



OFFSHORE TSO COLLABORATION
EXPERT PAPER III

Joint Planning in Europe's Northern Seas

Supporting Europe's energy security and
competitive growth through a regional approach
to offshore grid development

Summary	2
I. Introduction	3
II. Promising set of projects with planning horizon around 2040	6
III. OTC Contribution to Northern Seas Network Planning	15
IV. Outlook	24

Summary

The Offshore TSO Collaboration (OTC), launched in 2022, represents a collaborative effort by Northern Seas' transmission system operators (TSOs) to advance offshore network infrastructure development in line with the aims of the Esbjerg and Ostend declarations. Over the past three years, the OTC has worked together to support the collective aim of making the Northern Seas "The Green Power Plant of Europe".

In this third expert paper, the OTC presents the initial results of a significant piece of pilot joint analysis, undertaken as a regional network approach. In the context of increasing supply chain, cost and infrastructure security challenges, this approach could complement existing European and national system development processes while fostering economic and environmental benefits.

In the first instance, the results of this analysis provide a set of potential cross-border projects, the so-called 'Grid Map'. By evaluating these project considerations as part of a broader regional network, the OTC aims to jointly test benefits across the entire Northern Seas (rather than only on a project-by-project basis), resulting in a promising 'set' of conceptual projects which work better together, contributing to a more affordable system. The intention for this promising set of projects is to be submitted into the Ten-Year Network Development Plan (TYNDP) 2026 and could be considered by governments for joint cost-sharing negotiations.

In this paper we demonstrate how a regional approach can create a valuable and robust network plan. If the governments see this added value and wish to take a regional approach in the development of the Northern Seas Basin, the OTC TSOs could play a role in this future approach. The paper outlines a concept for a regional offshore planning process, that could support a government endorsed regional approach. This process would build upon and complement the existing Offshore Network Development Plan (ONDP) and TYNDP processes and would support national and regional initiatives.

In summary, as offshore energy infrastructure becomes increasingly vital for Europe's energy security and decarbonisation goals, regional planning efforts like the OTC, complemented by onshore grid capacity analysis, can provide a strong foundation for turning ambition into action. By undertaking joint analyses, developing a proposed set of projects, and proposing an ongoing process to support existing processes and initiatives, this collaboration aims to set a path towards a resilient and interconnected Northern Seas' energy system. The OTC welcomes ongoing political support and stakeholder engagement to evolve these ambitious plans, securing Europe's position as a leader in offshore renewable energy.

I. Introduction

Affordable green energy is one of the most important factors for keeping industry competitive and for the overall welfare of society; it also plays a role in securing Europe's energy independence. The coastal states around the Northern Seas are central to realising our offshore wind potential. The timely and intelligent expansion of onshore and offshore network infrastructure is a key enabler of this.

The development of the internal European energy market is a continuous effort pursued by the EU Member States and their neighbours, yielding welfare gains for European society in the order of billions of euros each year. An integral part of a well-functioning internal energy market is the availability of cross-border capacity for energy trade, allowing for the utilisation of different and complementary energy sources across the region. In addition, the energy transition increases the need for investments in the grid, including cross-border infrastructure, even more.

The initiatives taken by European Heads of State and Energy Ministers in Esbjerg (2022) and Ostend (2023) to jointly develop the Northern Seas as a *Green Power Plant of Europe*¹ are right on the mark and show an ambition that the respective OTC TSOs support. The decision to realise individual projects remains with the current national processes. As the OTC, we are working to fulfill the joint Ministers' declarations that come out of the North Seas Energy Cooperation (NSEC). This paper addresses the ambition to "establish a framework for common planning and to deliver benefits and share costs", as stated in the Odense Declaration (2024).²

The need is also acknowledged in the published report by Mario Draghi, who calls on Europe to "foster network upgrades and investments in grids to address the electrification of the economy and avoid bottlenecks". Regarding grid planning, the report proposes to "[s]teer a deeper coordination between national and cross-border network operators and grid planners to ensure investment efficiencies". This is in line with the conclusions brought forward by the Council of the EU in May 2024, which calls on the Commission to "further strengthen the regional approach to electricity infrastructure planning, including with non-EU neighbouring countries, with a long-term perspective and coordination through the four high-level groups."

The offshore network infrastructure of the future should encompass not only national, radial offshore connection systems but also bilateral and multilateral hybrid interconnectors, hydrogen infrastructure and energy hubs. This network will contribute to enabling a secure, sustainable and affordable supply of electricity to the countries of the Northern Seas' region and beyond, providing capacity for cross-border electricity trading, and increasing Europe's autonomy in energy supply.

In the last three years, the development and planning of such offshore network infrastructure in the Northern Seas has progressed as political ambitions have been set, initial cooperation projects identified, and relevant stakeholder groups activated. The joint work in the Northern Seas between ministries, transmission system operators, offshore wind farm developers and hydrogen stakeholders has successfully intensified.

