Public

Holistic Network Design

Implementation Plan
for Public Consultation

NESO
National Energy
System Operator

Contents

Executive Summary

The Draft HND Implementation Plan ('The Plan') provides an overview of the Holistic Network Design (HND), and Holistic Network Design Follow Up Exercise (HNDFUE) design exercises carried out under the Offshore Transmission Network Review (OTNR)[1]. The Plan is defined as the cumulative offshore network design recommendations from the HND and HNDFUE processes, as of August 2024.

These recommendations are formed of several high-level offshore network designs, the purpose of which is to connect offshore wind projects to the National Electricity Transmission System (NETS). These recommendations and the projects in scope were published by the Electricity System Operator (ESO) (predecessor to the National Energy System Operator (NESO))[2] within the *Pathway to 2030* and *Beyond 2030* suite of documents. The individual design recommendations were, in published order, the *Pathway to 2030 Holistic Network Design, Beyond 2030, Beyond 2030*: *Celtic Sea* and *Beyond 2030*: *INTOG.* Maps and diagrams shown in this document are taken directly from these publications where possible to allow for direct reference to the relevant section of each.

The proposed network for 2035 described in the *Pathway to 2030* and *Beyond 2030* documentation includes onshore infrastructure which does not fall under the scope of this draft HND Implementation Plan, or by extension the SEA, but should be covered at a later stage by the CSNP. The amount of coordinated undersea cabling proposed through HND and HNDFUE is, however, significantly greater than new onshore cabling routes. Network recommendations will be further developed and assessed by the energy industry, including through a detailed network design (DND) process.

Background

Offshore wind has been identified as a critical technology in achieving net-zero greenhouse gas emissions by 2050. To realise this target, a step change in both the speed and scale of deployment of offshore wind is required. Delivering the ambition for offshore wind deployment in the timescales required will be a challenge and will rely on an offshore and onshore transmission network that enables this growth. The transmission network needs to be expanded in a way that is economic and efficient for consumers and considers the impacts on communities and the environment.

In response to the requirement for a future offshore and onshore network that can enable this growth, the OTNR was commissioned by the UK Government in 2021. Through this, the ESO (and later us as NESO) carried out a series of offshore network design processes to determine the offshore network required to realise this ambition. As part of the OTNR, a *Terms of Reference (ToR)*

[1] gov.uk/government/groups/offshore-transmission-network-review

[2] NESO was formed as a publicly owned arms-length governmental body on 1 October 2024. Previously to this, this organisation was known as the Electricity System Operator, or ESO, a private company within the National Grid Group.

document was published for both the Holistic Network Design (HND) and Holistic Network Design Follow Up Exercise (HNDFUE), setting out the way we should conduct these design exercises, and the objectives to be considered when creating and evaluating network designs. Our network design objectives are shown below. They are consistent across both HND and HNDFUE processes, and, when evaluating and comparing designs, each objective is considered on an equal footing:

- **Economic and efficient** – Delivered in an economic and efficient way, ensuring the best value for bill payers.
- **Deliverability and operability** – Can be deliverable and operated in a practical, safe and reliable manner.
- **Environmental impact** – Minimise the impact, where possible, on the natural environment.
- **Local community impact** – Minimise the impact, where possible, on the communities that host this infrastructure.

As Offshore Coordination (OC), we have made the decision to conduct a Habitats Regulations Assessment/Appraisal (HRA), a Marine Conservation Zone (MCZ) Assessment and a Strategic Environmental Assessment (SEA) for the latest HND and HNDFUE recommendations (as of August 2024). Although not included as part of the original HND and HNDFUE commission, in consultation with our environmental stakeholders we believe these assessments are an appropriate level of environmental assessment at the strategic planning scale. While the HND and HNDFUE environmental and community appraisal process was built upon the principles of an SEA, producing these environmental assessments enables NESO to formalise this appraisal process, while allowing for possible net impact of our design recommendations to be assessed. The intention is that these assessments will help build trust with stakeholders, particularly in the natural environment, historic environment and community groups, and accelerate progress to net zero by exploring options for strategic mitigation and reinforcing recommendations for developers.

Scope of the Plan

This Plan provides design recommendations for the following elements of an offshore wind farm, and these are therefore covered in the HRA, MCZ and SEA documents: Cable route from the offshore wind farm to shore, the onshore substation and if required converter station[3], and the transmission connection. The Plan does not provide recommendations for the placement of the wind farm area, turbine layout or offshore platform position.

[3] Converter stations are only required for offshore wind farms that use High Voltage Direct Current (HVDC) technology to transmit the generated power longer distances to shore.

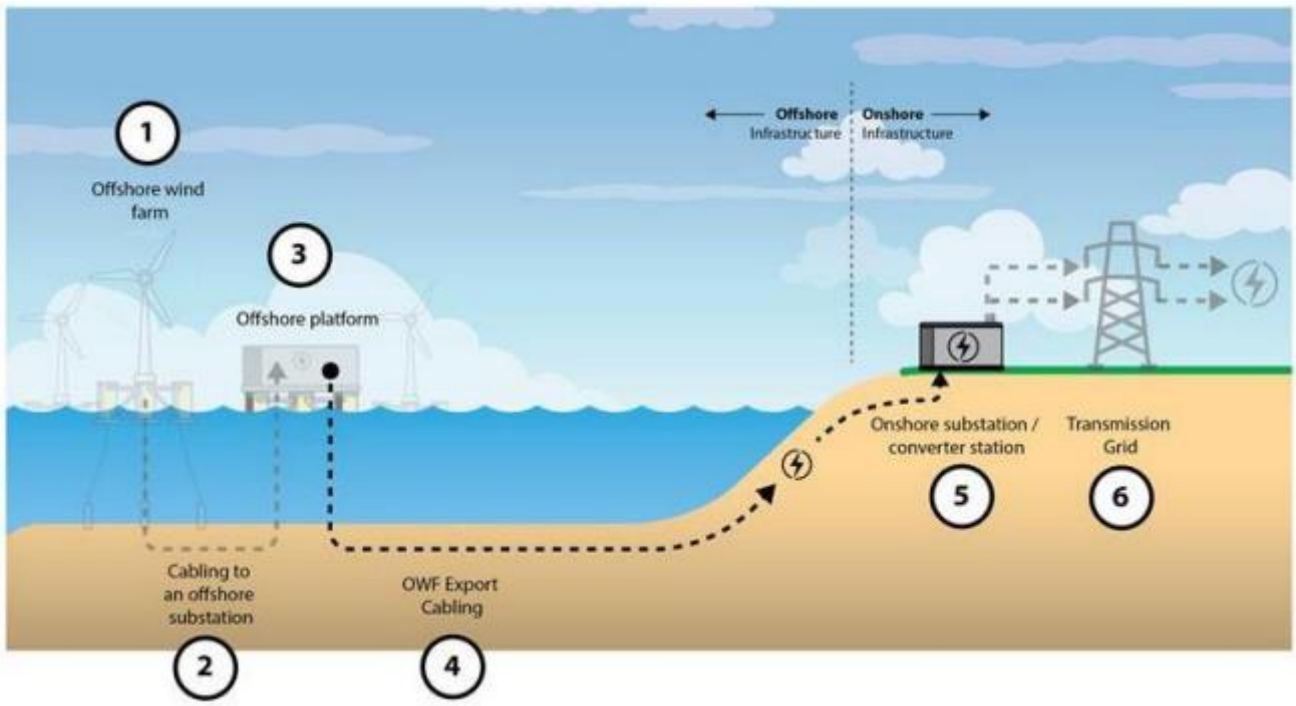

Figure 1: Offshore and onshore elements within the scope and outside the scope of the draft HND Implementation Plan

Future Project Development and Consenting

Following the design recommendations made in the Holistic Network Design (HND) and Holistic Network Design Follow Up Exercise (HNDFUE) publications, the in scope projects are now progressing the development of their individual projects. Final designs may not follow the study corridors identified by this Implementation Plan. Study corridors shown are recommendations based on strategic level analysis. At project level, detailed survey work may necessitate changes, which cannot be foreseen from a plan level.

Each individual project will seek the required consents to construct and operate all aspects of their project. This includes the offshore elements such as the wind turbines, an offshore platform that houses electrical collection and conversion equipment, array cables to connect the turbines to the platform, and an export cable to connect the platform to shore allowing the power to be exported onto the national electricity transmission system. Onshore elements include the continuation of the export cable from landfall to the onshore network, an onshore substation and if required a converter station, and the required transmission substation development to connect the offshore wind farm to the network.

As each project is developed, the individual project will be subject to an Environmental Impact Assessment (EIA) and individual HRA and MCZ assessment to examine and assess the potential direct and indirect significant effects of the project on the environment and assess if the project is liable to adversely affect the integrity of any European or Nationally designated site respectively.

These project specific reports, and the future project development and consenting applications that will be used to support, are subject to consultation with the relevant Statutory Nature Conservation Body (SNCB). That is NatureScot in Scotland, and Natural England and Natural Resources Wales in England and Wales respectively. The Joint Nature Conservation Committee (JNCC) and Marine Management Organisation (MMO) are also consulted for projects more than 12 nautical miles from shore.

While NESO have been responsible for the initial offshore network design that each in scope HND and HNDFUE project will consider, it is the responsibility of each individual project to seek the correct consents for construction and operation, and these projects will therefore be under scrutiny by SNCBs and other planning and consenting authorities at multiple future stages as they continue their development. Figure 2 below shows the end-to-end process of developing both the wider strategic plans for the in scope wind farms, and developing individual wind farms towards full operation.

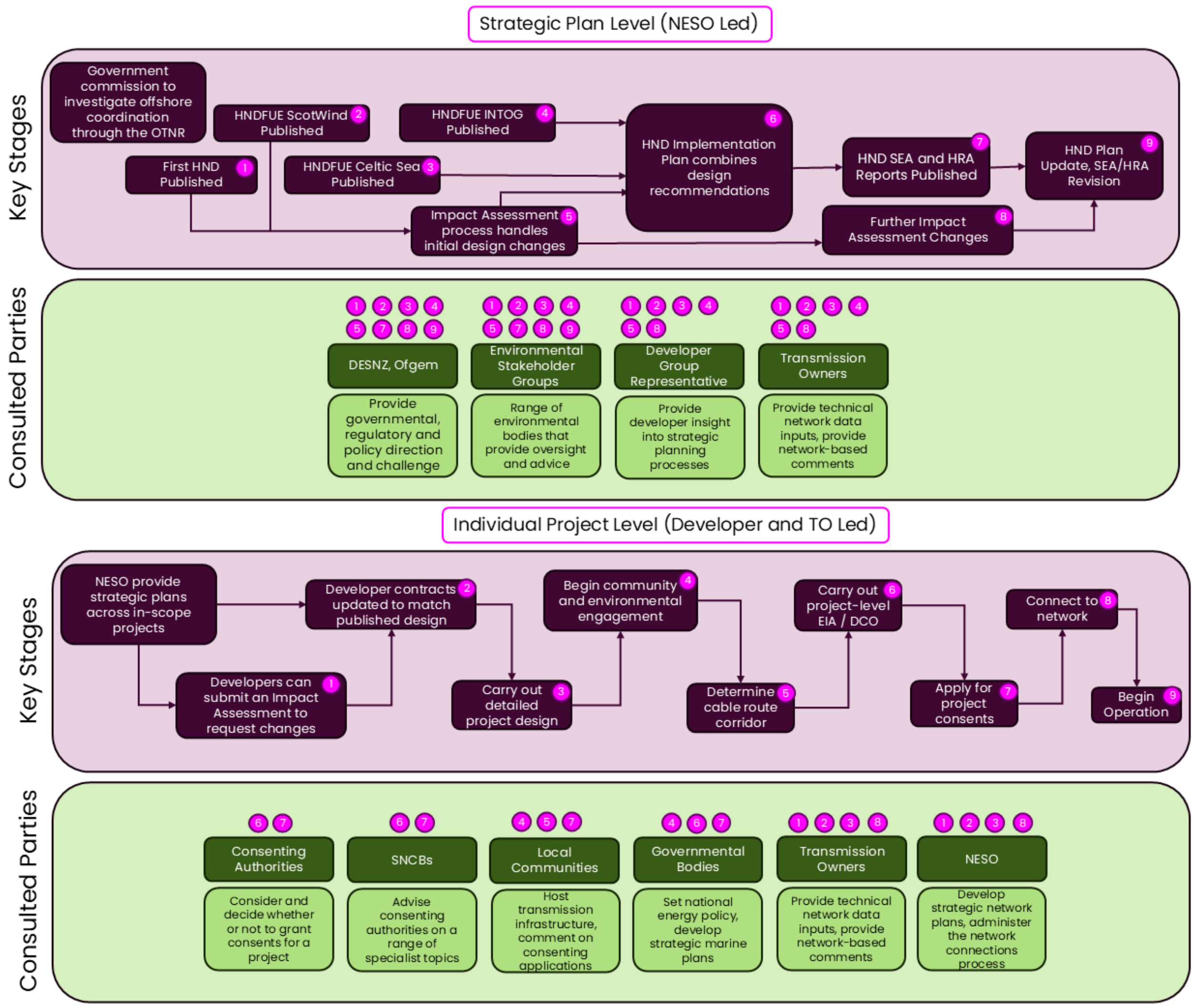

Figure 2: NESO and developer project stages

Holistic Network Design

What was the scope of this design process?

