for reliable sources of capacity. IC, OHA, and generators can participate in the CM market. This payment is intended to recover the missing money that electricity generators require to keep their assets up and running and available for supplying consumers. Consumers directly finance the CM through their energy bills. As such, this is a transfer of welfare from consumers to producers.

[12] The initial engagement with developers suggested that also 'Cost of EENS' should have also been included in 'Aggregate SEW.' However, as described in the MCA framework report, the economic value of this indicator is already embedded in the SEW calculations. Adding it to 'Aggregate SEW' would de facto lead to double counting the impacts of a project in terms of SoS.

[13] Please see: https://www.ofgem.gov.uk/publications/cap-and-floor-third-application-window-and-mpi-pilot-regulatory-framework-guidance-our-needs-case-assessment-framework

- **Changes in the costs of Contract for Difference (CfD) scheme.** Renewable and low carbon energy generators are often supported through schemes such as the CfD mechanism. The contract guarantees the generator a stable level of revenues at a pre-agreed level (the strike price) for the duration of the contract. If the wholesale market price exceeds the strike price, the generator pays back to consumers the extra revenues. On the contrary, if the wholesale market price is below the strike price, consumers top up the generator's revenues up to that level. This is another example of welfare transfer between consumers and producers.

Producer SEW

Producer SEW include:

- **Changes in wholesale market prices**, due to the addition of a new IC or OHA project. This will affect the gross margin for energy production, calculated as the revenues from electricity production less the costs of fuel and carbon emissions. Producers gain if ICs lead to higher prices and lose out if they result in lower prices.
- **Revenues under the CfD scheme,** as described above.

Interconnector and OHAs SEW

SEW for interconnector and OHA owners include:

- **Changes in revenues from arbitrage** payments captured by the IC or OHA owners when they offer cross-border capacity to trade electricity across markets. These revenues depend on the price differentials between those market. We have assumed implicit trading arrangements between the UK and the EU, meaning that ICs and OHAs receive all arbitrage payments directly.
- **Changes in CM revenues** earned by the IC or OHA project on either or both sides of the link by participating in the CM. These revenues contribute towards the calculation of payments under the C&F regime.
- **Changes in the payments from or to consumers under the C&F regime** based on the revenues earned by the ICs or OHAs. For each project, revenues from arbitrage payments and CM revenues are summed together before being compared to the respective cap and floor levels.
- **Cannibalisation of revenues** across IC and OHA projects, where the changes in electricity flows and price differentials between countries caused by a new project lead to higher or lower revenues on all the other ICs and OHAs.
- **Costs of constructing and operating an IC or OHA**, including the electricity transmission losses incurred when electricity flows across the project. For these costs, Arup used the information submitted by developers as part of their application for a cap and floor regime.

Total SEW

This indicator describes the net impact of a project across the three stakeholder groups described above in NPV terms.

2.3.2 Network costs

Network costs cover the onshore works required to connect the project to the national transmission system as well as wider reinforcement costs.

This information is sourced from the Connection and Infrastructure Options Note (CION) process. The process is coordinated by NGESO and involves collaboration between the developers and Transmission Owners (TOs) to assess the potential onshore connection options, the cost of the required transmission

works, and the requirements for technical environmental, planning consent and deliverability issues associated with each connection point. In their IPA submissions, developers have provided their CION.

The original intention of the MCA framework was to aggregate, where possible, all the monetary indicators. This would have also included network costs. However, Ofgem instructed Arup not to consider these costs under the current application window for the following reasons:

- Some developers have obtained their CION relatively recently, whilst others did so several years ago. The most dated CION would not necessarily reflect the evolution of the GB system in the past years, as the most recent ones do.
- The costs indicated within the respective CION do not account for the results of the Holistic Network Design (HND) work, and the implication it has on the most recent and future Network Option Assessment (NOA) process.[14]

It is worth also noting that due to the commercial sensitivity of the costs included in the CION, it would have not been possible to publish them.

2.3.3 System Operability (SO)

SO impacts describe the range of indicators that characterise and monetise the benefits a new project could provide to the GB power system through the provision of ancillary services (AS). This impact category is made of five indicators:

- Frequency stability;
- Frequency stability savings (monetised);
- Voltage stability;
- Voltage stability savings (Reactive Power Savings) (monetised); and
- Black start savings (Restoration) (monetised).

These indicators have been calculated by NGESO and refer to the GB electricity system only. The monetised indicators are expressed in NPV terms. The corresponding technical indicators are presented as the yearly average across the 25 years operational period of each project.

For more information on the methodology used to calculate these indicators, please refer to the NGESO's report published alongside this document.