¹ 'The Esbjerg Declaration on the North Sea as a Green Power Plant of Europe' (2022).

² NSEC 'Delivering the Offshore Renewable Energy Ambitions in Europe – The Odense Recommendations from the North Seas Energy Cooperation (NSEC) to the new European Commission 2024-2029' (2024).

We, the TSOs of the Northern Seas countries,³ launched the informal Offshore TSO Collaboration (OTC) in 2022 to progress the necessary work towards the required offshore infrastructure. Unlike other multilateral fora, the OTC comprises also Great Britain, which is decisive when looking at the Northern Seas' area in its entirety. So far, our group has published two expert papers: the first in 2023⁴ and the second in 2024.⁵

We have witnessed a growth in understanding and delivered important first steps towards realisation. But fundamental challenges remain, for which solutions are needed in the short- and medium-term so that the shared vision for the Northern Seas can be turned into investment decisions for real projects. Financial viability and affordability are significant challenges that require investment incentives to be addressed. Additionally, we are facing supply chain constraints, high costs, and inflation. All of these factors pose implementation risks, and for some, this has already led to the suspension of projects. Furthermore, the issue of security threats to offshore infrastructure such as submarine cables or offshore platforms is of high priority, noting the geopolitical context.

In this third expert paper, we focus on what we consider to be the most important steps to overcoming barriers and enhancing regional collaboration.

Firstly, we put forward a **refined recommendation for the development of a promising project set** of hybrid interconnectors in the Northern Seas. The proposal will not only be based on the already established national, bilateral and European studies, such as those published by ENTSO-E or individual TSOs, but also on a first **joint study executed by the OTC**. This ongoing pilot evaluates the individual connections on a collective basis aiming to achieve the best possible benefits for the region and beyond, with the aim of informing and complementing existing national and European planning processes. Furthermore, we propose this OTC pilot study serves as an additional basis for the forthcoming cost-sharing and funding debate.

Secondly, **we propose to continue this collaboration for the sea basin as the Offshore TSO Collaboration**, to further develop a comprehensive regional project set as the central basis for the necessary political decision-making processes at both the sea basin and national levels. **To this end, we would suggest leveraging the appreciated political support to strengthen the joint planning exercise by setting up a potentially recurrent sea-basin planning exercise in dialogue with the governments, regulators and relevant stakeholders, such as ENTSO-E.**

³ BE, DE, DK, FR, GB, IE, LU, NL, NO

⁴ OTC Expert Paper I: 'The Esbjerg Cooperation. Transforming the North Sea into Europe's green power plant.' (2023).

⁵ OTC Expert Paper II: 'Offshore TSO Collaboration. Unlocking the potential of the North Seas.' (2024).

The proposed solution of a joint regional planning can unlock a range of benefits. It can contribute to a more efficient build-out of the offshore infrastructure, enhancing the affordability of the transition towards clean energy and thereby helping Northern Seas' countries and Europe towards a more strategic energy independence. As TSOs we believe that such a joint regional collaboration between TSOs, governments and other important stakeholders is a stepping stone to a more coherent development of the offshore grid.

The intention of this work is not to replace, but to build upon existing European planning frameworks such as the TYNDP, ONDP and Regional Investment Plans in addition to national and bilateral planning work and considerations. The final decision for the realisation of individual projects remains with the current national processes.

II. Promising set of projects with planning horizon around 2040

A hybrid offshore network infrastructure for the Northern Seas

The Northern Seas are playing a crucial role in the transformation of the European energy system. Implementing cooperation projects between two or more countries can make the offshore wind power potential of the sea basin accessible across the region. But how do we know which cross-border projects are promising? How should they be combined into a multinational project set to deliver European, regional and national added value?

Several analyses and studies conducted at national, bilateral, multilateral and European levels, such as ENTSO-E's TYNDP and ONDP, have provided valuable insights into the potential of cross-border cooperation projects. Based on these insights, the OTC delivered an overview of specific hybrid interconnector project ideas and corridors in our last two expert papers.

For this third expert paper, a map that has been further developed is provided. Building upon previous studies and papers, this time the map additionally considers the ongoing work of the first joint OTC study exercise of the Northern Seas' TSOs. The time horizon is 'around 2040', meaning between the late 2030s and early 2040s.⁶

In this joint multilateral pilot study, many variants of potential regional offshore infrastructure topologies for the time horizon around 2040 are investigated, with ideas jointly discussed and tested. This is a different objective from ENTSO-E products, as these are defined by the requirements of the TEN-E regulation, whereas the OTC analyses are more flexible. The OTC objective is to converge on a jointly supported promising set of projects that could provide benefits to the region and beyond at an optimum of system costs, meaning it is therefore worthy of further consideration and development.