The first Holistic Network Design (HND) design process was published in 2022 and had the aim to determine a design recommendation for the purpose of connecting 23 GW of offshore wind. This process considered and compared a series of onshore and offshore design options, assessing these against future generation and demand scenarios, the existing transmission network and total capital and operational costs. Varying levels of offshore coordination were also tested to determine the benefits of a coordinated offshore network.

How was this design process carried out?

The methodology for the first HND enabled the appraisal and assessment of each design against the network design objectives, set out in our Terms of Reference (ToR). Environmental and community assessments were carried out using a range of Geographical Information System (GIS) data sources to determine any potential interactions between proposed design elements and environmental and community constraints. Appendix A contains specific details of the environmental and community constraints considered. An overview of this methodology is shown below in Figure 3:

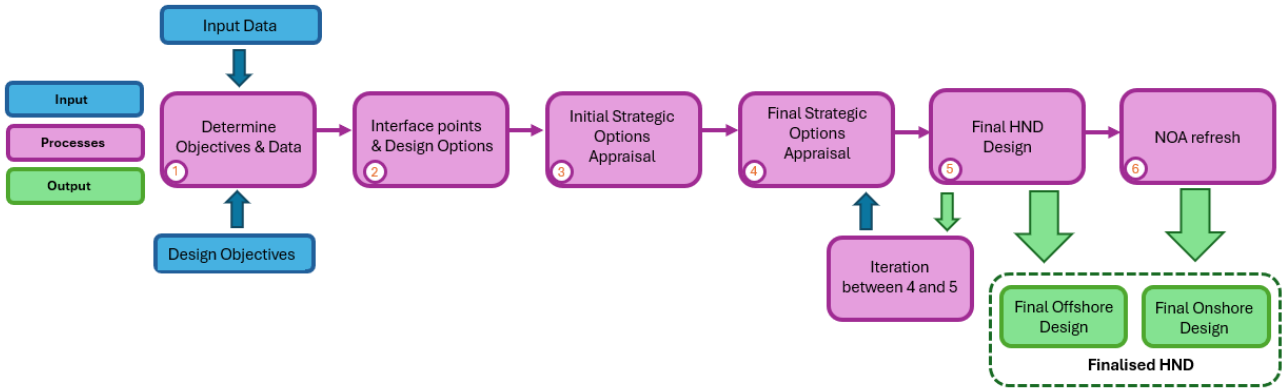

Figure 3: HND Methodology overview

The HND design process iterated through a series of coordinated and radial offshore design options, considering a variety of designs across both types and determining the most optimal design to connect the in scope generation through a 'strategic options appraisal' process. This compared the performance of each potential offshore design against the four objectives, considering both radial and coordinated designs. A radial design is one which aims to connect wind farms in a more standard, point-to-point fashion, without any coordination between projects. A coordinated design includes some level of electrical coordination with the design, such as point-to-point links between separate offshore projects. The best performing design, balanced against the four objectives, was selected. The optimal design featured a combination of radial and coordinated connections. Of the eighteen wind farms in scope, nine connected with a radial connection and nine used coordinated connections. Two of the radial connections in the Irish Sea used a shared cable corridor, but with separate cables and offshore infrastructure.

To determine the benefits of this coordinated design, it was compared against an 'optimised radial' design that would serve as a counterfactual for comparison. This design was determined in a similar manner to the coordinated design, evaluating a range of radial design options to identify the best-performing design across the four objectives. The final HND design was then determined through a final strategic options appraisal process, where the optimised radial and coordinated designs were then compared against each other across the design objectives.

An optimiser model was used to establish an optimal level of onshore reinforcement required for both the optimised radial and coordinated designs. This was carried out to allow a more extensive evaluation of both the onshore and offshore impacts of each design, and in particular to evaluate and quantify the potential savings in onshore infrastructure that could be achieved by the coordinated design. While the modelling and analysis of the onshore network was a key part of the HND process, the individual reinforcements determined were not recommended for future development based on this process alone. The HND was followed by a 'refresh' of the wider onshore network planning process known as the Network Options Assessment (NOA), which re-evaluated the onshore options present in the HND along with wider reinforcements against a much more comprehensive background, including planned and predicted generation and demand outside of the in scope HND wind farms.

What was the outcome and how was it published?

The recommended HND design is shown below in Figure 4. Between the optimised radial and coordinated designs, the coordinated design was found to be the best-performing when considering the objectives on an equal footing. The detailed justification of this design and the outcome of the design process was published in 2022 as the *Pathway to 2030 Report*[4]. Further details on the individual routes in this design, along with detail on all routes in the overall HND and HNDFUE design recommendations are shown in Table 1, in the section titled HND Implementation Plan Design Summary.

[4] neso.energy/document/262681/download

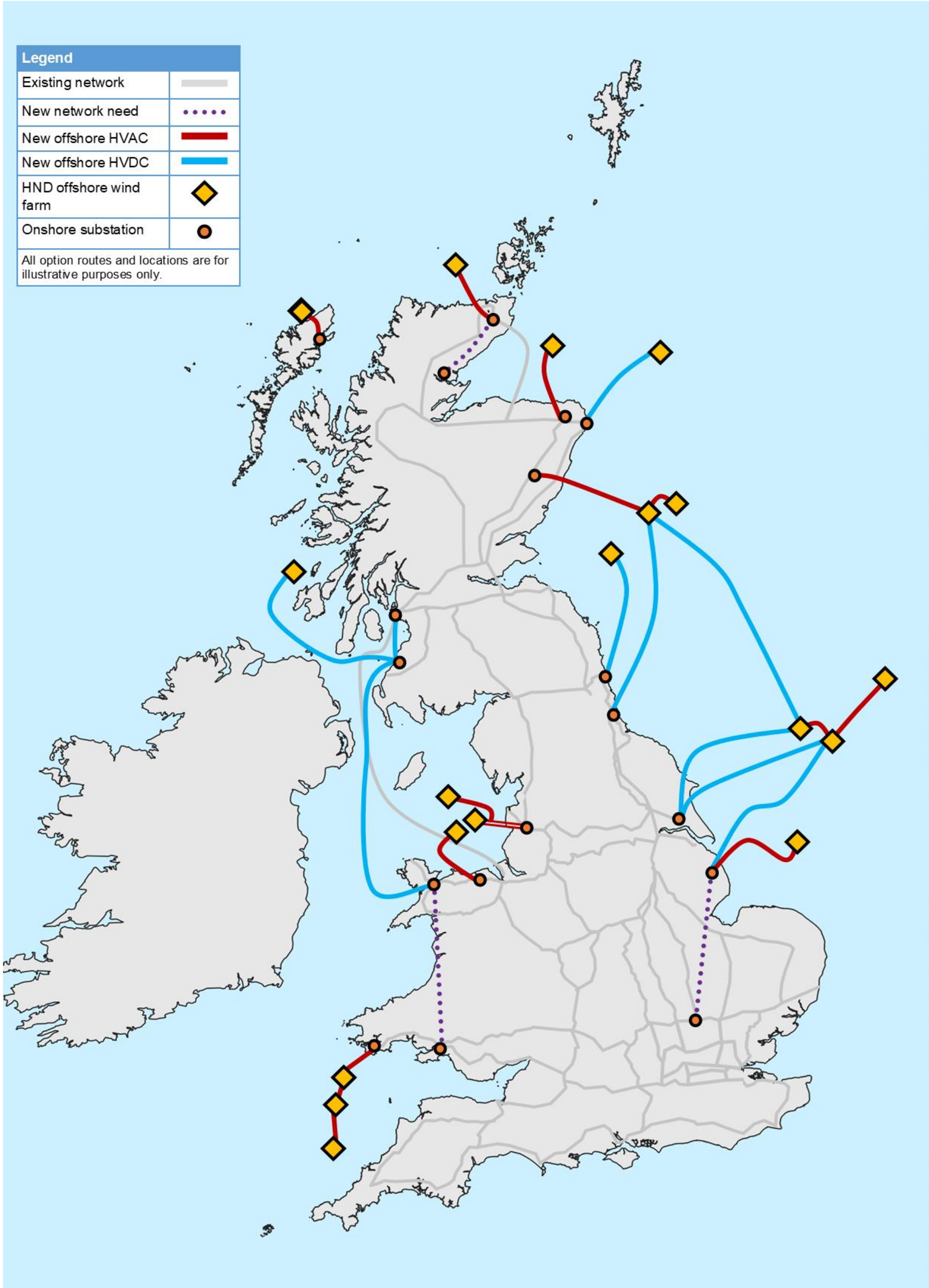

Figure 4: HND recommended design

Holistic Network Design Follow Up Exercise

In response to the release of further capacity within existing and new offshore wind leasing rounds by both The Crown Estate (TCE) and Crown Estate Scotland (CES), the Electricity System Operator (ESO) was then asked to carry out a follow up exercise to the original Holistic Network Design (HND) and deliver a set of design recommendations to connect a further 26 GW of offshore wind. This additional capacity was split across three separate leasing rounds: ScotWind, Celtic Sea (Round 5) and Innovation and Targeted Oil and Gas (INTOG). Three separate design exercises were then carried out by the ESO (and later by us as NESO) for the offshore wind farm sites leased in each of these rounds.

HNDFUE: ScotWind

What was the scope of this design process?

The Holistic Network Design Follow Up Exercise (HNDFUE) considered offshore network designs to connect the remaining capacity within the ScotWind leasing round. This included an additional 17 GW of offshore wind on top of the ScotWind projects included in the first Holistic Network Design (HND) process.

How was this design process carried out?

For the HNDFUE, the methodology was updated to reflect lessons learned during the HND process. Certain elements of the HND methodology, such as the network design objectives and the environment, community and technical constraints, remained unchanged. The core of the process was updated to allow for the assessment of both radial and coordinated options at two distinct stages. This updated methodology is shown below in Figure 5:

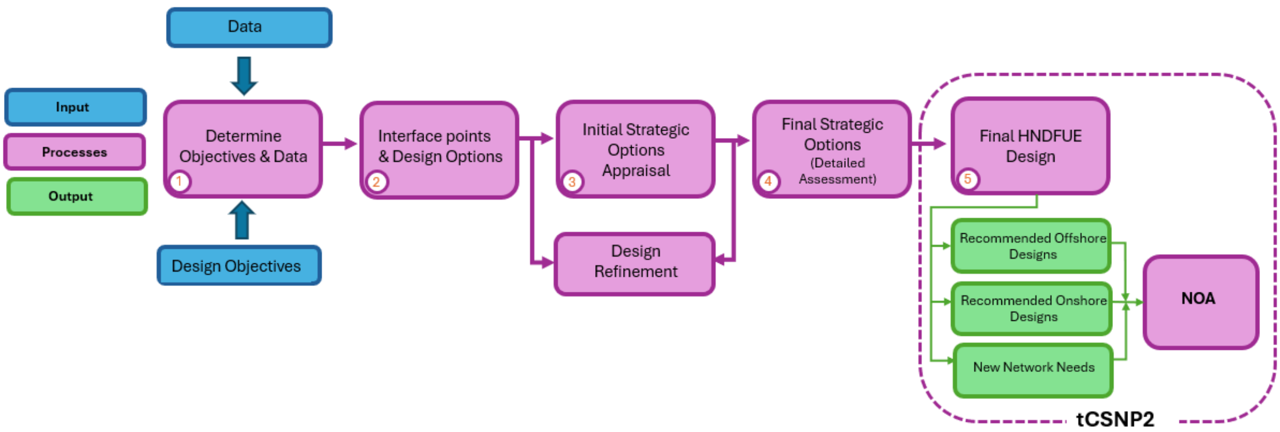

Figure 5: HNDFUE methodology

Using an expanded set of onshore interface points (substations), approximately 140 designs were initially drafted to capture a wide range of options. These initial designs considered a number of different options for coordination between offshore wind farms, and featured designs which were fully radial (no interconnection), fully coordinated (maximum interconnection) and many which explored different combinations of radial and coordinated elements. Designs were grouped based on the level and type of coordination featured within them and named based on their design group and design iteration.

The initial strategic options appraisal (ISOA) process then refined this longlist down to a shortlist of designs to proceed to the next step. Each design was assessed against the four network design objectives, with a BRAG (Black, Red, Amber, Green) rating assigned for each objective with the exception of Economic and Efficient. These colour values are designed to reflect the level of constraint within each design, and therefore the likelihood that it would encounter planning, consenting or technical issues during further development. A net present value (NPV) figure was used to illustrate the economic performance of each design. This allowed us to compare the economic performance of designs across the entirety of the longlist, as well as within the smaller design groups.

At this initial stage, both the offshore and onshore aspects or designs were considered. Given the number of designs to assess, devising a definitive onshore network to accommodate each offshore design was determined to be unrealistic at this stage. However, the onshore network needed to be considered to some extent at this early stage, and so representative onshore reinforcements known as “notional reinforcements” were determined and used to account for the onshore aspect. These represented an indicative need for reinforcement across particular parts of the onshore element and were used to understand the general level of reinforcement required for each design. This limited inclusion of the onshore network was required to assess designs at this stage but does not form part of the draft HND Implementation Plan.

Following the ISOA, six designs were selected to form the shortlist for appraisal at the next step in the process. They were selected due to both their individual performance within their design group, and the wider design group’s performance. The designs included some similarities in the interface points chosen or certain offshore topology elements due to the individual performance of these design elements, however the shortlisted designs still provided a range of coordination options from a fully radial design to a design with a high-level of coordination.