2.3.4 Flexibility – Impact on system constraints costs

In the current GB market design, when there is inadequate transmission capacity on the system to deliver the electricity generated to where the demand is located, constraint costs are created. These costs are the result of the need to pay generators to curtail their energy in locations where it exceeds the transmission capacity and demand in that transmission boundary. Constraints costs have grown significantly in recent years and are forecasted to grow even further over the next decade. The constraint costs in the GB system associated with a new IC or OHA project will be heavily dependent on where it connects in GB. In some instances, a new IC or OHA may help to alleviate constraints by allowing more GB generation to be exported rather than curtailed by NGESO. New ICs or OHAs can also constrain costs if they lead to more curtail options taken by NGESO than otherwise would have occurred.

This indicator has been calculated by NGESO, it refers to the GB electricity system only and it is expressed in NPV terms.

[14] The HND provides a recommended offshore and onshore design for a 2030 electricity network, which facilitates the Government's ambition for 50GW of offshore wind by 2030. The NOA provides NGESO's recommendation for which network reinforcement projects should receive investment, and when.

2.3.5 Decarbonisation

This impact category describes the changes in CO_2 emission due to a new project being connected. It is composed of five indicators:

- CO_2 reduction (SEW) (monetised);
- CO_2 reduction (Societal value) (monetised);
- RES integration (avoided RES spillage);
- RES integration (additional RES capacity);
- Overall decarbonisation.

These indicators have been calculated by Arup as part of the market modelling analysis commissioned by Ofgem.

CO2 reduction (SEW)

This indicator describes the cost imposed on electricity producers associated with a change in CO_2 emissions in GB due to a new project being connected. It is obtained by multiplying the difference in CO_2 emissions (in t) with and without a project by the market value of CO_2 (under the UK ETS in £/t).

The monetary value of the indicator is part of the SEW calculations already estimated in the market modelling analysis commissioned by Ofgem. Therefore, the value of this indicator is not meant to be added to the value of the SEW indicators.

This indicator is reported separately to ensure better visibility of the impact associated with CO_2 emission changes and is expressed undiscounted and in real 2022 terms.

CO2 reduction (Societal value)

This indicator describes those costs associated with a change in CO_2 emissions in GB that are not already captured by the previous indicator. In other words, this indicator describes the cost of CO_2 for society as a whole, rather than for electricity producers and consumers only.

To avoid double counting, this indicator is calculated by multiplying the difference in CO_2 emissions (in t) with and without a project by the difference between the societal value of CO_2 and the market value of CO_2. The societal value of CO_2 is based on the HMT Green Book values.

The societal value of carbon is calculated using an output from the market modelling analysis, i.e., the change in CO_2 in GB following the introduction of a new project. However, it does not feed into the SEW calculations. Once again, this indicator refers to GB only under the framework and is presented in NPV terms.

RES integration (avoided RES spillage)

This indicator applies to all projects (i.e., both IC and OHA projects). It captures the change in RES energy in the system that can occur following the introduction of a new project, which in turn might lead to a change in the generation dispatch.

Under the MCA framework, this indicator refers to GB only and it is expressed as the annual average across the 25 years of operation of a project.

RES integration (additional RES capacity)

This indicator applies only to projects that directly lead to the connection of new RES generation capacity in GB (e.g., an offshore wind farm (OWF)) such as OHA projects. None of the OHA projects assessed lead to such an outcome.

2.3.6 Security of Supply

This category assesses the ability of a power system to provide an adequate supply of electricity to meet the demand at any moment in time. This is measured through one dedicated indicator:

- Cost of Expected Energy Not Served (EENS).

This indicator has been calculated by Arup as part of the market modelling analysis commissioned by Ofgem. The monetary value of this indicator is part of the SEW calculations for GB. This indicator is reported on separately to ensure better visibility of the impact on security of supply.

2.3.7 Hard-to-monetise impacts

This category provides Ofgem with sight of any potential hard-to-monetise impacts that may be of concern to the public when building new infrastructure. This category is composed of five indicators:

- Environmental Impacts
- Landscape Impacts
- Noise/ Disturbance
- Impacts on Local Community
- Other impacts

IC and OHA projects are at a relatively early stage of development when their IPA application is submitted. Additionally, the above impacts are considered in more detail at the planning and environmental permitting stages. Considering that these do not fall within Ofgem's remit, these indicators are assessed only qualitatively.

2.4 Assessment process

The MCA framework is designed to support Ofgem in reaching a final decision and not to replace Ofgem by determining the outcome of the assessment. To achieve this, the framework uses a RAG rating system to describe the performance of the projects assessed and build the case in favour of a specific project.