A major motivation behind the new pilot study is the confidence that TSOs in close cooperation can develop a solid and consistent set of projects.

⁶ The reference scenario of the current French National Development Plan released in February 2024 does not consider any new interconnectors beyond 2030. The projects that are under study in the OTC collaboration are subjected to several pre-conditions.

This combined approach explains why, compared to the 2024 OTC map, most lines seem familiar. However, this year, they appear in a new light: based on agreed scenarios and input assumptions, the results demonstrate how projects impact each other, e.g. by building on each other's existence or by competing with or supporting each other. This more holistic approach, including also Great Britain, further contributes to ensuring continuity and reliability across planning processes. The resulting knowledge base should be continuously updated in the future with new information and with the results of discussions with governments and stakeholders.

The OTC Map – 2025 edition

The map considers three different categories of projects: planned projects (green), promising projects (solid yellow) and promising candidates (dashed yellow) – which reflects the map's focus on projects beyond what is in operation today.

- Planned projects: these projects are considered to be mature, have been given regulatory approval in at least one country, and are expected to be built.
- Promising projects: these projects have shown strong economic benefits in the joint OTC pilot study and/or other analyses and could be technically feasible around 2040. This means these links should be developed further. The level of maturity differs across promising projects.
- Promising candidates for further investigation: these projects could have the potential to make a positive economic contribution. At the time of writing, the full scope of the joint study has not been finalised yet and some national or bilateral discussions and/or political negotiations need to be concluded before elevating their status to promising.

The OTC TSOs intend to jointly submit a set of projects as part of the upcoming TYNDP 2026 process.

Furthermore, these projects also need to be assessed in the respective national planning processes, in order to analyse the resulting reinforcement needs of the onshore grid.

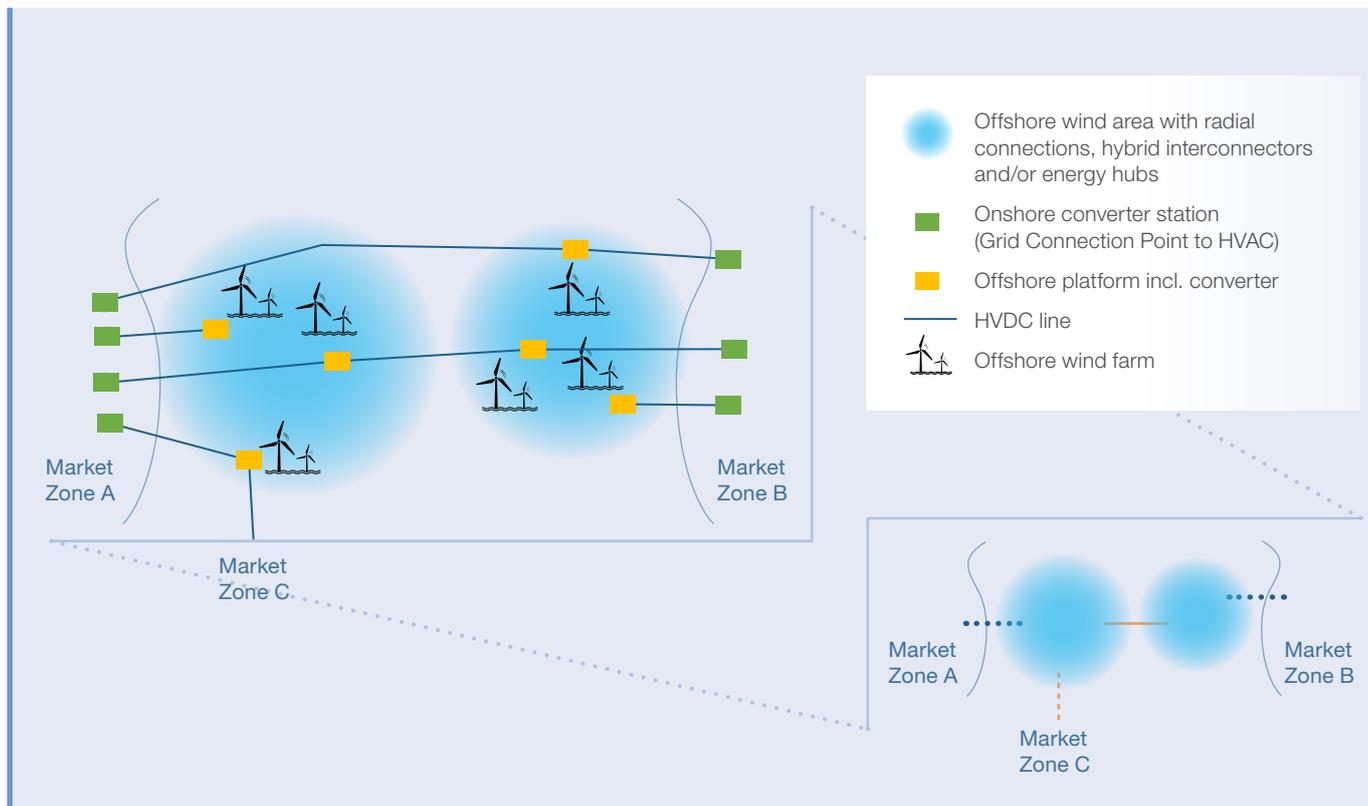
As seen in earlier publications, the general direction of corridors from north to south and west to east is substantiated and appears again on the updated project map. Usually, the related benefits are driven by the diversity of renewables across the Northern Seas. Connection of the large hydro-based system in Norway can help to balance the outputs of other renewables and the variance in wind patterns can lead to different outputs across the Northern Seas. Given the large distances involved, weather systems can take many hours to pass across countries, while electricity can be exchanged at a rate which is close to the speed of light. Increasing the level of interconnection between collective electricity systems can therefore help to smooth out periods of over- or undersupply in a cost-effective way.