To understand the onshore impact of the shortlisted designs in more detail, we worked closely with the Transmission Owners (TOs) to identify the representative onshore reinforcement requirements for the designs in further detail. These works were identified from a single scenario considering the connection of the offshore wind generation within each design. Once the potential onshore reinforcements were identified for each design, the optimiser model was used to determine the optimal level of onshore network reinforcement required for each shortlisted design. The process balanced the impact of building each reinforcement with the cost and impact of not building it, and the resulting onshore network constraints. This assessment was carried out for each shortlisted design in turn. The assessment included appraisal of the individual and in-combination effects of the potential onshore options against all four network design objectives.

Following the detailed onshore evaluation of each shortlisted design, the offshore design elements were also reappraised in more detail, including evaluation of a potential cable corridor for each design element. The results from both the onshore and offshore appraisals were then used to carry out an assessment of the shortlisted designs across the network design objectives, considering each objective on an equal footing. To support the comparison and assessment of designs across these objectives, each design was ranked for each objective.

What was the outcome and how was it published?

During the HNDFUE ScotWind design process, approximately 140 designs were appraised at the initial stage, consisting of 114 unique routes from wind farms to shore, or between wind farms. These routes considered 30 different interface points as potential places to connect to the transmission network. Based on the outcome of high level appraisals of these designs across the four network design objectives, six designs were shortlisted for further detailed appraisal. Following the assessment of the shortlist, we identified a modified design (designated S_009s) that formed a hybrid of two shortlisted designs (designated S_009i-1 and S_008n-3).

Design S_009s shown below in Figure 6 was determined to be the best-performing design when considering all objectives on an equal footing. This design performs well across all four network design objectives when compared to the other shortlisted designs, and transfers power efficiently across the network to centres of demand. While the radial design was slightly more economical than this recommended design, the recommended design performed substantially better when considering the community impact, environmental impact and deliverability and operability factors. This is due to the radial design requiring significantly more onshore infrastructure, while still also needing a large amount of infrastructure in the marine environment, resulting in more reinforcement overall when compared to our recommendation. The final design contained 23 individual cable routes (including routes between platforms within the same project lease area), covering a total of approximately 3,754 km.

The recommendation that resulted from this design exercise was published in 2024 as the *Beyond 2030 Report*[5]. The detailed justification behind selecting this design, and more information on the outcome of the design process is available in the *Beyond 2030 Technical Report*[6]. Further details on the individual routes in this design, along with detail on all routes in the overall HND and HNDFUE design recommendations are shown in Table 1, in the section titled *HND Implementation Plan Design Summary*.

[5] neso.energy/document/315516/download
[6] neso.energy/document/304761/download

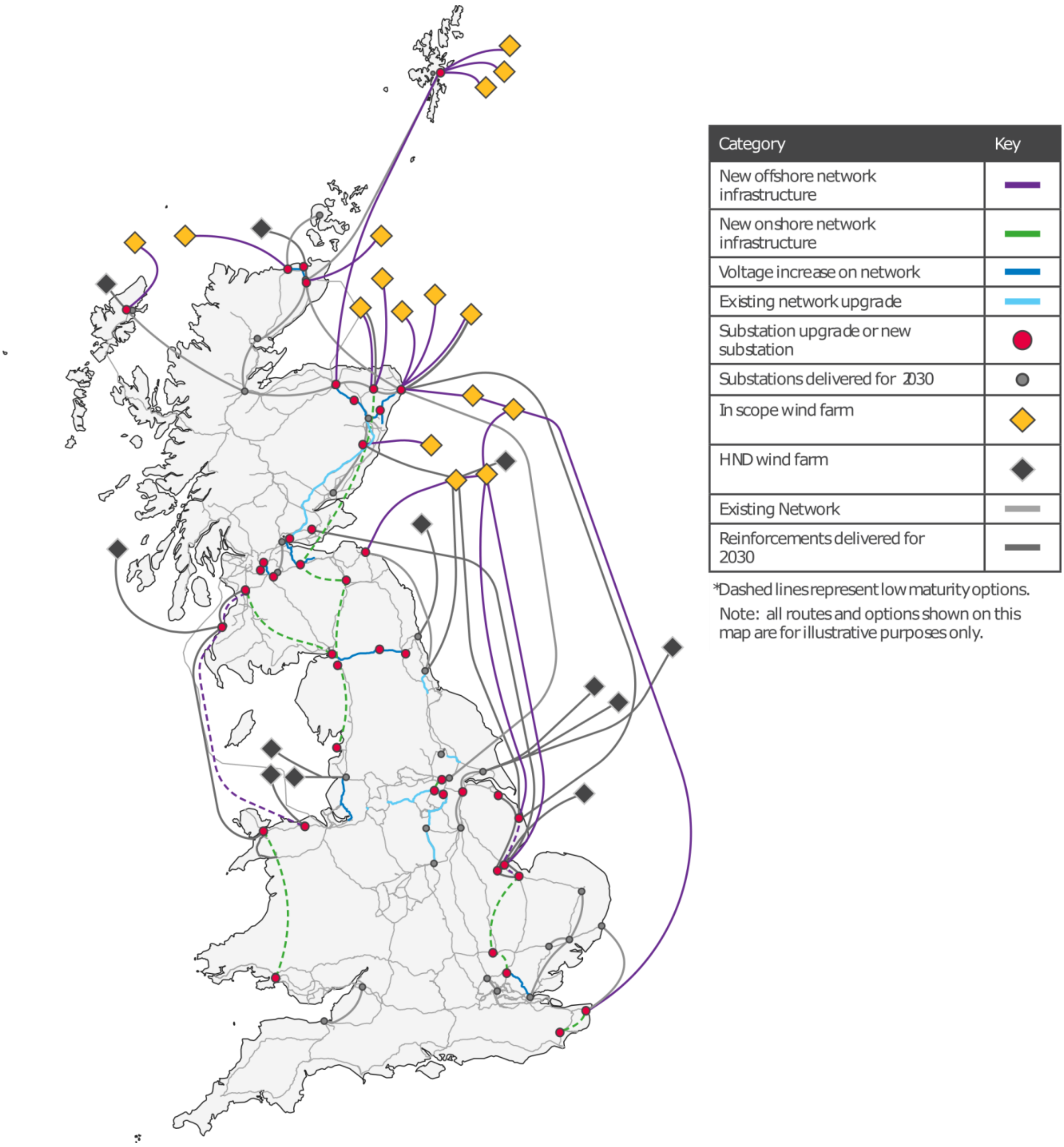

Figure 6: HNDFUE ScotWind recommended design

HNDFUE: Celtic Sea

What was the scope of this design process?

The second design exercise within the Holistic Network Design Follow Up Exercise (HNDFUE) process was to connect three Project Development Areas (PDAs) in the Celtic Sea with a total capacity of 4.5 GW of floating offshore wind. This design exercise was carried out to complement The Crown Estate's (TCE) Offshore Wind Leasing Round 5. In contrast to the previous Holistic Network Design (HND) and HNDFUE ScotWind processes, the offshore network design was determined before the leasing round was completed, providing prospective applicants detail on the network design, connection point and estimated connection dates ahead of their participation in the leasing round. This approach aimed to increase transparency between developers, TCE and NESO.

How was this design process carried out?

The network design process for Celtic Sea was carried out using the same HNDFUE Methodology as was used for the ScotWind network design, with a two-step design refinement process to determine a single recommended design (Figure 6). The design process once again considered the same four network design objectives, evaluating designs against these objectives on an equal footing.

To connect wind farms in the Celtic Sea with the onshore electricity network, suitable onshore interface points (substations) were identified. These interface point locations were provided by the Transmission Owner (TO) for our consideration and generally consisted of coastal locations where existing transmission infrastructure had the capacity to accommodate new connections. Proposed new substations, or those in early development stages were also considered as viable interface points. Each interface point was assessed based on its capacity for additional connection, relevant features and constraints within the landfall site, and onshore cable route corridors to the interface point. Following a high-level assessment of these interface points, five were selected for use within offshore network designs.

Once suitable interface points were selected, a longlist of designs was drafted. During this stage, 21 possible network designs were identified. These included a variety of options for connecting the Celtic Sea wind farms to shore, such as radial (point-to-point) designs, and coordinated designs, featuring interconnection between PDAs, that would enable power to flow between South Wales and the South West during low wind conditions. Assessing a broad range of designs allowed the evaluation of how different features impacted performance.

As per the HNDFUE methodology, these designs were then evaluated within an initial strategic options appraisal (ISOA) process. After appraising across the four network design objectives, seven designs were shortlisted. In a similar fashion to the HNDFUE ScotWind process, only notional onshore reinforcements were used at this stage to understand the onshore impact of each design.

In preparation for the final strategic options appraisal (FSOA) process, the onshore and offshore elements of each shortlisted design were re-evaluated. Detailed studies were carried out by the TO (National Grid Electricity Transmission (NGET)) to determine the specific onshore reinforcements required, and a more detailed cable routeing exercise was carried out to provide a more in-depth offshore appraisal for each design.

Following the completion of the TO's onshore studies for the shortlisted designs, the TO advised that connecting to one of the interface points used in several designs (Baglan Bay 275 kV) would require reinforcement of the whole 275 kV network in South Wales. This extensive upgrade would involve significant onshore works and pose a risk to the delivery date. To avoid this, the establishment of a new 400 kV substation near Baglan Bay was proposed. This new substation was designated as the South Wales Connection Node (SWCN). It is anticipated to be situated between Swansea North and Cilfynydd substations, although an exact location is yet to be finalised by the TO. For the purpose of assessing designs incorporating this new interface point, an indicative location for the substation was assumed along the existing 400 kV circuit. This location was selected to avoid environmental and community constraints where possible. As a result of the proposed new substation, all designs initially connecting into Baglan Bay were updated and design names modified to reflect this change.

What was the outcome and how was it published?

During the HNDFUE Celtic Sea design process, a total of 21 designs were appraised at the initial stage, consisting of 21 unique routes from wind farms to shore. These routes considered 5 different interface points as potential places to connect to the transmission network. Based on the outcome of high level appraisals of these designs across the four network design objectives, seven designs were shortlisted for further detailed appraisal. After assessing the shortlist, a new design was created (named C_011z) by altering an existing shortlisted design (named C_011x). The modification involved changing the interface point for PDA 1 from Pembroke (which encountered multiple environmental and community constraints), to Carmarthenshire, which was found to be less restricted. This was then added to the shortlist, bringing the number of designs for consideration up to eight.

Design C_011z, illustrated in Figure 7, was identified as the best performing, considering all objectives on an equal footing. It connects 3 GW into South Wales (Carmarthenshire and South Wales Connection Node (SWCN)) and 1.5 GW into the South West (North Devon). For the connection into SWCN, high voltage direct current (HVDC) technology was proposed, while the connection to the remaining interface points was recommended to be high voltage alternating current (HVAC) technology. Although it was found to be more expensive than design C_011a (the second-best performing design), C_011z offered a better balance across the environmental, community, deliverability, and operability objectives, and has the lowest level of known risk to its timely development and delivery among all the designs considered. With a design configuration of 3 GW into South Wales, it avoids the immediate requirement for a new onshore 400 kV overhead double circuit and the associated delivery risk, significantly reducing its environmental and community impact and potentially delays to connection dates. This final design contains three individual cable routes, covering a total of approximately 402 km.

The design recommendation that resulted from this exercise was published in 2024 as the *Beyond 2030: Celtic Sea* publication[7]. The detailed justification behind selecting this design and more information on the outcome of the design process is available in the *Celtic Sea Technical Annex*[8]. Further details on the individual routes in this design, along with detail on all routes in the overall HND and HNDFUE design recommendations are shown in Table 1, in the section titled *HND Implementation Plan Design Summary*.