The assessment and RAG rating process have been discussed with Ofgem as well as with key stakeholders during the two modelling workshops held by Arup. Since then, a few changes have been required as the NGESO and Arup analysis progressed. Table 7 Table 7 - Assessment approach below summarises them.

Table 7 - Assessment approach

Procedure	Description and original purpose	Changes since modelling workshops	Justification
Aggregate SEW	This is an additional indicator meant to aggregate the following monetised indicators: • Total SEW (including project costs) • Network costs • Frequency response savings • Reactive response savings • Black start • CO2 reduction (Societal Value) • Cost of EENS This measure was meant to be used in building the case of a specific project by aggregating all monetary impacts in one single value. This was then supposed to be used in the assessment process as described below.	Aggregate SEW **will not** be used in this assessment	The change was implemented for the following reasons: • Marginal divergence in the results from Arup market modelling and NGESO system modelling analysis, as explained in section 2.2.3. • Network costs available are outdated and most likely superseded by the HND work, as described in section 2.3.2. • Cost of EENS should not be used, as it already embedded in the SEW calculations.
Shortlisting projects based on Aggregate SEW under the Base Case scenario in the FA runs and MA runs	This first step in the assessment was meant to be used as a pass/fail test to measure the robustness of each project under the most favourable conditions, i.e., under FA. Projects delivering negative results under the base case would have been removed from the assessment. Projects delivered positive results would have been taken forward.	The pass/fail test **will not** be used in this assessment **FA results will still be used to identify projects likely not to perform well overall**	The change was implemented for the following reasons: • Aggregate SEW as an additional indicator is not used in this assessment, as explained above. • Developers highlighted that the selection of FES scenarios would not necessarily represent high, base, and low value scenarios from an IC or OHA perspective, as they were not designed in such a way.
RAG rating	The initial RAG rating was designed as follow: • Red: negative results under both Low and Base case scenarios • Amber: negative results under the Low scenario but positive under the Base case scenario	**The RAG rating has been updated** as follows: • Red: negative results under all scenarios • Amber: positive results in any one or two scenarios	The change was implemented as developers highlighted that the selection of FES scenarios would not necessarily represent high, base, and low value scenarios from an IC or OHA perspective, as they were not designed in such a way. This means that a project may perform differently under

Procedure	Description and original purpose	Changes since modelling workshops	Justification
	• Green: positive results under both.	• Green: positive results under all scenario	the different FES scenarios due to their design (i.e., performing very well under the Low Case and poorly under the High Case). It was acknowledged this could have negatively impacted the assessment of the projects considered.
RAG rating for hard-to-monetise impacts	The initial RAG rating was defined in the 2022 MCA framework report published by Ofgem as follow: • Red: a significant concern or impact has been identified that will require further investigation at the planning and environmental policy stages. • Amber: a minor concern or impact has been identified that may require further investigation at the planning and environmental policy stages. • Green: no concern or impact has been identified.	**The RAG rating has been updated** as follows: • Red: the impact has not been considered/little information was provided • Amber: the impact has been considered and relevant information was provided as evidence • Green: the impact has been considered, relevant information was provided as evidence and mitigation plans/actions were identified	The change was implemented as the initial rating was considered difficult to implement consistently across projects. It is noted that applicant projects are at a different and, in most cases, relative early stage of development. Hence, not all developers were able to provide equally detailed or complete information as indicated in the 2022 MCA framework report. This in turn made difficult to assign a rating without risking over-rewarding or over-penalising projects at different development stages. Therefore, it was decided to utilise a new rating based on the overall quality of the developers' submission, the analysis provided and the information available to developers at the time of their IPA and shared in their applications, demonstrating that the hard-to-monetise impact categories have been taken into consideration. Arup suggest that those projects awarded with a C&F regime and that have not been able to provide to Ofgem more detailed or complete information at the IPA stage, should do so as the project progress. This will allow Ofgem to maintain oversight of the relevant hard-to-monetise impacts associated with them.
Network costs	These costs where initial meant to be assessed quantitatively and to be netted off SEW results	**Arup did not assess network costs as instructed by Ofgem.** For more details, please refer to the IPA consultation document.	This is covered in section 2.3.2.

3. MCA assessment

This section presents the results for each project under each indicator of the MCA framework, for all three scenarios considered, under both FA and MA. Please note that the results presented are always the change occurring between the target case (i.e., when a project is introduced) and the counterfactual.