The maturity of some projects has evolved since the publication of the last OTC Map in May 2024. This includes two multi-purpose interconnector projects (Nautilus and LionLink), which will integrate large-scale offshore wind farms (in Belgian and Dutch waters respectively) into new interconnectors leading to Great Britain. Both of these pilot projects have been approved as part of Ofgem’s (GB regulator) Initial Project Assessment process.⁷ For the first time, projects between Great Britain, Ireland and France are featured in the project map. This reflects the extended scope of the project identification and assessment exercise, being consistent with the ONDP 2024 as well, showing that offshore hybrid projects could also provide value for society in the Irish and Celtic Seas.

In addition, several projects between the UK and Europe have been newly identified. A stronger connection between British and European markets could generate economic benefits for both systems. It is anticipated that additional offshore wind leasing would be required within British waters to facilitate such projects. Future leasing will be subject to the decisions of The Crown Estate, Crown Estate Scotland and the development of Great Britain’s first Strategic Spatial Energy Plan due to be published by NESO in 2027.

Figure 2:
OTC Grid Map 2025 – detailed view of what the technical solutions could look like within the clouds on the OTC Grid Map above

The map also shows some of the planned connections to the coasts. Depending on project maturity these lines may represent previously planned projects or hypothetical capacity which would be subject to additional offshore wind leasing decisions within each country. In all cases, lines are



⁷ Future governmental decisions regarding the scope of the Princess Elisabeth Island could have different potential implications, in particular on Nautilus, that will be considered in upcoming versions of the map.

representative of a connection to the electricity market of each country and do not represent a planned cable route or indicate a preferred landing point.

As in 2024, the 2025 project map includes offshore hydrogen demonstration projects in the Netherlands and Germany. In the current Site Development Plan of the German Exclusive Economic Zone (EEZ), the further development of the other energy generation area (SEN-1) is being investigated. The subject of system integration will be explored in greater detail in the future work of the OTC.

In the OTC Grid Map, offshore wind areas are depicted as blue clouds for simplification, with the connections between individual offshore platforms and the mainland aggregated into a single line. Within each depicted cloud lies a variety of specific infrastructure types and topologies, which can connect renewable energy sources either to individual countries or to multiple countries. For instance, the graphic above shows various configurations of hybrid interconnectors that include one or more offshore wind farms alongside illustrations of radial connections. In particular, the graphic is intended to illustrate that offshore platforms located within the same cloud are not necessarily interconnected. Within the OTC, the focus was placed on offshore development. The further design of the onshore connections and reinforcements will be carried out in accordance with the corresponding European and national network planning processes.