[7] neso.energy/document/322521/download

[8] neso.energy/document/322526/download

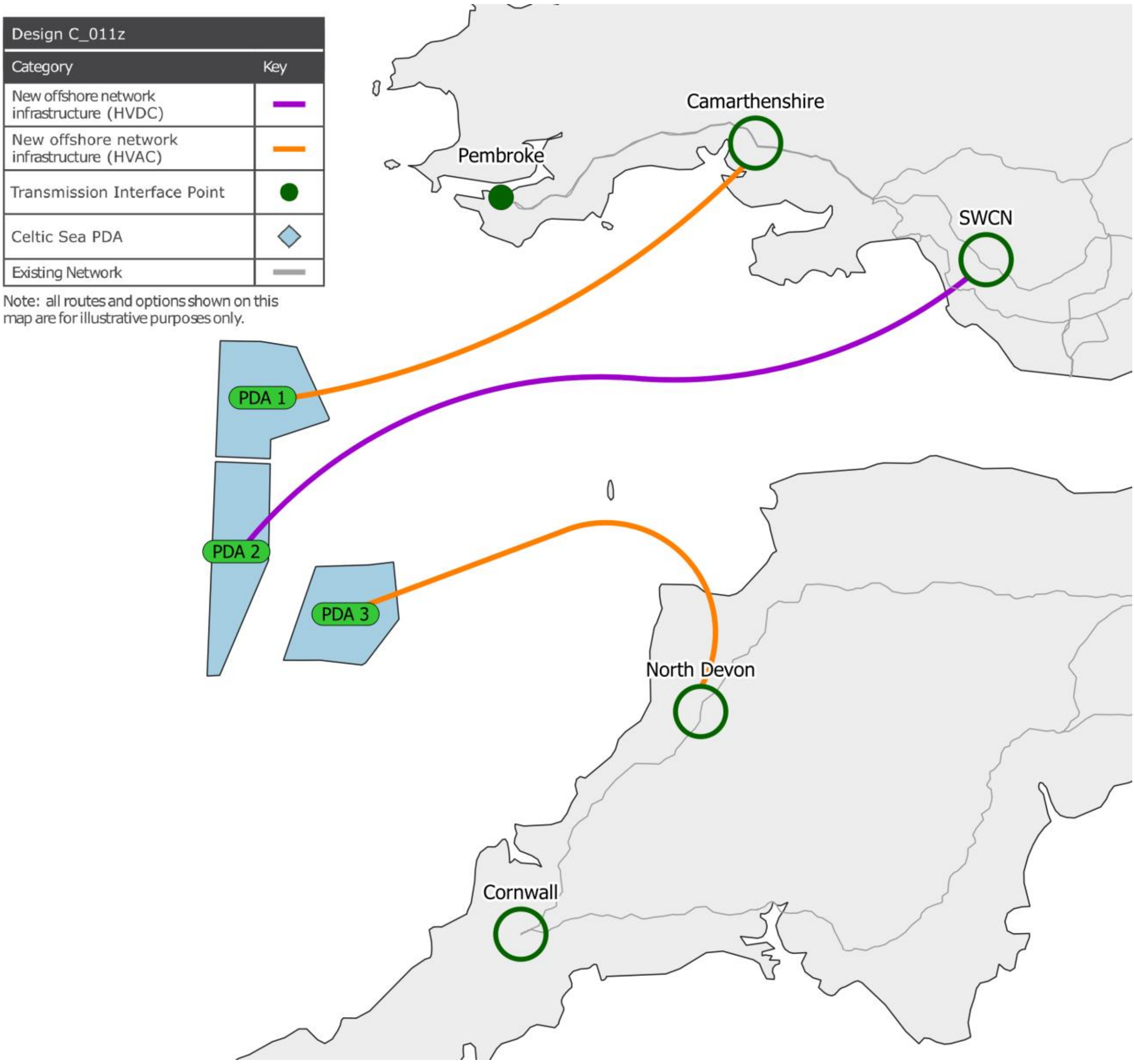

Figure 7: Celtic Sea recommended design

HNDFUE: INTOG

What was in scope of this design process?

The Innovation and Targeted Oil and Gas (INTOG) leasing round was included within the Holistic Network Design Follow Up Exercise (HNDFUE) Terms of Reference (ToR) with the submission of change control request CC005 in May 2023. The INTOG leasing round by Crown Estate Scotland (CES) aimed to boost offshore wind farm innovation, and reduce carbon emissions from oil and gas production, in line with the targets in the North Sea Transition Deal (NSTD).

INTOG projects were categorised as either Innovation (IN) or Targeted Oil and Gas (TOG) projects. The IN projects are smaller scale innovation projects of 100 MW. These projects will seek to trial innovations within the offshore wind sector, such as floating wind installations. The TOG projects are projects supplying electricity to oil and gas platforms in the North Sea, to reduce their carbon emissions. A total of 12 areas were leased for INTOG by CES, however the INTOG design process considered 6 in scope projects that were less progressed in their development and therefore could be evaluated without substantially delaying individual projects. INTOG projects that are not considered by the draft HND Implementation Plan are still subject to project level assessment as part of their own individual consenting processes, as with all offshore wind projects.

A key goal of the NSTD is to decarbonise North Sea oil and gas platforms. One of the ways to achieve this for oil and gas platforms is to utilise renewable electricity to provide heat and power. The NSTD includes a specific target to achieve oil and gas electrification by 2030, and this was therefore a keen focus of the INTOG design process. This INTOG specific requirement for a demand connection differentiated this from previous HNDFUE processes. The TOG projects anticipated that their demand would reduce during the 2030s as the platforms curtail output before eventually undergoing decommissioning. This would result in additional offshore wind generation output flowing into the transmission system as the projects progress.

Following discussions with the Office of Gas and Electricity Markets (Ofgem) and the Department for Energy Security and Net Zero (DESNZ), and with approval from the Transmission Networks Board, the NorthConnect interconnector was also added to the scope of this design process. To fully evaluate the effectiveness of coordination between the in scope projects and NorthConnect, designs were drafted both with and without it in scope for coordination. The developer of the Aspen, Beech and Cedar projects (Cerulean Winds) also presented a concept to construct an offshore hybrid asset (OHA) link from the Beech wind farm to Germany at the beginning of the HNDFUE INTOG process. This was included in the background of the economic modelling, but it did not form part of our final recommended design, and no recommendation has been made at this point by NESO relating to this element of the Cerulean project.

How was this design process carried out?

The INTOG design process once again followed the HNDFUE methodology. When determining interface points for designs to connect to, the Transmission Owners (TOs) were also asked to provide an indication of when each site could accept a connection. These were known as 'bay availability dates' and formed the basis of our assumptions on when each site could provide a demand connection to in scope TOG developers.

As with previous design exercises, a longlist of designs was drafted, exploring different offshore configurations to connect the in scope projects to the onshore network. Designs were split into IN designs and TOG designs for assessment in this process, based on the category of projects they considered. The IN and TOG projects were considered separately due to differences in both geographic location and project scale between the two project types. TOG designs were drafted within several design categories to evaluate different combinations of the following factors: coordinated or radial designs, coordination with the NorthConnect interconnector and the use of interface points located further south along the eastern coast of Great Britain.

A shortlist of designs was then identified in the same manner as previous HNDFUE processes, by comparing designs across the four network design objectives on their economic values and BRAG (Black, Red, Amber, Green) ratings accordingly, then identifying the best performing design within each design group. Input to this process was continually provided by subject matter experts representing each objective, to ensure an informed decision. Six designs were shortlisted for the TOG element (one in each design category), and two designs were shortlisted for the IN.

What was the outcome and how was it published?

The recommended INTOG design was found to provide bay availability to all TOG projects by 2030, and a coordinated yet flexible connection for both IN projects. As the IN and TOG elements of INTOG were assessed separately, the recommendation is therefore the combination of the final recommended designs for each. The recommended INTOG design is shown in Figure 8.

During the HNDFUE INTOG design process, a total of 35 TOG designs were appraised at the initial stage, consisting of 39 unique routes from wind farms to shore, or between wind farms. These routes considered 12 different interface points as potential places to connect to the transmission network. Based on the outcome of high level appraisals of these designs across the four network design objectives, six TOG designs were shortlisted for further detailed appraisal. Following further detailed analysis, a final TOG design was selected as the best performing design, as shown in Figure 8 below. This TOG element of the final design featured three HVDC connections from the in scope TOG projects to shore. The Cerulean projects – Aspen and Cedar – connect to Fetteresso and Near Branxton respectively. The NorthConnect interconnector coordinates with the Cenos project and forms an OHA connecting to Peterhead.

The TOG element of this design performs well across environment and community objectives, due to a reduction in cables making landfall and a lower proportion of interface points in sensitive areas. This design was therefore ranked joint first in both objectives when compared with other designs in the shortlist. This design also performs well economically, due to the benefits of coordination with NorthConnect. The benefit of the earliest possible connection for both projects results in substantial carbon cost savings, where the projects can support decarbonisation of the oil and gas platforms. Lastly, coordination with NorthConnect allows an additional export path for generation. This design performed second best out of all the shortlisted designs, second only to design TOG_M010Y-NC in this regard. The recommended design also performs well in deliverability and operability, due to lower offshore complexity when compared to coordinated designs and was ranked first in this objective.

Similarly to the TOG designs, a total of six IN designs were appraised in this design process, consisting of seven unique routes from wind farms to shore, or between wind farms. These routes considered the Peterhead area as a single interface point to connect to the transmission network. Based on the outcome of high level appraisals of these designs across the four network design objectives, two IN designs were shortlisted for further detailed appraisal. Following further detailed analysis, a final IN design was selected as the best performing design, as shown in Figure 8 below. The IN element of this design features coordination between the two IN projects, and then a direct link to Peterhead Area. The IN element was recommended based on two key factors. Firstly, the slightly better performance across the design objectives demonstrated that it would represent a marginally better solution than an alternative design, (namely IN_004). Secondly, it was determined, during the course of the final strategic options appraisal (FSOA) analysis, that developing the additional cable required in both designs as a separate link, rather than a bundled solution, would allow the project to proceed with more flexibility when both constructing and operating the IN projects. By not bundling these projects with the nearby SW_NE6 project, this allows them the flexibility to realise the separate innovation goals of the INTOG leasing round in a separate manner to SW_NE6.

The recommendation that resulted from this design exercise was then published in 2024 as the *Beyond 2030: INTOG* publication[9]. The detailed justification behind selecting this design and more information on the outcome of the design process is available in the *INTOG Supplementary Report*[10]. Further details on the individual routes in this design, along with detail on all routes in the overall HND and HNDFUE design recommendations are shown in Table 1, in the section titled *HND Implementation Plan Design Summary*.

[9] neso.energy/document/349556/download

[10] neso.energy/document/349561/download

Public

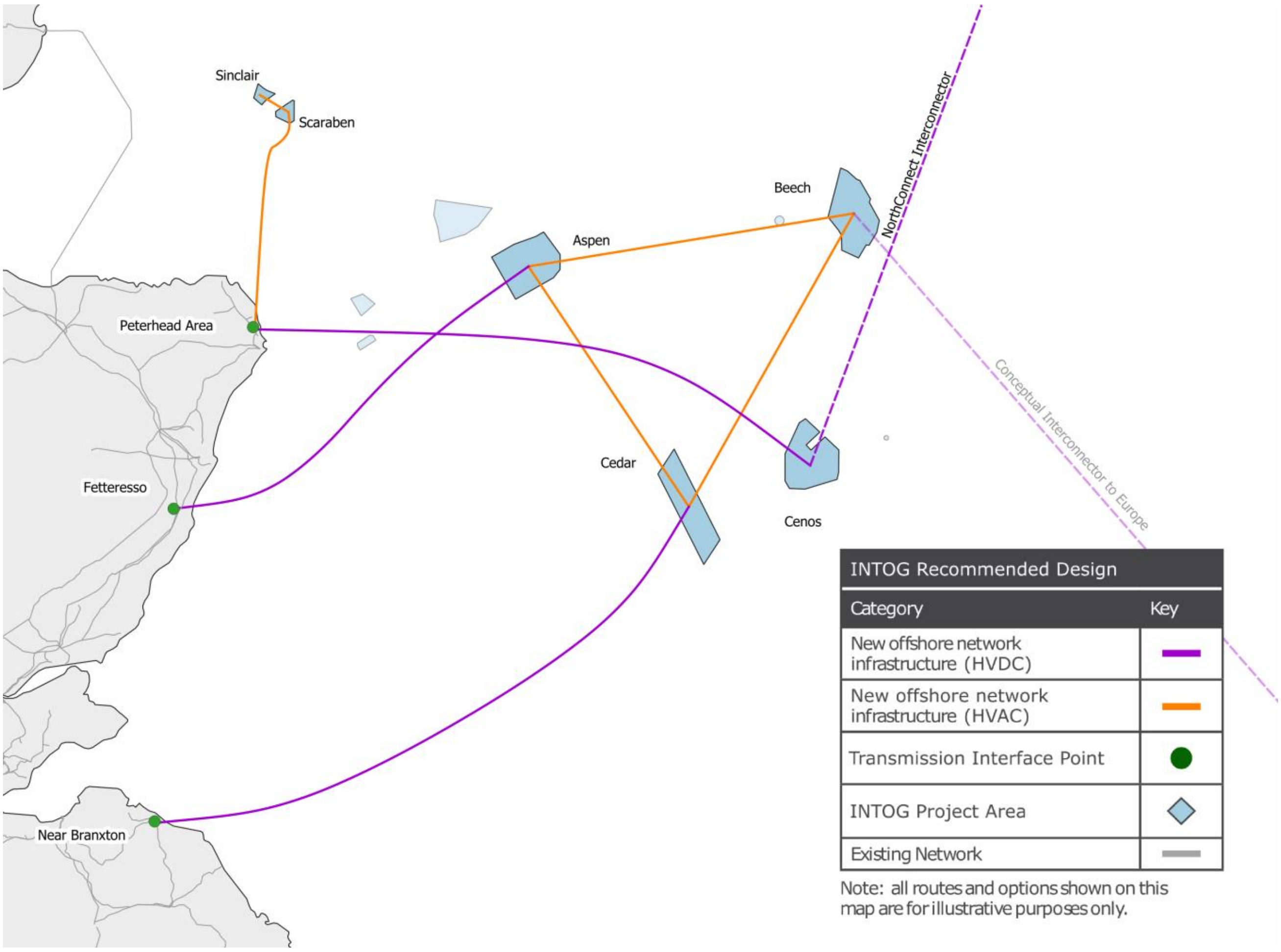

Figure 8: Recommended INTOG design

Design Changes: Impact Assessment

Beyond 2030, published in March 2024, incorporated our recommended design for projects from Holistic Network Design Follow Up Exercise (HNDFUE) ScotWind as well as *the Holistic Network Design (HND)* published in July 2022. Each design sets out a single, integrated network that supports the large-scale delivery of electricity generated from offshore wind, taking power to where it is needed across Great Britain. Since the publication of the HND, Transmission Owners (TOs) and in scope offshore wind developers with non-radial connections have started to produce the detailed network design (DND).

As part of the DND phase, TOs and developers consider the designs in more detail, and potential design changes are to be expected. This required us to develop a process to assess the impact of proposed changes, against the baseline of the HND, using the four HND design criteria. These changes may include a change in technology, cable route or length, or a change of network configuration that would have a material impact on the design criteria. We refer to this process as the Impact Assessment (IA) process. Changes made through this process were raised, assessed and implemented following the publication of these designs in the *Pathway to 2030* and *Beyond 2030* suite of publications.