Positive values for an indicator are to be considered as benefits, and negative values as losses. For example:

- A positive value for the SEW indicators shows a gain in SEW, whilst a negative value indicates a loss in SEW.
- A positive value for the SO and Flexibility indicators shows a benefit in terms of cost savings, whilst a negative value indicates a loss in terms of increased costs.
- Similarly, a positive value for the Decarbonisation and SoS indicators shows cost savings, whilst a negative value represents increased costs.
- The **only exception** is the 'Overall decarbonisation' indicators, for which a negative value represents a reduction in CO_2 emissions and a positive value represents an increase.

Unless specified, the indicators refer to GB only. As described earlier, the RAG ratings have been assigned as follows:

- Red: negative results under all scenarios
- Amber: positive results in any one or two scenarios
- Green: positive results under all scenario

A brief summary of the hard-to-monetise impacts associated with each project is also provided in Appendix A.

3.1 W3 interconnector projects results

Aminth

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	22.44	(2.25)	(2.40)		0.59	(3.14)	(1.67)	
SEW	Producers SEW	£bn real 2022, NPV	(16.93)	2.57	2.56		0.22	3.04	1.58	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.34)	0.57	0.58		0.12	0.44	0.29	
SEW	Total SEW	£bn real 2022, NPV	5.18	0.88	0.74		0.93	0.34	0.21	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.61	0.66	0.58		0.67	0.77	0.67	
System operability	Frequency response savings	£bn, NPV, real 2022	0.08	0.10	0.09		0.11	0.10	0.10	
System operability	Voltage stability	Average TVar/y	3.47	3.47	3.47		3.47	3.47	3.47	
System operability	Reactive response savings	£bn, NPV, real 2022	0.11	0.11	0.11		0.11	0.11	0.11	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.04	0.04	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(1.68)	(1.97)	(0.48)		(0.50)	(0.89)	(0.07)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	0.02	(0.04)	(0.32)		0.01	(0.07)	(0.32)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	0.05	(0.07)	(0.17)		0.02	(0.11)	(0.16)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.81	1.09	0.98		0.81	1.09	0.98	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(6.90)	(11.80)	(13.10)		(6.81)	(11.17)	(10.22)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	5.04	0.11	-		0.16	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Aquind

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	28.95	(2.12)	(3.73)		6.32	(2.87)	(2.27)	
SEW	Producers SEW	£bn real 2022, NPV	(18.70)	5.05	5.93		(1.32)	5.49	3.94	
SEW	Interconnectors SEW	£bn real 2022, NPV	(1.54)	(0.19)	(0.27)		(0.76)	(0.17)	(0.36)	
SEW	Total SEW	£bn real 2022, NPV	8.71	2.74	1.93		4.24	2.46	1.32	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.96	1.02	0.79		0.77	0.91	0.73	
System operability	Frequency response savings	£bn, NPV, real 2022	0.14	0.17	0.16		0.16	0.13	0.13	
System operability	Voltage stability	Average TVar/y	3.70	3.95	3.72		3.70	3.95	3.72	
System operability	Reactive response savings	£bn, NPV, real 2022	0.14	0.13	0.13		0.14	0.13	0.13	
System operability	Black start	£bn, NPV, real 2022	0.05	0.04	0.05		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(7.22)	(6.33)	(2.26)		(3.54)	(3.41)	(0.40)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	0.18	0.30	0.10		0.18	0.30	0.27	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	0.55	0.50	0.03		0.56	0.51	0.12	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	1.09	1.81	1.47		1.09	1.81	1.47	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation (Europe)	Mt	(20.80)	(29.20)	(18.20)		(20.06)	(25.40)	(16.28)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	5.25	0.09	-		0.25	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Cronos

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	16.37	(5.09)	(5.26)		(2.68)	(5.61)	(4.00)	
SEW	Producers SEW	£bn real 2022, NPV	(9.92)	7.24	6.97		4.54	7.20	5.09	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.57)	0.21	0.07		(0.02)	0.18	(0.10)	
SEW	Total SEW	£bn real 2022, NPV	5.89	2.37	1.79		1.84	1.77	0.99	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.47	0.62	0.56		0.63	0.75	0.71	
System operability	Frequency response savings	£bn, NPV, real 2022	0.08	0.10	0.07		0.12	0.11	0.10	
System operability	Voltage stability	Average TVar/y	3.47	3.47	3.47		3.47	3.47	3.47	
System operability	Reactive response savings	£bn, NPV, real 2022	0.11	0.11	0.11		0.11	0.11	0.11	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(6.25)	(7.07)	(2.99)		(3.52)	(4.59)	(1.30)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.24)	(0.39)	(1.08)		(0.19)	(0.38)	(0.99)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.67)	(0.64)	(0.50)		(0.53)	(0.63)	(0.46)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.60	0.84	0.87		0.62	0.87	0.90	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(11.60)	(19.30)	(13.00)		(9.50)	(14.19)	(6.42)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	4.64	0.07	-		0.13	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