Project List

Border	Description
	<ul style="list-style-type: none"> • Further links between Ireland and Great Britain are considered. Mares and LirlC have both obtained (in principle) cap and floor regimes from Ofgem and have been factored into the study's background. • An additional multi-purpose interconnector connecting the potential offshore wind leasing areas in each respective country's EEZ has been found to be beneficial. The viability of such links would be subject to the respective offshore leasing activities of each country. • Such a multi-purpose interconnector could facilitate wind off the south coast of Ireland in an area recently legislated for offshore development and, if technically feasible, could be targeted for delivery in the late 2030s.
	<ul style="list-style-type: none"> • Recent and ongoing studies, including the OTC Grid Map study and the ONDP, support increased capacity. However, grid reinforcement is a prerequisite for further interconnector developments in France. EirGrid and RTE are initiating more detailed market studies to assess a hybrid interconnector which would stretch from the south coast of Ireland to northwestern France. • The project aligns with the Irish Government's policy statement on interconnection and could connect offshore wind in both the Irish and French EEZs. This includes wind that would be located in an area of the Celtic Sea which the Irish government has recently legislated for in offshore development. • If technically feasible and economically viable, this project would be targeted for delivery after 2040, once the French internal grid has been reinforced. • No project is currently included in the French draft NDP.
	<ul style="list-style-type: none"> • Multiple projects, including non-regulated projects, still need to undergo a political agreement between the French and British governments and national regulatory authorities (NRAs). • Our study found that 1 GW of additional interconnection capacity between Britain and France added value. • The study CRE published on the value of new interconnection capacity between the two countries found that under certain conditions, a capacity of around 1 GW of new interconnection could be beneficial for France. CRE's analysis highlighted that the benefits for France were insufficient compared to the costs of a new project if the costs and revenues were shared equally between the UK and France. In CRE's view, only a redistribution of costs between the two countries was likely to be considered acceptable for projects to proceed. A joint statement has been made by CRE/Ofgem on the next steps to achieve 'around 1 GW' of new interconnection. • No project is currently included in the French draft NDP.
	<ul style="list-style-type: none"> • Nautilus – the hybrid system between GB and the Princess Elisabeth Island (part of the blue cloud) - is depicted on the Grid Map as "planned". It is to be noted that future governmental decisions regarding the scope of the Princess Elisabeth Island could have different potential implications, in particular on Nautilus, that will be considered in upcoming versions of the map. • Like in the ONDP, an additional level of interconnection over and above the already planned Nautilus project has been identified as being beneficial within the study. • This assumes additional offshore wind leasing on the east coast of Great Britain which would then be connected to the Belgian mainland. • Future offshore wind capacity will be subject to the recommendations of the Strategic Spatial Energy Plan and leasing decisions of The Crown Estate, and The Crown Estate Scotland.

Project List

Border	Description
	<ul style="list-style-type: none"> • For LionLink, the development phase started in 2023. The interconnector should be operational in 2032. • Furthermore, a new promising interconnector candidate has been identified. This assumes additional offshore wind leasing on the east coast of Great Britain which would then be connected to the Dutch offshore wind area. • Future offshore wind capacity will be subject to the recommendations of the Strategic Spatial Energy Plan and leasing decisions of The Crown Estate, and The Crown Estate Scotland.
	<ul style="list-style-type: none"> • The map shows four projects between Germany and the UK. Two point-to-point interconnectors are categorised as planned projects, NeuConnect and Tarchon (each 1.4 GW). Moreover, TYNDP 2024 has already identified the benefit of a 2 GW hybrid project between the two countries. • In addition to that, several studies have identified the potential for a further hybrid interconnector project (2 GW). Our study has also found that establishing an additional hybrid interconnector between the two countries could provide significant economic benefits. • This assumes additional offshore wind leasing on the East coast of Great Britain which would then be connected to Germany. Future offshore wind capacity will be subject to the recommendations of the Strategic Spatial Energy Plan and leasing decisions of The Crown Estate, and The Crown Estate Scotland.
	<ul style="list-style-type: none"> • Several studies have identified the potential for links between Denmark and Great Britain. This is to be further investigated. • The Danish and British ministries have signed a Memorandum of Understanding (MoU) to cooperate on offshore energy infrastructure.
	<ul style="list-style-type: none"> • There could be a capacity for up to two hybrid interconnectors, with a potential for up to 2800 MW HVDC connections with Norway. The OTC pilot study and/or other studies on system level have indicated that up to two hybrid interconnectors could be beneficial within 2040 timescales. See Statnett report 'Grid concepts Sørvest F – An analytical basis for determination of grid concepts for bottom fixed offshore wind in Sørvest F' (2025).⁸ • Statnett (NO) has signed MoUs with Amprion (DE), Elia (BE), Energinet (DK), National Grid (UK), TenneT (NL) and TenneT (DE) respectively. Grid topologies and technical and market issues related to possible hybrid interconnectors have been investigated.
	<ul style="list-style-type: none"> • TritonLink continues to demonstrate benefits for the EU society. • Cost-sharing and funding remain key challenges for the further maturation of the project.
	<ul style="list-style-type: none"> • An MoU was signed on 24 April 2023 between Elia (Belgium) and TenneT (Netherlands) that covered a study of electrical interconnector options that would link Belgium to the Netherlands. • A joint task force has been launched, and grid studies are being undertaken throughout 2024 and 2025 to, amongst other things, investigate the potential socio-economic benefits of multi-purpose or hybrid interconnectors.

⁸ See Statnett report 'Grid concepts Sørvest F – An analytical basis for determination of grid concepts for bottom fixed offshore wind in Sørvest F' (2025).