Deviations from the recommendations may have wider implications for the transmission network and other industry processes. It is important that we understand the full impact of any design changes, as there may be consequences that are not immediately obvious, and we are best placed to conduct this holistic assessment.

IA is an ongoing process, and there are still several IA submissions in progress as of the writing of this draft HND Implementation Plan. However, for the purposes of the environmental assessment (including SEA, HRA and MCZ), there are currently two IAs completed and included in the Plan.

The first two IAs are included in the baseline and detailed below, the full list at time of publishing (October 2025) are in the Appendix C.

The first IA, known as Southern Cluster 1 (SC1), was submitted in August 2023 by HND parties which were due to be electrically connected off the east coast of England. These parties are known as the "Southern Cluster" (given their location in relation to other HND projects) and includes National Grid Electricity Transmission (NGET), Scottish & Southern Electricity Networks Transmission (SSEN-T), RWE (Dogger Bank South (DBS) East and DBS West) and SSE Renewables and Equinor (Dogger Bank D). The group submitted four categories of designs, ranging in levels of interconnection. The request followed recent movements in the global supply chain of HVDC technology which would make the HND network in this area challenging to deliver for 2030.

The IA identified a design which presented benefits across several of our network design objectives compared to the original HND recommended design (the 'baseline'). The best performing design, referenced as Category D (shown in Figure 9), included reduced interconnection for the Southern Cluster compared to the baseline HND, with the three offshore wind farms of the Southern Cluster connecting directly to shore via lower capacity cables (1.44 GW) and a single transmission cable (2 GW) coming from the Northern Cluster to Lincolnshire.

There were a number of changes that had occurred since the HND was published in 2022 which led to this outcome. Increases in the cost of offshore equipment above the rates of general price increases, challenges in the supply chain for transmission assets, and the identification of opportunities to realise additional electrical and physical capacity are key factors. A significant driver of this assessment and outcome was the updated delivery timescales for different technology types provided to us (then as the Electricity System Operator (ESO)) by the Southern Cluster parties. It was asserted that this would mean a delay of a number of years to delivery of the Southern Cluster projects. The Category D design was found to deliver economic benefits by enabling earlier connection of generators, operability benefits in providing a simpler design, environmental benefits in reducing assets in a marine area that is sensitive to cabling, and a small change in community impact driven by an additional convertor station being required onshore.

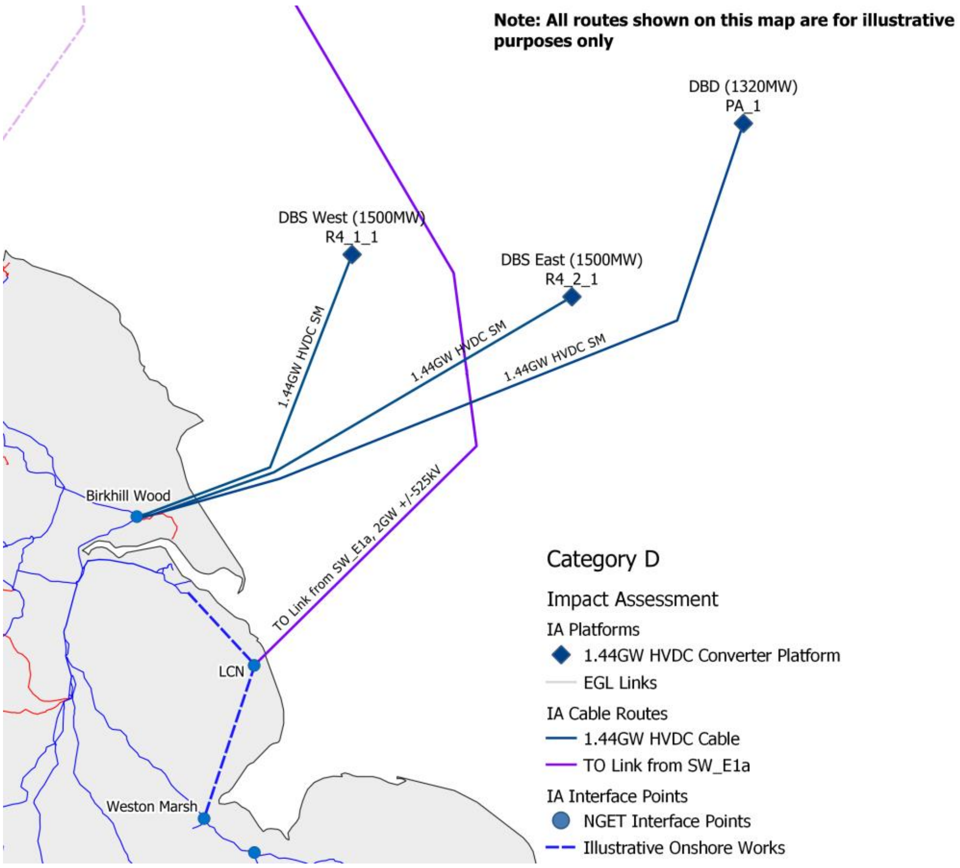

Figure 9: SC1 impact assessment outcome

The second IA, known as North Cluster 1 (NC1) was submitted in October 2023 by Scottish and Southern Electricity Networks (SSEN) on behalf of HND parties who were due to be electrically connected off the east coast of Scotland and England. These parties are known as the "North Cluster" (given their location in relation to other HND projects) and include SSEN-T, National Grid Electricity transmission (NGET), BP-EnBW (Morven) and Renantis (Bellrock). The group submitted three categories of designs, exclusively looking at the options for cabling technology and configurations from the offshore platform arrangements of Morven Windfarm to the landing point connection onshore at Hurlie (Fiddes). The request followed a recent alternating current (AC) cable assessment which has identified a reduced ability to transmit high volumes of power securely along long offshore AC cables without significant reactive power compensation.

The IA identified a design which presents benefits across several network design objectives compared to the original HND recommended design (the 'baseline'). The best performing design, referenced as Category C, performed more favourably against the HND design objectives than all other categories put forward. This design included a technology change to the link from E1a to Hurlie (Fiddes), from AC to direct current (DC), providing regional environmental benefits due to a reduction in cables and trenches, marginal economic benefits and significant operability benefits. The link that was the subject of this change is shown in 9 below:

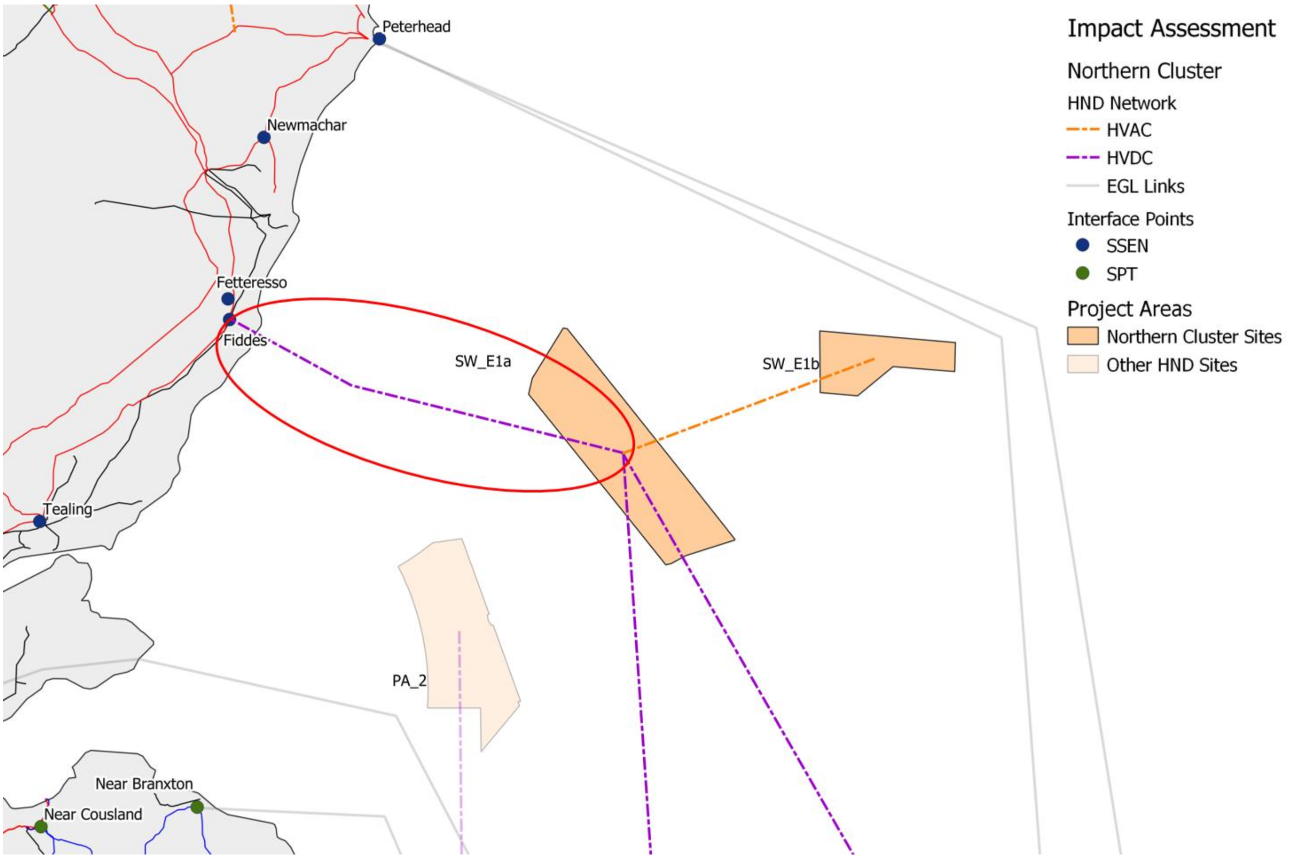

Figure 10: Northern Cluster Impact Assessment

In relation to design changes since the original HND publications, it should also be noted that, following discussion from environmental consultees, a minor change to SW_E1a_to_Hawthorn Pit 5 km cable study corridor was also carried out as part of the MCZ Stage 2 assessment. The study corridor route was updated to remove any overlap with the North East of Farnes Deep HPMA boundaries and adhere to a minimum 2 km buffer (as per guidance from JNCC and Natural England) between the study area and the HPMA. Further details of this minor update are captured as part of the HND MCZ Stage 2 Assessment.

HND Implementation Plan Design Summary

Following the Holistic Network Design (HND) and Holistic Network Design Follow Up Exercise (HNDFUE) design processes, and subsequent impact assessments (IAs), the final combination of all design recommendations is shown below in Figure 11. This represents the HND Implementation Plan design.

Figure 12 that follows this also shows how the overall offshore design recommendation has changed from the initial HND design, through HNDFUE ScotWind, INTOG and Celtic Sea and the IAs covered in the previous section. Details on the individual project names and connections are shown in Table 1 following these diagrams.