LirIC

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	(1.04)	(2.52)	(0.77)		(1.68)	(2.15)	(0.30)	
SEW	Producers SEW	£bn real 2022, NPV	1.16	2.55	0.63		1.20	1.83	(0.21)	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.51)	(0.48)	(0.27)		(0.47)	(0.31)	(0.49)	
SEW	Total SEW	£bn real 2022, NPV	(0.40)	(0.45)	(0.41)		(0.95)	(0.62)	(1.01)	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.17	0.24	0.14		0.27	0.31	0.23	
System operability	Frequency response savings	£bn, NPV, real 2022	0.02	0.04	0.03		0.05	0.04	0.04	
System operability	Voltage stability	Average TVar/y	1.74	1.74	1.74		1.74	1.74	1.74	
System operability	Reactive response savings	£bn, NPV, real 2022	0.05	0.05	0.05		0.05	0.05	0.05	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.04	0.04	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(0.22)	0.05	(0.20)		0.01	0.23	(0.30)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	0.01	(0.06)	(0.02)		0.01	(0.02)	0.07	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	0.02	(0.09)	(0.02)		0.03	(0.03)	0.03	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.24	0.70	0.02		0.24	0.70	0.02	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(9.10)	(8.50)	(4.10)		(2.88)	(5.06)	(3.34)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	1.04	0.04	-		0.03	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	(1.35)	(2.46)	(0.77)		(1.57)	(2.40)	(0.48)	
SEW	Producers SEW	£bn real 2022, NPV	1.50	2.51	0.64		1.33	1.98	(0.05)	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.53)	(0.48)	(0.31)		(0.42)	(0.41)	(0.55)	
SEW	Total SEW	£bn real 2022, NPV	(0.38)	(0.43)	(0.45)		(0.65)	(0.83)	(1.07)	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.11	0.13	0.08		0.15	0.15	0.10	
System operability	Frequency response savings	£bn, NPV, real 2022	0.01	0.02	0.02		0.02	0.02	0.02	
System operability	Voltage stability	Average TVar/y	1.89	1.89	1.89		1.89	1.89	1.89	
System operability	Reactive response savings	£bn, NPV, real 2022	0.06	0.06	0.06		0.06	0.06	0.06	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.04	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(0.54)	(0.66)	(0.38)		(0.32)	(0.55)	(0.39)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.00)	(0.07)	(0.02)		0.01	(0.02)	0.07	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.01)	(0.10)	(0.02)		0.02	(0.02)	0.02	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.45	0.80	0.40		0.45	0.80	0.40	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(9.00)	(9.90)	(4.10)		(3.13)	(5.39)	(3.99)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	1.28	0.05	-		0.03	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

NU-Link

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	19.50	(4.42)	(4.75)		(1.94)	(4.93)	(3.59)	
SEW	Producers SEW	£bn real 2022, NPV	(13.48)	5.73	5.68		3.14	5.86	4.07	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.49)	0.38	0.28		0.04	0.38	0.07	
SEW	Total SEW	£bn real 2022, NPV	5.53	1.68	1.20		1.24	1.31	0.55	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.17	0.32	0.19		0.28	0.44	0.29	
System operability	Frequency response savings	£bn, NPV, real 2022	0.03	0.05	0.02		0.07	0.04	0.04	
System operability	Voltage stability	Average TVar/y	3.02	3.02	3.02		3.02	3.02	3.02	
System operability	Reactive response savings	£bn, NPV, real 2022	0.09	0.09	0.09		0.09	0.09	0.09	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.04	0.04	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(1.90)	(2.08)	(0.57)		(0.79)	(1.25)	(0.01)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.12)	(0.22)	(0.75)		(0.10)	(0.23)	(0.68)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.35)	(0.36)	(0.38)		(0.27)	(0.37)	(0.33)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	1.01	1.39	1.00		1.01	1.39	1.00	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(8.50)	(16.00)	(11.50)		(6.28)	(12.18)	(6.94)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	4.41	0.09	-		0.13	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Tarchon