Project List

Border	Description
	<ul style="list-style-type: none">• A hybrid interconnector between the two countries is being discussed at ministerial level and further investigations are ongoing. The benefit and cost negotiations have not yet started.• TenneT supports both ministries in their ongoing discussions regarding the technical design and integration into the North Sea development and energy infrastructure planning process.
	<ul style="list-style-type: none">• A hybrid interconnector between the two countries is being discussed at ministerial level and an agreement has been reached on the topology.• The technical design is being developed as part of an ongoing cooperation between Amprion and Energinet.• In addition to the hybrid interconnector, there could be the potential for cross-border radial lines between Germany and Denmark. This would allow wind farms in the Danish EEZ to be exclusively connected to the German mainland.

What's behind the map: the joint OTC pilot study

The OTC Grid Map pilot seeks to identify sets of projects that have a cumulative benefit that is greater than the sum of the individual parts. This attempt can lead to more efficient networks and, in the long term, can also reduce the impact on the environment and coastal communities by potentially reducing the overall volume of infrastructure required in the Northern Seas, thus improving affordability by lowering overall costs.

The ambition of this approach is also reflected in the volume of offshore renewables considered within the study. The circa 300 GW for the Northern Seas countries, including their capacities in adjacent sea basins as well, also reflects the overall ambitions expressed to the EU in December 2024. Sensitivity studies accounting for uncertainty regarding this volume are ongoing.

Like many other studies, the OTC pilot run applied the TYNDP 2024 National Trend (NT+) and Distributed Energy (DE) scenarios. The British Future Energy Scenario (FES) was integrated into the study. To facilitate this integration, modifications were required to align some assumptions to reflect the anticipated behaviour of offshore systems and to reflect non-binding national targets or commercial conditions.

By applying the TYNDP 2024 scenarios, the joint study includes the impact of hydrogen (some of which has been modelled as being offshore) on meeting the requirements of a 'whole-energy' system. The modelling naturally considered this hydrogen market within Europe and helped to explore the synergy with offshore wind capacity. Further analysis on the impact of hydrogen development is so far limited, however we are committed to continuing the work on the integration of electrons and molecules and are planning to work closely with the hydrogen system operators to achieve this.

The first step in the joint study was to develop possible project topologies. The early part of the analysis considered multiple climate years to test the robustness of the hypothesis that efficiently linking together different parts of the Northern Seas provides consistent socio-economic benefits.

In addition to the projects already known from the last project map, further project options were developed based on the needs identified in the ONDP and confirmed by the TYNDP 2024. Several high-level philosophies were discussed to categorise early topologies which then were further developed into the project set. The various combinations considered concepts with increasing levels of ambition and technical complexity (point-to-point, hybrid interconnectors, cross-border radial connections as well as multilateral offshore network infrastructure). The development of each concept reflects the perspectives and constraints of the respective national TSOs and governments as well as their technical feasibility in the 'around 2040' timeframe.

After a first round of simulations, work was undertaken to make the solutions identified more economic and efficient by exploring the relative utilisation of each asset and resultant energy mixes and prices within each country.

The next set of iterations was focused on conducting sensitivities on previously successful topologies by iteratively adding or removing links that did or did not perform efficiently. As part of this stepwise approach, the best performing elements were combined and taken to the next level as a new topology. This iterative process allowed the impact of external factors on the economic viability of the set of projects to be assessed. This also identified which markets naturally complement each other well.

III. OTC Contribution to Northern Seas Network Planning

In this chapter we demonstrate how a regional approach can create a valuable and robust network plan. If the governments see this added value and wish to take a regional approach in the development the Northern Seas Basin, the OTC TSOs could play an important role. The chapter outlines a concept for a regional offshore planning process that could support a governmental endorsed regional approach and could be integrated within ENTSO-E's TYNDP/ONDP framework.

As TSOs from around the Northern Seas, we see opportunities for enhanced regional coordination and collaboration in transmission infrastructure planning. Imagining the Northern Seas as an area without national borders, the idea of easier sharing of offshore renewable energy sources (RES) becomes more obvious. Currently, some offshore RES might not materialise if that exchange is not actively facilitated.

This paper showcases a first indication of our collaborative study work.

While the pilot study at hand, once finalised, can make a meaningful contribution to a more efficient and regional view of energy infrastructure development, we are equally sure that such joint efforts should evolve into collaboration which supports closer regional political dialogue. Implications on required TSO-resources have not yet been assessed in detail but will need to be addressed.

To activate the energy potential of the Northern Seas in the most efficient and sustainable way, we need to develop a joint view of both the technical potential and suitable means for its exploitation.

In the following chapter, we describe:

- European and regional grid planning today and opportunities beyond this;
- the parameters to follow and factors to consider when scoping out a more collaborative planning framework on a regional level, and;
- an opportunity for developing a joint Northern Seas' network infrastructure planning process.

European and regional grid planning today

The current national, bilateral and European planning process can be complemented by a broader regional perspective over a set of projects. By doing so, more RES potential can be unlocked at less cost, facilitating negotiations at the regional level.