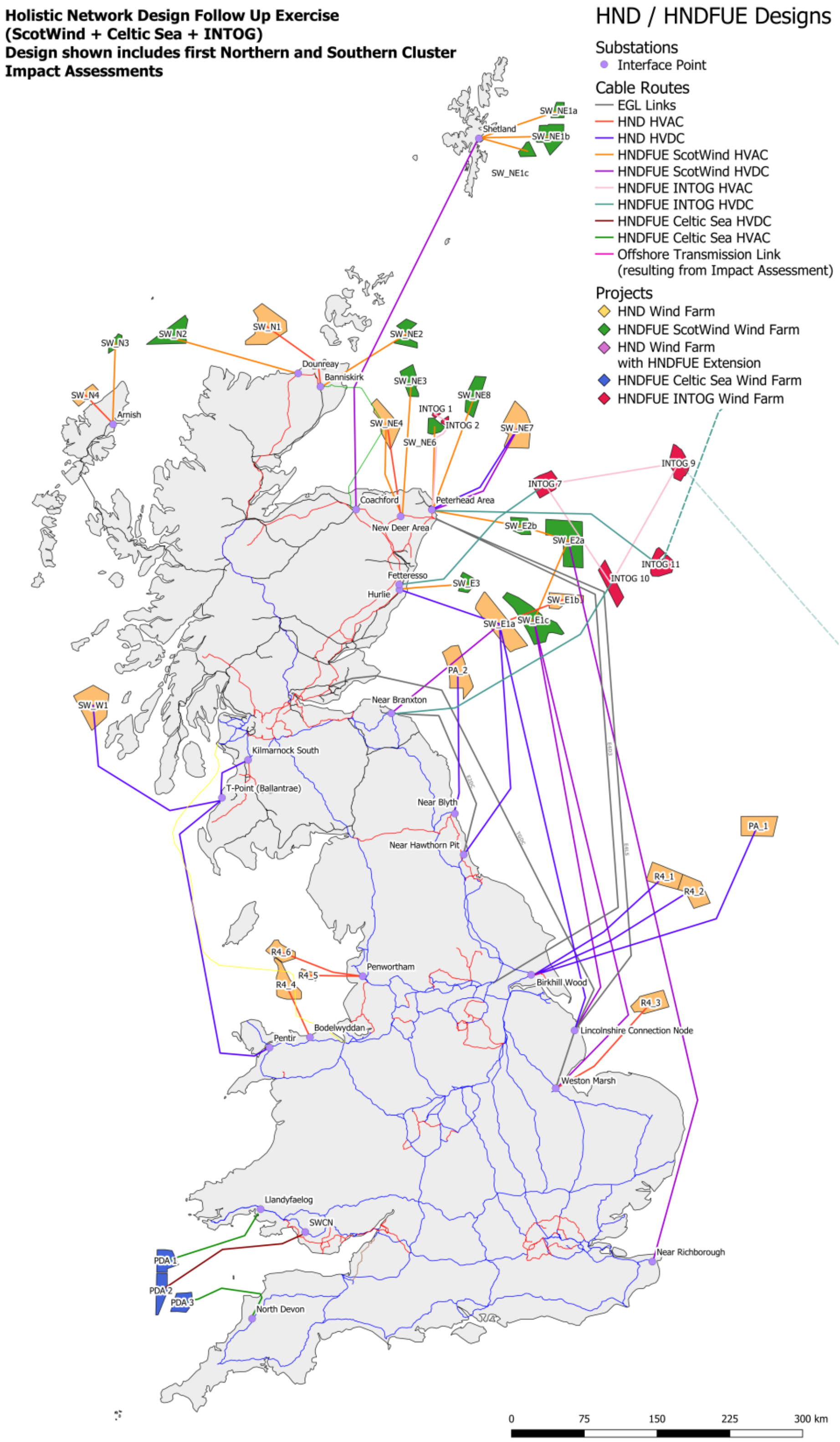

Figure 11: HND Implementation Plan design

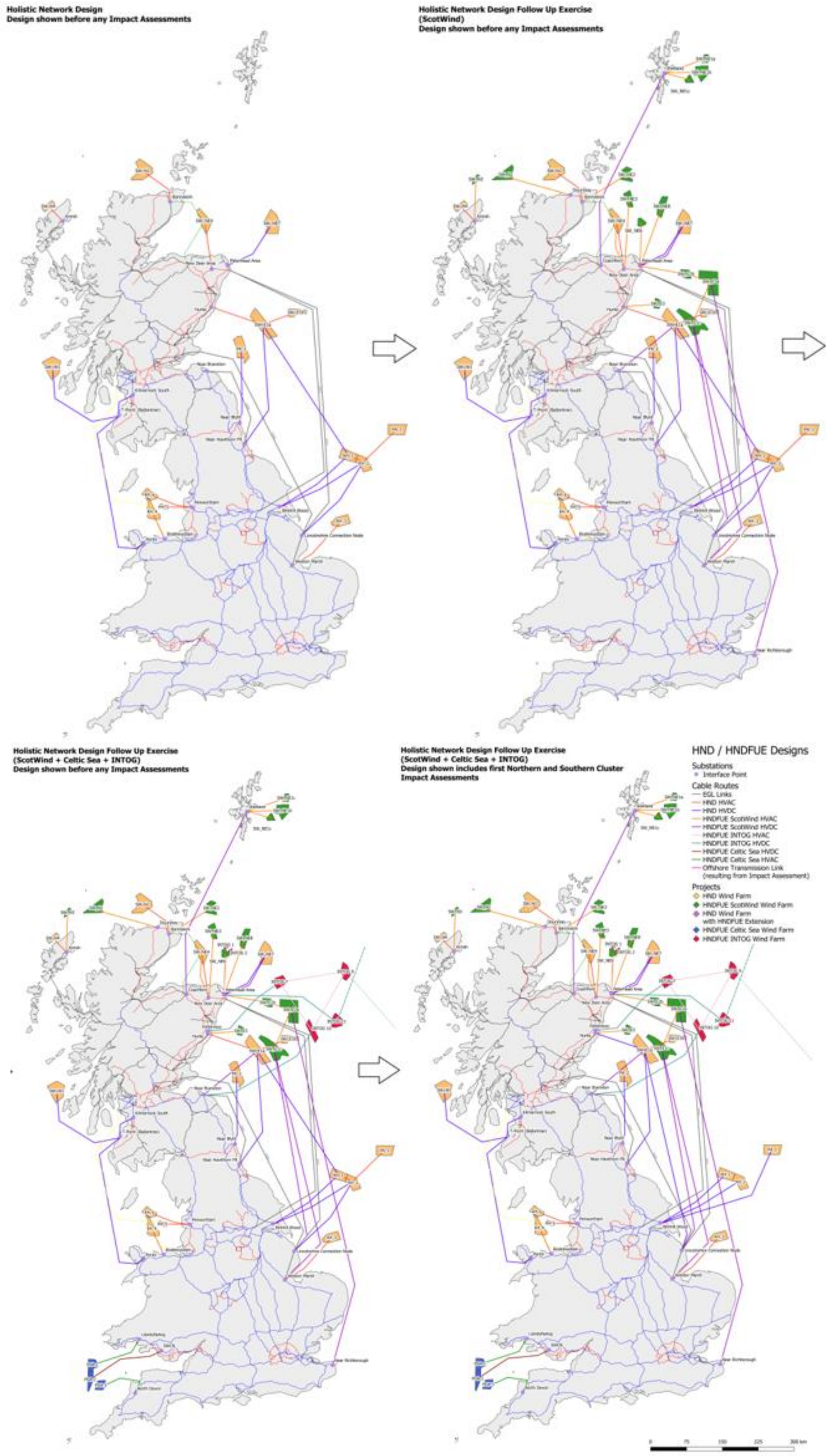

Figure 12: Progression of HND and HNDFUE designs

Table 1: HND/ HNDFUE Projects[11] shown in Figure 11

Map ID	Project Name	Part of HND	Connection Site	Connection Type	Capacity (MW)
PA_1	Dogger Bank D	HND1	Birkhill Wood	HVDC Converter Station	1,320
PA_2	Berwick Bank	HND1	Near Blyth	HVDC Converter Station	1,800
R4_1	Dogger Bank South West	HND1	Birkhill Wood	HVDC Converter Station	1,500
R4_2	Dogger Bank South East	HND1	Birkhill Wood	HVDC Converter Station	1,500
R4_3	Outer Dowsing	HND1	Weston Marsh	HVAC Substation	1,500
R4_4	Mona	HND1	Bodelwyddan	HVAC Substation	1,500
R4_5	Morecambe	HND1	Penwortham	HVAC Substation	480
R4_6	Morgan	HND1	Penwortham	HVAC Substation	1,500
SW_E3	Bowdun	HNDFUE ScotWind	Hurlie	HVAC Substation	1,008
SW_E1c	Ossian	HNDFUE ScotWind	Lincolnshire Connection Node, Weston Marsh, SW_E1a	HVDC Converter Station, Coordinated Connection through SW_E1a	3,528
SW_NE8	Buchan	HNDFUE ScotWind	Peterhead Area[12]	HVAC Substation	960

[11] Names of various Interface Points and Wind farm sites have changed during the development of the draft HND Plan. This is due to the development of projects, the refinement of Interface Point locations, as well as variation in the application of naming conventions. Details of naming conventions have been included in Appendix B of this draft HND Implementation Plan.

[12] References in Connection Site to 'area' are a simplification to aid understanding. The environmental assessments that accompany this draft Plan will refer to more specific locations in order to better assess potential environmental impacts around the interface point sites.

Map ID	Project Name	Part of HND	Connection Site	Connection Type	Capacity (MW)
SW_NE3	Stromar	HNDFUE ScotWind	New Deer Area	HVAC Substation	1,000
SW_NE6	Broadshore	HNDFUE ScotWind	Peterhead Area	HVAC Substation	900
SW_E1b	Bellrock	HND1	SW_E1a	Coordinated Connection through SW_E1a	1,200
SW_NE7	Marram	HND1, with extension in HNDFUE ScotWind	Peterhead Area	HVDC Converter Station (x2)	3,000
SW_W1	MachairWind	HND1	Kilmarnock South and Pentir via Ballantrae T-Point	HVDC Converter Station (x2)	2,000
SW_E2a	Campion	HNDFUE ScotWind	SW_E2b, Near Richborough	Coordinated Connection through SE_E2b, HVDC Converter Station	3,000
SW_NE2	Ayre	HNDFUE ScotWind	Spittal	HVAC Substation	1,008
SW_N4	Spiorad na Mara	HND1	Arnish	HVAC Substation	740
SW_N3	Tallisk	HNDFUE ScotWind	Arnish	HVAC Substation	495
SW_E2b	Muir Mhòr	HNDFUE ScotWind	Peterhead Area, SW_E2a	HVAC Substation, Coordinated Connection through SW_E2a	798
SW_N2	Havbredey	HNDFUE ScotWind	Dounreay	HVAC Substation	1,500

Map ID	Project Name	Part of HND	Connection Site	Connection Type	Capacity (MW)
SW_N1	West of Orkney	HND1	Spittal	HVAC Substation	2,250
SW_NE4	Caledonia	HND1 with HNDFUE ScotWind extension	New Deer Area	HVAC Substation (x2)	2,000
SW_NE1a	Shetland	HNDFUE ScotWind	Shetland, Blackhillock	HVAC Substation, HVDC substation (shared with all Shetland projects)	500
SW_NE1c	Ocean Winds Shetland	HNDFUE ScotWind	Shetland, Blackhillock	HVAC Substation, HVDC substation (shared with all Shetland projects)	500
SW_NE1b	Arven	HNDFUE ScotWind	Shetland, Blackillock	HVAC Substation, HVDC substation (shared with all Shetland projects)	1,800
SW_E1a	Morven	HND1, with extension in HNDFUE ScotWind	Hurlie, Nr Hawthorn Pit, Lincolnshire Connection Node, Branxton	HVDC Converter Station (x4)	3,000
PDA 1[13]	Round 5 (Celtic Sea) PDA 1	HNDFUE (Celtic Sea)	Carmarthenshire	HVAC Substation	1,500

[13] These projects are contained within the Crown Estate's Round 5 (Celtic Sea) leasing round and are yet to be awarded to developers as of January 2025. Each project development area (PDA) has a maximum capacity of 1500 MW

Map ID	Project Name	Part of HND	Connection Site	Connection Type	Capacity (MW)
PDA 2	Round 5 (Celtic Sea) PDA 1	HNDFUE (Celtic Sea)	South Wales Connection Node	HVDC Converter Station	1,500
PDA 3	Round 5 (Celtic Sea) PDA 1	HNDFUE (Celtic Sea)	North Devon	HVAC Substation	1,500
INTOG 1	Sinclair	HNDFUE (INTOG)	INTOG 2	Coordinated Connection through INTOG 2	100
INTOG 2	Scaraben	HNDFUE (INTOG)	Peterhead Area	HVAC Substation	100
INTOG 7	Aspen	HNDFUE (INTOG)	Fetteresso	HVDC Converter Station	1,000
INTOG 9	Beech	HNDFUE (INTOG)	INTOG 7, INTOG 10	Coordinated Connection through INTOG 7 and INTOG 10	1,000
INTOG 10	Cedar	HNDFUE (INTOG)	Near Branxton	HVDC Converter Station	1,000
INTOG 11	Cenos	HNDFUE (INTOG)	Peterhead Area	HVDC Converter Station	1,350

HND Implementation Plan Environmental Assessments

Three environmental assessments have been carried out for the draft Holistic Network Design (HND) Implementation Plan; a Habitats Regulations Assessment/Appraisal (HRA); a Marine Conservation Zone (MCZ) Assessments and a Strategic Environmental Assessment (SEA). Whilst it is not mandated that Offshore Coordination carry out a MCZ assessment, due to the size and scope of the design exercises, carrying out these assessments will ensure our recommendations have given the appropriate level of consideration to environmental concerns. All three assessments were carried out in parallel with each other, and a description of each has been provided below.

Habitats Regulations Assessment/Appraisal (HRA)

A HRA has been undertaken on the draft HND Implementation Plan. In summary, HRA is:

- A statutory process which consists of an iterative series of assessments required under the Conservation of Habitats and Species Regulations 2017 (as amended), The Conservation (Natural Habitats, &c.) Regulations 1994 (applicable in Scotland), and Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended), for any plan or project that could affect European designated sites for nature conservation.
- European designated sites include Special Areas of Conservation (SACs), Special Protection Areas (SPAs), candidate Special Areas of Conservation (cSACs), potential Special Protection Areas (pSPAs) and, as a matter of Government policy, Ramsar sites (wetlands of international importance).

NESO commissioned AECOM to undertake an independent and objective HRA on the draft HND Implementation Plan, in accordance with the requirements of Scottish, English and Welsh HRA Regulations.

The HRA process included Stage 1 assessment of potential likely significant effects and Stage 2 Appropriate Assessment (AA) of the potential for Adverse Effects on Site Integrity (AEoSI) of European sites (including Ramsar sites). A derogation report was also produced, indicating the process and outcomes for the derogation test identified as being necessary as part of the AA for the draft HND Implementation Plan in relation to the potential for AEoSI for four identified study corridors of the Recommended Design.

Marine Conservation Zone (MCZ) Assessment

NESO commissioned AECOM to undertake an independent and objective MCZ Assessment on the draft HND Implementation Plan. In summary, MCZ assessments are undertaken to determine whether possible impacts of a proposed activity have the potential to hinder the conservation objectives of sites designated under the Marine and Coastal Access Act 2009 (MCAA). This process encompasses a variety of sites designated (collectively referred to herein as MCZs, unless otherwise stated) within UK's territorial and offshore waters:

- MCZs in English, Welsh, and Northern Irish waters;
- Highly Protected Marine Areas (HPMA) in English waters; and
- Nature Conservation Marine Protected Areas (NCMPAs (herein referred to as MPAs)) in Scottish waters.