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	13.42	(4.86)	(5.69)		(2.31)	(5.56)	(4.56)	
SEW	Producers SEW	£bn real 2022, NPV	(7.65)	6.86	7.12		4.26	7.14	5.64	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.18)	0.55	0.45		0.39	0.51	0.31	
SEW	Total SEW	£bn real 2022, NPV	5.58	2.55	1.89		2.34	2.09	1.39	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.24	0.41	0.24		0.44	0.57	0.42	
System operability	Frequency response savings	£bn, NPV, real 2022	0.04	0.06	0.04		0.09	0.07	0.07	
System operability	Voltage stability	Average TVar/y	3.45	3.45	3.45		3.45	3.45	3.45	
System operability	Reactive response savings	£bn, NPV, real 2022	0.11	0.11	0.11		0.11	0.11	0.11	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(1.95)	(0.52)	(0.04)		(1.30)	(0.19)	0.18	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.22)	(0.35)	(1.04)		(0.19)	(0.38)	(0.96)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.62)	(0.59)	(0.48)		(0.06)	(0.63)	(0.45)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	1.56	4.04	2.26		1.56	4.04	2.26	
Decarbonisation	RES integration (additional RES capacity)	MW	n/a	n/a	n/a		n/a	n/a	n/a	
Decarbonisation	Overall decarbonisation	Mt	(12.30)	(20.10)	(14.00)		(10.29)	(16.13)	(8.02)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	4.60	0.10	-		0.15	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

3.2 OHA projects results

LionLink

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	39.53	(6.01)	(4.75)		3.45	(6.13)	(3.32)	
SEW	Producers SEW	£bn real 2022, NPV	(29.79)	6.23	4.83		(1.02)	6.20	3.32	
SEW	Interconnectors SEW	£bn real 2022, NPV	(1.55)	0.13	0.02		(0.80)	(0.06)	(0.17)	
SEW	Total SEW	£bn real 2022, NPV	8.19	0.36	0.10		1.63	0.01	(0.17)	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	1.07	1.09	1.06		1.11	1.12	1.13	
System operability	Frequency response savings	£bn, NPV, real 2022	0.16	0.16	0.16		0.17	0.17	0.17	
System operability	Voltage stability	Average TVar/y	4.46	4.46	4.46		4.46	4.46	4.46	
System operability	Reactive response savings	£bn, NPV, real 2022	0.14	0.14	0.14		0.14	0.14	0.14	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(1.92)	(1.61)	(0.31)		(1.16)	(1.13)	(0.04)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.21)	(0.36)	(1.01)		(0.18)	(0.38)	(0.88)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.58)	(0.60)	(0.48)		(0.50)	(0.63)	(0.42)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.13	0.95	0.42		0.13	0.95	0.42	
Decarbonisation	RES integration (additional RES capacity)	MW	0	0	0		0	0	0	
Decarbonisation	Overall decarbonisation	Mt	(5.30)	(14.00)	(8.70)		(5.10)	(10.94)	(4.55)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	5.91	0.12	-		0.22	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Nautilus

Impact category	Indicator	Unit	FA				MA			
			LW	CT	FS	RAG	LW	CT	FS	RAG
SEW	Consumers SEW	£bn real 2022, NPV	17.97	(4.86)	(4.52)		(2.33)	(5.24)	(3.15)	
SEW	Producers SEW	£bn real 2022, NPV	(12.05)	6.15	5.43		3.49	6.17	3.69	
SEW	Interconnectors SEW	£bn real 2022, NPV	(0.79)	0.06	0.03		(0.17)	0.06	(0.17)	
SEW	Total SEW	£bn real 2022, NPV	5.13	1.35	0.94		0.99	0.99	0.37	
Network costs	Onshore works	£m, real 2022	-	-	-		-	-	-	
System operability	Frequency stability	Average TWh/y	0.58	0.60	0.57		0.64	0.65	0.68	
System operability	Frequency response savings	£bn, NPV, real 2022	0.08	0.09	0.09		0.10	0.10	0.10	
System operability	Voltage stability	Average TVar/y	3.47	3.47	3.47		3.47	3.47	3.47	
System operability	Reactive response savings	£bn, NPV, real 2022	0.11	0.11	0.11		0.11	0.11	0.11	
System operability	Black start	£bn, NPV, real 2022	0.04	0.03	0.04		0.04	0.05	0.05	
Flexibility	Balancing Market impacts	£bn, NPV, real 2022	(4.40)	(5.20)	(2.40)		(2.80)	(3.33)	(1.27)	
Decarbonisation	CO_2 reduction (SEW)	£bn real 2022, NPV	(0.21)	(0.33)	(0.96)		(0.16)	(0.32)	(0.79)	
Decarbonisation	CO_2 reduction (Societal value)	£bn real 2022, NPV	(0.59)	(0.54)	(0.45)		(0.44)	(0.53)	(0.38)	
Decarbonisation	RES integration (avoided RES spillage)	Average TWh/y	0.09	0.07	0.16		0.09	0.07	0.16	
Decarbonisation	RES integration (additional RES capacity)	MW	0	0	0		0	0	0	
Decarbonisation	Overall decarbonisation	Mt	(8.80)	(15.70)	(10.20)		(6.89)	(10.65)	(4.92)	
Security of Supply	Cost of EENS	£bn real 2022, NPV	4.86	0.07	-		0.10	-	-	
Hard to monetise impacts	Environmental impact	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Local community impacts	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Noise/Disturbance	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Landscape	qualitative	-	-	-		-	-	-	
Hard to monetise impacts	Other impacts	qual/quant	-	-	-		-	-	-	