In short, to accelerate the pace, there is a need for more regional coordination in offshore development in the Northern Seas at the political, administrative and system operator levels, extending beyond the scope of bilateral negotiations and encompassing broader multilateral discussions and alignment.

ENTSO-E's Ten-Year Network Development Plan is the cornerstone of joint infrastructure planning at the EU and regional levels. Every two years, ENTSO-E publishes a TYNDP; for the 2026 edition, ONDP is integrated into the TYNDP. Building upon European Commission-approved, cross-sector scenarios, ENTSO-E, along with TSOs, derive the need for new infrastructure from a European socio-economic welfare perspective⁹, summarised in an Infrastructure Gaps Report (IGR). The TYNDP also points towards the need for reinforcement of internal networks and has shown that this is an important prerequisite¹⁰. Eventually, project promoters, both regulated and non-regulated entities (the latter usually referred to as 'merchant project promoters') submit project proposals to fill the reported "gaps". Once the project collection closes, ENTSO-E conducts a cost-benefit analysis (CBA) based on a Commission-approved methodology to assess the related costs and benefits of the submitted projects. The CBA results for each individual project are published in the final TYNDP report, with their assessment being provided against the same scenarios, same climate years and same perimeters for all projects, thus facilitating their comparison against each other.

Once assessed as being beneficial in the TYNDP, a possible next step for project promoters is to seek the label of 'Project of Common Interest' (PCI), or 'Project of Mutual Interest' (PMI) for projects with third countries. PCI/PMI status comes with increased visibility, faster treatment during the permitting procedure and, if various other criteria are met, allows for access to EU financial support.

⁹ The Identification of System Needs (IOSN) study carried out by ENTSO-E is a pan-European optimisation exercise, looking at the combination of real and conceptual projects that maximises benefits (in terms of reduced curtailment of renewable energy, improved security of electricity supply etc.) while minimising system costs.

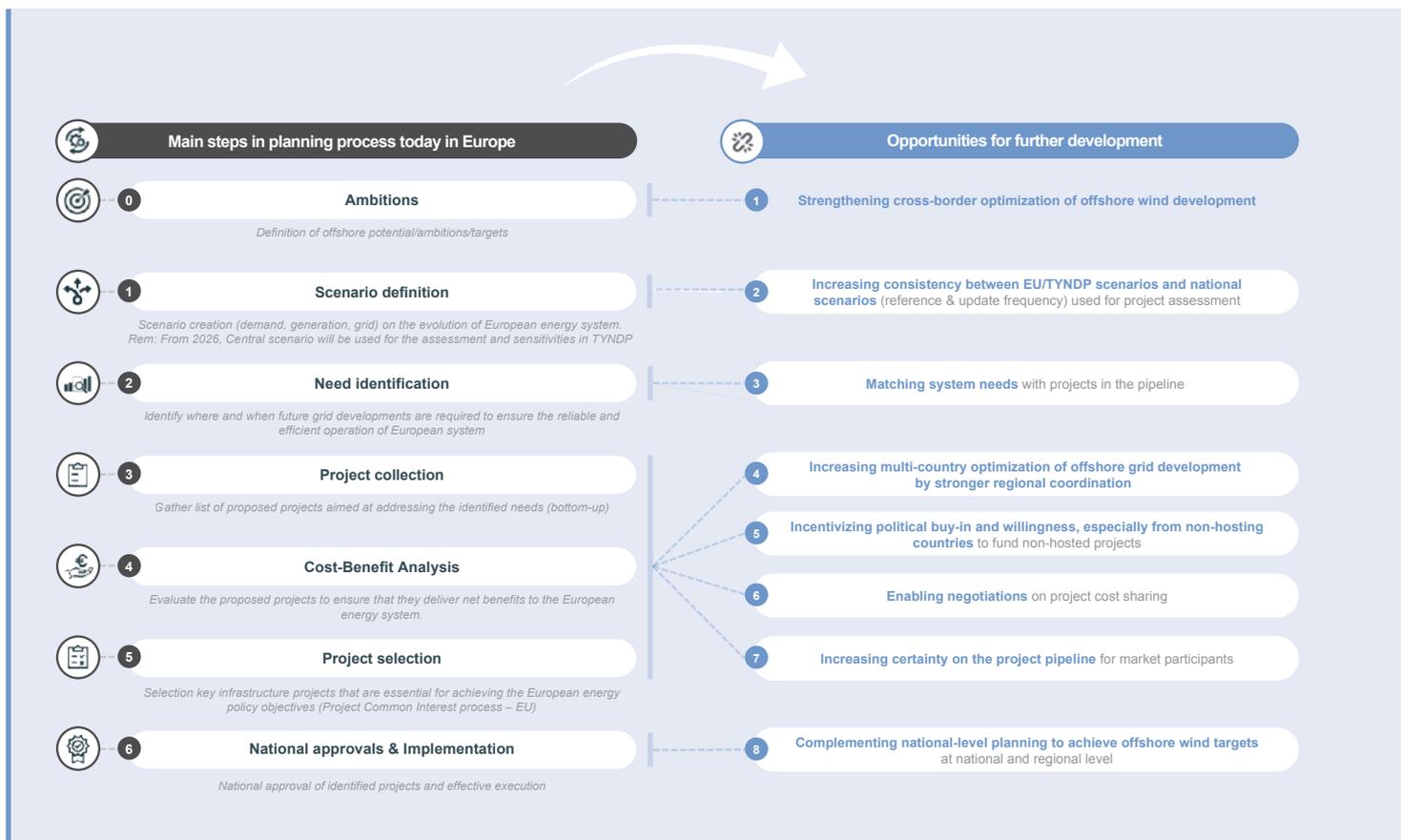
¹⁰ TYNDP 2024 'Infrastructure Gaps Report - Opportunities for a more efficient European power system by 2050', p. 37.