The MCZ assessment for Offshore Coordination predominantly follows legislation under Section 126 of the MCAA 2009. The process follows the Marine Management Organisation's (MMO) guidance for English MCZ assessments (2013) and has been applied to Welsh and Scottish waters in the absence of guidance from the respective regional authorities.

Strategic Environmental Assessment (SEA)

NESO commissioned RPS to carry out a SEA for the draft HND Implementation Plan in accordance with the European Communities Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive), and in accordance with The Environmental Assessment of Plans and Programmes Regulations 2004 (S.I. 2004 No. 1633), The Environmental Assessment of Plans and Programmes (Wales) Regulations 2004 (Welsh Statutory Instrument 2004 No. 1656), and the Environmental Assessment (Scotland) Act 2005 (2005 asp 15).

The purpose of the SEA, and subsequent SEA Environmental Report, is to provide a formal and transparent assessment of the likely significant effects on the environment arising from implementation of the draft HND Implementation Plan, including consideration of reasonable alternatives.

The outcomes of the three environmental assessments carried out on this draft HND Implementation Plan are captured within the "Environmental Assessment Outcomes" section of this Plan.

Environmental Assessment Outcomes

Habitats Regulations Assessment/Appraisal (HRA)

The HRA Report for the draft Plan considered the potential for likely significant effects, and subsequently Adverse Effects on Site Integrity of identified European sites, with regard to their Qualifying Interest Features and associated Conservation Objectives. In the majority of cases, it was concluded that the Plan will not have an adverse effect on the integrity of any European sites alone or in combination with other plans or projects.

This conclusion was partly due to the requirement for a down-the-line project level HRA for specific planning applications when the fullest level of detail on each scheme is available. It was also partly due to the conclusion that it would be possible for most new cable routes to either avoid or adequately mitigate adverse effects on the integrity of European sites. Finally, it was partly due to the fact that the Plan is not legally, spatially or technically binding on developers and therefore does not restrict developers to utilise a corridor identified in the Plan.

The exceptions identified by the HRA were for cable routes PA_1 to Birkhill Wood, R4_1 to Birkhill Wood, R4_2 to Birkhill Wood, and SW_N4 to Arnish (Lewis). The HRA Derogation Report considered these routes further. It concluded that for three of the study corridors (PA_1 to Birkhill Wood, R4_1 to Birkhill Wood and R4_2 to Birkhill Wood, all of which connect to wind farms located within Dogger Bank and thus require traversing Dogger Bank SAC) it is likely that at the planning application level a robust Derogations case can be made, subject to further detailed work that will need to be undertaken for the planning application. For one corridor (PA_1 to Birkhill Wood) the developer has identified a feasible alternative study corridor, which they intend to pursue. However, despite the alternative study corridor reducing the risk of needing cable protection compared to the original study corridor, derogations and compensatory provision would still be required. For the corridor SW_N4 to Arnish (Lewis)) an alternative corridor was considered but was concluded as not technically or financially viable. The original study corridor was considered to offer greater opportunities for the delivery of sufficient mitigation to avoid or reduce an adverse effect on the integrity on any European sites. Therefore, the original study corridor was taken forward; with potential compensatory measures identified.

Marine Conservation Zone (MCZ) Assessment

The Stage 1 MCZ assessment for the draft Plan identified eight study corridors as having the potential to hinder the conservation objectives of an English MCZ, Highly Protected Marine Area (HPMA), or Scottish Marine Protected Area (MPA), despite the implementation of best practice mitigation measures. As such, these Study Corridors were further considered by a Stage 2 Assessment. This stage identified 'other means of proceeding' for all eight identified route corridors that it considered to be reasonably feasible, given the level of design detail at plan-level. For several of the identified route corridors, this applied to micro-siting within the MCZs, informed by targeted surveys. For the identified route corridor from SW_E1a (Morven) to Hawthorn Pit, this considered avoidance of the North East of Farnes Deep HPMA by a minimum of 2 km.

Strategic Environmental Assessment (SEA)

The report findings highlight the potential positive and negative effects of implementing the draft Holistic Network Design (HND) Implementation Plan at a strategic level across the various SEA 'topics'. The results of this have demonstrated the successful application of the appraisal process to avoid the most sensitive environmental designations where possible.

In summary, the SEA indicated the potential for significant negative effects on Biodiversity, Flora and Fauna from development of cabling within identified route corridors and onshore infrastructure within interface areas. This was due to the potential for direct, short-term, negative effects on features of designated sites that are unavoidable by cable routes, and indirect effects on designated sites within proximity to developments, noting that identified route corridors aimed to avoid all designated sites, where this was possible. The potential for moderate negative effects on Biodiversity, Flora and Fauna was also indicated, owing to the significant amount of offshore and onshore cabling required, which could have longer-term negative effects on protected habitats such as reefs, where recovery may be difficult, as well as the significant amount of onshore interface infrastructure required, albeit with potential avoidance of sensitive areas.

The potential for significant, short-term temporary, negative effects was identified for Material Assets, primarily due to the significant amount of unavoidable infrastructure, including cables and pipelines, that would need to be crossed by cables within the Recommended Designs, as well as infrastructure that is unavoidable within interface areas, and the potential for damage and/or disruption to services, as well as interaction with busy shipping and fishing areas during construction and decommissioning.

HND Implementation Plan Monitoring

The SEA Directive requires that the implementation of a Plan or Programme is monitored to identify, at an early stage, any unforeseen adverse effects and to undertake appropriate remedial action. With regards to Plan monitoring, NESO will be responsible for tracking the development of the HND/HNDFUE projects included in the draft HND Implementation Plan towards successful consenting. Contrary to updates captured as part of the NESO Impact Assessment process, deviations from the original HND/HNDFUE radial connection recommendations would not be assessed formally within our future assessments, however they would be included as part of the revised baseline for future Plan updates to ensure cumulative impacts can be accurately assessed.

SEA monitoring should be undertaken in conjunction with proposed updates of the HND Implementation Plan, to enable monitoring outcomes to influence the Plan review and development. The proposed monitoring programme, which will be carried out by environmental consultants, has been included as part of the SEA Environmental Report which is based on the

Indicators and Targets established in the Strategic Environmental Objectives (SEOs). Much of the environmental monitoring proposed can be collated from ongoing environmental monitoring and reviews undertaken by bodies such as statutory nature conservation bodies and the Office for National Statistics. The indicators and data proposed for the monitoring the implementation of the Draft HND Plan are intentionally focused at a strategic level, to match the SEOs and are nationally consistent and are freely available. Monitoring is also likely to be required as part of consenting conditions at the project level for cabling and associated infrastructure developments. Project level monitoring outcomes may influence future understanding of environmental interactions that can be taken into account during subsequent HND Implementation Plan updates. It should also be noted that with required survey campaigns there should be opportunities to share new information from collaborative approaches to expand knowledge and understanding, to inform future developments and aid future decision-making processes.

HND Implementation Plan Next Steps and Revision Schedule

Next Steps

Following the successful completion of NESO internal governance, the public consultation begins on 3 November 2025 until 30 January 2025. During this 13-week period, the draft Holistic Network Design (HND) Implementation Plan, and corresponding Strategic Environmental Assessment (SEA), Habitats Regulations Assessment/Appraisal (HRA) and Marine Conservation Zone (MCZ) assessments are publicly available in a digital format via the NESO website for review and comment.

Following completion of the consultation period, all comments will be collated and the draft HND Implementation Plan, SEA Environmental Report, HRA Report and MCZ Report will be reviewed and revised as necessary. Provided there are no objections or comments that will significantly alter the draft HND Implementation Plan and associated assessments, NESO, as Competent Authority, will undergo an internal approval process, following which we will formally submit the Plan and associated assessments to the Appropriate Authority for final approval.

Following successful approval by the Appropriate Authority, the final version of the HND Implementation Plan can be adopted. This is currently anticipated to be in Summer 2026.

Following release of the adopted HND Implementation Plan, an SEA Statement will be drafted to summarise the process undertaken and identify the manner by which environmental considerations and consultations were integrated into the final HND Implementation Plan.

Revision Schedule

NESO are committed to reviewing the HND Implementation Plan and associated environmental assessments required, until a time where the Plan is concluded. This is expected to be when the projects associated with HND/HNDFUE are at a sufficiently advanced stage in project level consenting or are no longer required. The revision schedule will involve the following elements:

- A formal review of the Plan and associated environmental assessments is expected to be carried out every three years.
- In addition to this formal three-yearly review period, a programme of monitoring will be carried out to capture the evolution of HND and HNDFUE project level developments in line with the HND Implementation Plan.
- Should "significant changes[14]" to the existing Plan be required, then an "interim SEA Light[15]" may be required to assess the potential impacts of the change on the Plan.
- If, as a result of this review, a revision of the Plan is required, then the next iteration may be carried out and published before the three-year review period.
- We will also review the impact of bringing forward a plan revision at this stage on other NESO wide Projects.
- The formal review period will always be re-started with the next HND Implementation Plan iteration taking place three years after the last version was published.

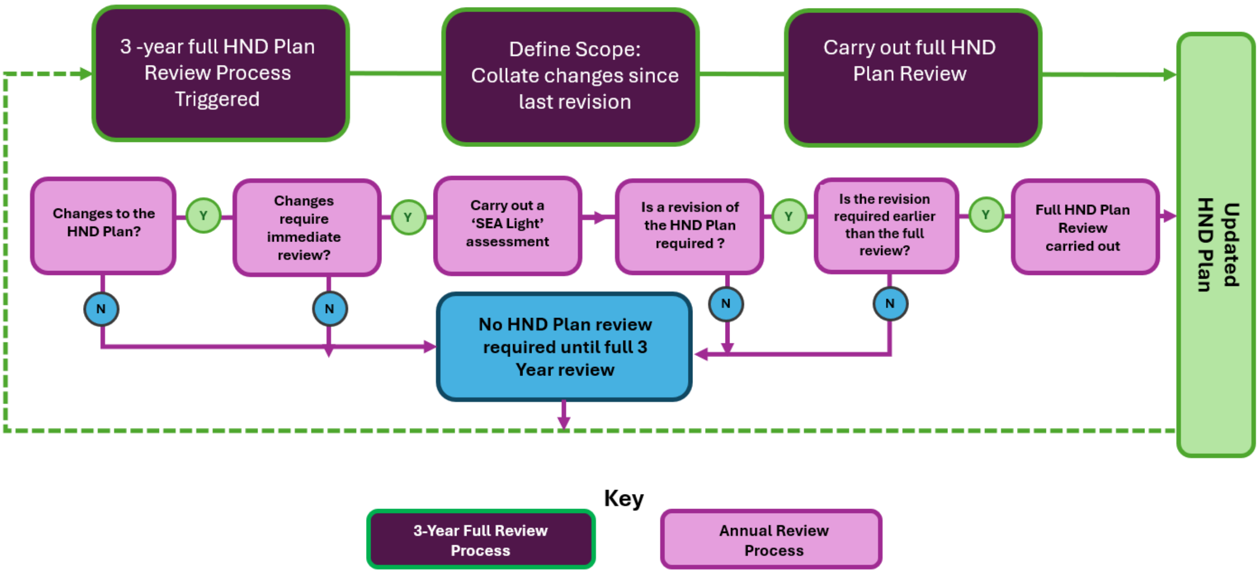

Figure 13: HND Implementation Plan Iteration Schedule

[14] "Significant changes" would cover updates triggering the need for a NESO Impact Assessment (IA) e.g. a coordinated design change, or a change resulting in a significant change to the environmental classification of a particular design, e.g. multiple radial design changes which may result in a significant detrimental change to the expected cumulative impacts associated with it.

[15] An SEA light is a high-level assessment tool which allows you to assess the potential impacts of a specific change under the various environmental and social topic areas covered under a formal SEA. It allows you to predict the potential impacts associated with a change to the Plan e.g. change to an original cable route design, ahead of a formal SEA revision.

Appendix A: Environmental and Community Constraints

Geographical Information System (GIS) data was collected for the constraints and sensitivities to be considered as part of the equal footed HND/HNDFUE appraisal exercises. Each constraint was classified in order to reflect the likelihood that it would contribute to planning, consenting or technical issues during further development. Classifications were displayed on a scale of Black, Red, Amber or Green (BRAG), where Green is the least constraining and Black is the most constraining. This system of classification was known as a BRAG rating. Table 2 below shows the definition of each BRAG rating in the context of constraint classification.

Table 3 shows the BRAG ratings resulting from each constraint considered within environmental and community assessments.

Table 2: Constraint BRAG ratings

Rank	Environment/Community	Technical
Black	Features or designations which affect the likelihood of an option being achievable to such a degree that the option should not be considered as part of the Holistic Network Design (HND).	Features or constraints that are likely to affect the feasibility of construction and/or buildability of the HND to such a degree that the option should not be considered as part of the design.
Red	Features or designations that are so significant or pose such a high degree of risk to the design that they should be avoided[16], except in exceptional cases which include where potential mitigation (or compensation) is known; where the potential benefits to the design would clearly outweigh the potential harm and/or impacts; or where there are no alternatives.	Features or constraints that are likely to affect the feasibility of construction and/or buildability of the design to such a degree that options affecting them should not be included in the HND without potential solutions to the issues raised.
Amber	The most protected features and/or areas that are likely to require detailed assessment and/or mitigation and should be avoided if possible.	Significant technical constraints that may cause cost increases and/or significant schedule delays; not ideal but likely to be achievable and/or capable of resolution.
Green	Features or designations to be taken into account in constraint assessment/study but which are likely to be capable of resolution.	Informative of approach but medium to low likely technical constraint causing significant cost increase and/or significant schedule delays.