Appendix 1 – Summary of Hard-to-monetise impacts

There are several impact areas that carry value but are difficult to monetise. This is because they have less tangible societal value or no clear market value. To account for these, the MCA framework includes five qualitative indicators to describe hard-to-monetise impacts associated with a new IC or OHA project. These are:

- Environmental impacts;
- Landscape impacts;
- Noise/Disturbance;
- Impacts on Local Community; and
- Other impacts.

Hard-to-monetise impacts are important to capture because they can influence whether a project proposal is successful when considered against planning and environmental policy.

This Appendix provides a brief summary of the information developers provided in their IPA submissions to inform these five indicators.

W3 interconnector projects

Aquind

The developer has provided the Non-Technical Summary (NTS) of Environmental Statement (ES) required under planning and permitting regulation. The ES reports the findings of the Environmental Impact Assessment (EIA) and assesses the likely significant effects of the Aquind project. The document covers a number of areas such as:

- physical processes;
- marine water and sediment quality;
- impacts on local marine and land natural life and habitats;
- impacts on human activities (e.g., fisheries, navigation, shipping) and local communities;
- soils and agricultural land use, ground conditions, groundwater, surface water resources and flood risk;
- heritage and archaeology;
- traffic and transport, air quality, noise, and vibration;
- socioeconomics, human health, waste, and material resources; and
- carbon and climate change.

For each area covered by the NTS, the document indicates the likelihood and expected magnitude of impacts associated with the project, mitigation measures and residual effects during construction and operation.

Table 8 - Resulting RAG rating for Aquind Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	
Noise/Disturbance	
Landscape	
Other impacts	

Aminth, Cronos, and Tarchon

Being developed by the same entity, these three projects contain similar information on hard-to-monetise impacts in their IPA submissions. Due to the relative early development stage of these projects, the developer could not include a quantitative analysis of the relevant hard-to-monetise impacts but provided a qualitative assessment.

The hard-to-monetise covered are:

- **Environmental impacts:** the developer will be commissioning a full scope EIAs for the onshore and marine components of the project to ensure impacts are fully measured and mitigated. The project intends to maintain collaborative relationships with all key stakeholders, such as local authorities, central government and agencies, local communities, local conservancy, and environmental groups. The developer is already collaborating with some of these to ensure risks are understood and relevant mitigation actions are undertaken early on.

  The developer states that its management team has adopted carbon abatement goals and an overarching low-waste policy throughout the construction, operation and decommissioning of the project.

- **Local community impacts:** the developer plans to engage with local institutions such as schools and colleges to raise awareness about the projects, and to work closely with local nature conservancy groups to identify locations where mitigation areas could be provided or enhancements to local nature reserves could be awarded funding. In addition, once operational, the developer intends to offer small grants and awards for schools, charities, and local community groups. The developer has also provided indicative figures for jobs creation during the construction and operational phase.

- **Noise/disturbance**: the developer did not address this hard-to-monetise impact in its submissions.

- **Landscape:** the developer will be collaborating with its chosen architect and the local planning authorities to ensure that the components of the projects are designed in a way that is visually appealing and harmonious to the local natural environment. This includes landscaping to reduce the visual impact of any exterior electrical components. The landscaping will be consistent with the local environment and incorporate a diversity of trees and shrubs to attract and create habitat for local species.

Table 9 - Resulting RAG rating for Aminth, Cronos and Tarchon Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	

Hard to monetise impacts	RAG
Noise/Disturbance	
Landscape	
Other impacts	

NU-Link

Considering the early stage of development of the project, a complete EIA for NU-Link is not yet available. However, hard-to-monetise impacts have been covered qualitatively. The developer has considered the impacts expected following best practice when developing an IC project which would apply to NU-Link.