Table 3: Environmental, community and technical constraints

[16] To be avoided except for linear constraints - being point to point features, where it may not be possible to avoid crossing these constraints.

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
National Parks	UK National Parks	N/A	N/A	A	A	R
Areas of Outstanding Natural Beauty (AONBs)	England and Wales AONB and Scotland NSAs	N/A	N/A	A	A	R
Heritage Coasts	England and Wales Heritage Coasts	N/A	N/A	A	A	R
National trails	England and Wales National Trails, and Scotland's Great Trails	N/A	N/A	A	A	A
Special Areas of Conservation (SAC)	Onshore and offshore UK SACs - identified as having sensitive features	R	R	R	R	R
	Onshore and offshore UK SACs - not identified as having sensitive features	A	A	A	A	R
Special Protection Areas (SPA)	Onshore and offshore UK SPAs - identified as having sensitive features	R	R	R	R	R
	Onshore and offshore UK SPAs - not identified as having sensitive features	A	A	A	A	R
pSPAs	England and Scotland proposed SPAs	A	A	A	A	R
cSACs	UK candidate SACs	A	A	A	A	R
SCI	Sites of Community Importance	A	A	A	A	R
Ramsar sites	UK Ramsar sites	A	A	A	A	R
Proposed Ramsar sites	UK Proposed Ramsar sites	A	A	A	A	R
SSSIs (Sites of Special Scientific Interest)	UK SSSIs	A	A	A	A	A
National Nature Reserves (NNRs)	UK National Nature Reserves	A	A	A	A	A

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
Biosphere Reserves	UK Biosphere Reserves	G	G	G	G	G
Marine Protected Areas (MPAs)	UK Marine Protected Areas	A	A	A	N/A	N/A
Marine Conservation Zones (MCZs)	UK Marine Conservation Zones - identified as having sensitive features	R	R	R	N/A	N/A
	UK Marine Conservation Zones - not identified as having sensitive features	A	A	A	N/A	N/A
Ancient Woodlands	UK Ancient Woodlands	N/A	N/A	A	A	R
Important Bird Areas	UK Important Bird Areas	G	G	G	G	A
RSPB Reserves	UK RSPB Reserves	G	G	G	G	A
Seabird At Sea Density (Summer/Winter)	UK Seabirds at Sea Density	G	G	N/A	N/A	N/A
Annex 1 Sandbanks	UK Annex 1 Sandbanks	A	A	A	N/A	N/A
Annex 1 Submarine Structures	UK Annex 1 Submarine Structures	A	A	A	N/A	N/A
Annex 1 Saltmarsh	UK Annex 1 Saltmarsh	A	A	A	N/A	N/A
UK Grey Seals	UK Grey Seal - High density	G	G	A	N/A	N/A
UK Harbour Seals	UK Harbour Seal - High density	G	G	A	N/A	N/A
SCANS 3 (marine mammal densities)	UK Marine Mammal densities	G	G	G	N/A	N/A
Fish spawning grounds	UK Fish spawning grounds 2010	G	G	N/A	N/A	N/A
Fish nursery grounds	UK Fish Nursery grounds 2010	G	G	N/A	N/A	N/A
World Heritage Sites (WHS)	UK World Heritage Sites	R	R	R	R	B
Scheduled Monuments	UK Scheduled Monuments	R	R	R	R	R

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
Listed Buildings	UK listed buildings (Grade I, II* and II listed buildings)	N/A	N/A	A	A	R
Registered Parks and Gardens and Gardens and Designed Landscape	Registered Parks and Gardens and Gardens and Designed Landscape	N/A	N/A	A	A	R
Wreck locations	UK wreck locations	R	R	R	N/A	N/A
Protected wrecks	England and Wales protected wrecks	R	R	R	N/A	NA
Ship Hulk	Ship Hulk	R	R	R	N/A	NA
Registered Battlefields	England and Scotland Registered Battlefields	N/A	N/A	A	A	B
Historic Marine Protected Areas	Scotland Historic Marine Protected Areas	R	B	R	N/A	NA
Air Quality Management Areas (AQMAs)	UK Air Quality Management Areas	NA	NA	NA	G	G
Major Settlements	UK Major Urban Settlements (for noise, see also Socio-Economics)	N/A	N/A	G	G	A
Geoparks	UK Geoparks	N/A	N/A	G	G	G
Water- lakes	Lakes and large water bodies for Great Britain	N/A	N/A	N/A	A	B
Water- rivers	Rivers for Great Britain	N/A	N/A	G	G	R
National Flood Zones/Areas Benefiting from Defences	3 National Flood Zones and 3 Areas benefiting from defences	N/A	N/A	G	G	A
Former Landfill Sites	England and Wales former landfill sites	N/A	N/A	A	A	A
Major settlements/Urban Areas	UK Major Urban Settlements	N/A	N/A	R	R	R

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
National Trust Land	National Trust Open Land and Limited Access Land	N/A	N/A	A	A	R
Trans-European Networks (roads or national/European walking/cycling routes)	Roads and Railway	N/A	N/A	G	G	R
Military Airfields/ Sites/ Practice Areas	Military Areas - onshore sites and offshore live firing areas	A	R	A	G	R
Passenger Airports	Airports	N/A	N/A	A	A	R
Major onshore utilities and other installations	Includes electrical and gas but not telecoms	N/A	N/A	A	A	B
Port Lands		R	R	R	R	R
Harbour Areas		G	A	G	N/A	N/A
RYA marinas	RYA Marinas - check buffer	R	R	R	N/A	N/A
RYA sailing and racing areas	RYA Boating Areas	G	A	G	N/A	N/A
Dredging	UK Dredging Navigation	A	R	A	N/A	N/A
	UK Aggregate Dredging Extraction	R	R	R	N/A	N/A
Dredge and Spoil Dumping Sites	UK Dredge Spoil Dumping sites	R	A	N/A	N/A	N/A
Offshore energy generation and cable routes	UK Offshore Energy Generation Sites – Existing sites	R	R	N/A	N/A	N/A
	UK Offshore Energy Generation Sites – Proposed sites	G	A	N/A	N/A	N/A
	UK Offshore Energy Cable Routes – Existing routes	A	A	R	N/A	N/A

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
	UK Offshore Energy Cable Routes – Proposed routes	G	A	G	N/A	N/A
Offshore Infrastructure	Offshore Telecom Cables	A	A	A	N/A	N/A
	Offshore Power Cables	A	A	A	N/A	N/A
	Offshore Pipelines	A	A	A	N/A	N/A
	UK Oil and Gas Wells and Diffusers	R	R	N/A	N/A	N/A
	UK Offshore Oil and Gas Installations	R	R	R	N/A	N/A
	UK Offshore Carbon Capture and Storage Site Agreements	A	A	N/A	N/A	N/A
	UK Offshore Meteorological and Oceanographic Equipment Agreements	A	A	N/A	N/A	N/A
Other planned infrastructure (e.g. coastal development near potential landfall areas)		A	A	A	A	A
Traffic Separation zone	Traffic Separation Zones	A	B	N/A	N/A	N/A
Shipping Lanes	Shipping Lanes	A		A	N/A	N/A
AIS Vessel Density Grid	UK AIS Vessel Density grid High density shipping areas	A	A	A	N/A	N/A
Designated Anchorage Areas	Designated anchorage areas	R	R	R	N/A	N/A
Bathing Waters	Bathing Water	G	R	G	N/A	N/A
Shellfish Waters	Shellfish Waters	G	A	G	N/A	N/A
Fishing Activity	UK Fishing Activity-Areas of high intensity fishing effort	G	G	G	N/A	N/A

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
Marine Fish Farms	UK Marine Finfish	A	R	A	N/A	N/A
Bathymetry	Slope 10 - 15%	G	G	G	N/A	N/A
Bathymetry	Slope >15%	R	B	R	N/A	N/A
Bathymetry	Depth <10m	G	N/A	N/A	N/A	N/A
Bathymetry	Depth <20m and Depth >50m	N/A	B	N/A	N/A	N/A
Cliff Shoreline	>15m	N/A	N/A	R	N/A	N/A
Average Wave Height (sig wave 50%tile)	>2.5m	N/A	R	N/A	N/A	N/A
Uplands Topography	>200m	N/A	N/A	N/A	G	R
Slope Topography	Slope >57% (30 degrees)	N/A	N/A	N/A	R	R
Areas of mobile sediment- from sand or Rock/ other substrata part of data	Offshore Sand	G	G	G	N/A	N/A
Known geological constraints (Offshore)	Offshore Rock	A	A	A	N/A	N/A
Known geological constraints (Onshore)	Shallow soils and exposed rock	N/A	N/A	A	A	G

Appendix B: HND Naming Conventions

Naming convention changes within the HND Implementation Plan

Names of various Interface Points have changed during the development of the draft Holistic Network Design (HND) Plan. This is due to a number of reasons including the development of projects and the refinement of Interface Point locations.

Table 4: Constraint BRAG ratings

	HND Name	HNDFUE Name	Celtic Sea Name	INTOG Name
Interface point name	Peterhead	Peterhead 1	N/A	N/A
	N/A	Peterhead 2	N/A	N/A
	N/A	Peterhead DCSS[17]	N/A	N/A
	Weston Marsh	Weston Marsh	N/A	N/A
	Near Spalding North	N/A	N/A	N/A

For example, during the first phase of HND (HND1), only one site was required at Peterhead (hence the name being 'Peterhead'. By Holistic Network Design Follow Up Exercise (HNDFUE) however, the development of a second site in the area was required. Therefore, during the HNDFUE design phase, 'Peterhead' became 'Peterhead 1', emphasising it as a site which is distinct from the new 'Peterhead 2'.

Since HND, names of a number of interface points have changed further, as projects develop. It is not considered necessary to set out these changes here, because the new names do not appear within these environmental assessments and related documents. The latest names will however be captured within subsequent iterations to the HND Implementation Plan and associated environmental assessments.

Naming convention changes beyond the HND Implementation Plan

In recognition of the varying processes being undertaken as part of the development of offshore wind energy in Scotland, such as the Scottish Government's draft updated Sectoral Marine Plan for Offshore Wind Energy, NESO's transmission network planning through the HND and HNDFUE, and the Crown Estate Scotland leasing process, the below tables set out a comparison of naming codes and labels used across the above pieces of work. This variation arises primarily from different applications of these naming conventions and the table aims to aid readers looking across various documents and processes. Those marked as "N/A" for the HND name are not within the scope of either the HND or HNDFUE.

[17] Peterhead 2 and Peterhead DCSS are the same site, but Peterhead 2 is an extension of the original Peterhead DCSS. The name is given to acknowledge an electrical distinction, but for the purposes of the physical footprint, these are part of the same site.

Table 5: Crown Estate Scotland/ScotGov/NESO Naming Disparities for ScotWind

ScotWind Site Names				
SMP Region	**SMP OA**	**Project Name**	**NESO HND**	**CES**
West	W1	MachairWind	SW_W1	Machair
North	N1	West of Orkney	SW_N1	West of Orkney Windfarm
	N2	Havbredey	SW_N2	Havbredey
	N3	Talisk Offshore Wind Project	SW_N3	Talisk
	N4	Spiorad na Mara	SW_N4	Spiorad na Mara
Shetland	NE1A	Arven South	SW_NE1C	Arven South
	NE1B	Arven	SW_NE1B	Arven
	NE1C	Stoura	SW_NE1A	Stoura
North East	NE2	Ayre	SW_NE2	Ayre
	NE3	Stromar	SW_NE3	Stromar
	NE4	Caledonia	SW_NE4	Caledonia
	NE6	Broadshore	SW_NE6	Broadshore
	NE7	MarramWind	SW_NE7	Marram
	NE8	Buchan	SW_NE8	Buchan
East	E1A	Ossian	SW_E1C	Ossian
	E1B	Bellrock	SW_E1B	Bellrock
	E1C	Morven	SW_E1A	Morven
	E2A	Muir Mohr	SW_E2B	Muir Mhor
	E2B	Campion Wind	SW_E2A	Campion
	E3	Bowdun	SW_E3	Bowdun

Table 6: Crown Estate Scotland/ScotGov/NESO Naming Disparities for INTOG

INTOG Site Names				
SMP Region	**SMP OA**	**Project Name**	**NESO HND**	**CES**
West	W1	MachairWind	SW_W1	Machair
North	IN1	Sinclair	Sinclair	Sinclair
	IN2	Scaraben	Scaraben	Scaraben
	IN3	Salamander	N/A	Salamander
	TOG6	Green Volt	N/A	Green Volt
	TOG7	Aspen	Aspen	Aspen
	TOG9	Beech	Beech	Beech
East	IN4	Flora	N/A	Flora
	TOG10	Cedar	Cedar	Cedar
	TOG11	Cenos	Cenos	Cenos
	TOG12	Culzean	N/A	Culzean
	TOG13	Judy	N/A	Judy

Appendix C: List of Impact Assessments

Agreed – incorporated into August 2024 Baseline Freeze

- *HND Southern Cluster* (review of the OWF design coordination within the Dogger Bank area)
- *HND Northern Cluster* (technology change from HVAC to HVDC)

Agreed – after August 2024 Baseline Freeze

Three have been agreed at HND Board level. These are:

- *HNDFUE Ossian part 1* (technology change from 2x bipole to 3x smp and additional onshore converter station) and *HND Northern Cluster 2* (review of OWF design in the east of Scotland region)
- *HNDFUE Muir Mhor* (review of Muir Mhor and Campion OWFs)
- *HNDFUE collaborative* (review of the topology and design coordination)