The hard-to-monetise impacts covered are:

- **Environmental impacts:** The developer is aligned with governmental pledges toward achieving Net Zero and the aspiration to mitigate adverse effects on local air quality, soliciting bids from its contractors that advocate for the utilization of zero-emission equipment. Furthermore, the developer is committed to documenting all Scope 1, 2 and 3 emissions in an annual report delineating the project's environmental impact. The developer will devise and adhere to a comprehensive plan outlining strategies to minimize emissions stemming from its equipment and construction practices, following the principles of reuse and recycling to substitute virgin materials once the asset has reached its end of life.
- **Local community impacts:** The developer is committed to mitigating adverse impacts and maximizing positive benefits for the broader community. This commitment encompasses a substantial sum that contributes to the annual turnover of local businesses, coupled with the active promotion of local employment through a procurement process that favours local sourcing. The developer further endeavours to establish community sponsorship programs focused on educating the community about the energy infrastructure and its global significance.
- **Noise/disturbance**: The developer acknowledge that noise impacts will occur during the construction, decommissioning, and the operations phase. Offshore noise, though existent, will occur at a sufficient distance from communities to be deemed negligible. The developer intends to minimise operational noise through conscientious design, encompassing the establishment of ambitious noise emissions limits. In the phases of construction and decommissioning, the developer will also explicitly mandate contractors to use low-noise equipment.
- **Landscape:** The onshore and offshore cable routes of the project are anticipated to exert no visible impact on the landscape. Regular monitoring protocols will be instituted, coupled with prompt rectification measures for offshore installations. For onshore converter station buildings and equipment, planning applications will adhere to established planning policy frameworks and best design principles. These applications will encompass proposals for building screening, the utilization of building materials that harmonize, where possible, with the local environment, and landscaping strategies designed to enhance and compliment the local environment and habitats.

Table 10 - Resulting RAG rating for NU-Link Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	
Noise/Disturbance	
Landscape	

Hard to monetise impacts	RAG
Other impacts	

MaresConnect

The developer will be completing a full Environmental Impact Assessment Report (EIA) as part of its planning and permitting work. However, during the development phase of the project, the developer has worked with CEPA to provide a high-level assessment of environmental, local community impacts, noise, and landscape.

The document covers a number of areas such as:

- ground conditions and potential flooding;
- benthic ecology and marine mammals;
- ornithology, wildlife, and biodiversity;
- coastal processes;
- traffic and transport;
- recreational users of landfall sites;
- commercial fisheries;
- noise and disturbance;
- landscape and visual; and
- archaeology and cultural heritage.

For each area, the document provides the developer's own RAG ratings and indicates the expected magnitude of impacts associated with the project, mitigation measures and residual effects during construction and operation.

Table 11 - Resulting RAG rating for MaresConnect Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	
Noise/Disturbance	
Landscape	
Other impacts	

LirIC

The developer sets out the hard-to-monetise impacts which have been used in the process of selecting the preferred project detail though assessment using BRAG (black, red, amber, green) ratings. Although not part of a formal EIA, the developers provided evidence of professional judgement from expert consultants assessing the magnitude of several types of impacts in order to select the project's sites that would mitigate them the most. The hard-to-monetise impacts covered are:

- nature conservation/ ecology;
- water environment;
- access/transport;
- noise;
- landscape and visual; and
- archaeology/ cultural heritage.

High level, early mitigation actions and plans were also described.

Table 12 - Resulting RAG rating for LirIC Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	
Noise/Disturbance	
Landscape	
Other impacts	

OHA projects

LionLink and Nautilus

Being developed by the same entity, these two projects contain similar information on hard-to-monetise impacts in the IPA submissions received by Ofgem.

It is acknowledged that the projects are at an early development stage. However, the developer only relatively generic information for some of the hard-to-monetise impact indicators.

- **Environmental impacts:** The developer provided evidence of environmental impacts consideration in the selection of the sites for the projects (for both the transmission and generation assets). It also indicated the appointment of external advisors to conduct all the analysis and surveys required to successfully clear the permitting and consenting procedures it will undertake.
- **Local community impacts:** The developer did not provide much information on potential impacts on local communities, partly because landfall points are still under investigation. The developer confirmed the appointment of external consultants to manage community engagement.
- **Noise/disturbance**: Similarly, little detail was provided with regards to potential noise/disturbance associated with the project.
- **Landscape:** Likewise, whilst it can be inferred that landscape impacts have been considered in the identification of suitable sites for the projects, little information was provided.

Table 13 - Resulting RAG rating for LionLink and Nautilus Hard-to-monetise impacts

Hard to monetise impacts	RAG
Environmental impact	
Local community impacts	

Hard to monetise impacts	RAG
Noise/Disturbance	
Landscape	
Other impacts	