Enhanced socio-economic welfare through more regional collaboration

A more regional planning approach, building upon existing processes at European level, is an important step to take to unlock projects of pan-European benefit and to exploit the potential of Europe's energy resources in the most efficient way in terms of costs, utilisation of space, nature and resilience.

The long-term goal is to facilitate the joint identification of a set of relevant offshore projects within the region and its onshore impact, working towards an overall coherent network configuration in the Northern Seas, culminating in joint regional planning which is backed by system operators and governments alike. By building trust in the joint analysis, the realisation of cross-border infrastructure projects of overall European value shall be supported, potentially leading to cost-sharing based on the identified benefits and costs of the identified set of projects.

Figure 3:
Current planning process
and ideas for further
developments



Principles for scoping out a new infrastructure planning framework

To make progress on regional coordination, an adequate planning and governance framework could be developed, for grid infrastructure and generation assets alike. Regarding the following considerations, the following disclaimer applies: the focus of the OTC ambitions is limited to the responsibility of system operators. In addition, a more aligned approach on generation capacity would be equally indispensable.

Against this background, the following principles could be considered as part of a more collaborative infrastructure network planning framework.

- **Complementarity with existing European and national processes**

Based on the TYNDP scenarios, approved by the European Commission, the needs regarding more cross-border transmission capacity are addressed in ENTSO-E's Infrastructure Gaps Report and the ONDPs. These are based on a Pan-European optimisation, which is also valid for the costs and benefits analysis of individual TYNDP projects. TYNDP projects are submitted by project promoters. It is important to acknowledge that each of these steps remain relevant in a more collaborative offshore grid planning process, as joint scenario development and infrastructure needs' assessments will also prevail in the future. Therefore, the way forward could be to complement the existing framework rather than setting up new approaches from scratch. As such, the current approach is improved, without creating long and complex institutional debates, which would lead to uncertainty and likely slow down the decision-making process. Indeed, exactly the opposite is needed: the required infrastructure to be quickly delivered in a fair and efficient way.

- **Cross-sector alignment reflecting European and national frameworks**

Given the various degrees of sector integration in European and national energy infrastructure planning, the cross-sectoral scope of the exercise needs to be determined. While an integrated infrastructure planning approach across energy carriers has been developed in some countries (such as in Denmark and the UK), others have chosen different paths. Building upon the joint scenarios developed by ENTSO-E, ENTSO-G and ENNOH a more integrated modelling approach will enhance cross-energy planning in the future. As scenario building is the starting point of all further planning this will ensure compatibility with national and current European planning processes as well as accelerate the implementation of the first projects in the Northern Seas. Naturally, the interface between energy carriers, first and foremost electricity and hydrogen, must also be adequately served subsequent to the joint scenario stages. As such, close alignment regarding the outcome of respective modelling exercises is indispensable.

- **Clear deliverables and accountability from the start**

To meet the expectations linked to a more regional planning approach, a clear deliverable, or product, should be developed including related mandates, roles and responsibilities, deadlines and accountability. How such a framework and respective products could be developed is outlined in the next chapter.

- **Close alignment between system operators and governments**

Considering the national implications of cross-border infrastructure development, close alignment with the national governments and authorities is one of the most important steps in the process. Within the EU, the choice between different energy sources and the general structure of the energy supply remain with the individual Member State. The consideration of these principles becomes ever-more relevant in a framework involving non-EU countries such as the UK. Therefore, while a regional infrastructure planning exercise can clearly contribute to the joint interest of a more efficient and therefore more affordable energy transition, no decisions can be taken without the consent of the governments of the countries involved in such an exercise. Close alignment with the appropriate national stakeholders is therefore essential during the relevant planning stages, from the scoping out exercise, to project set validation, cost-sharing discussions and finally to investment decisions.

- **Clarify interface with commercial developers**

Beyond national authorities, any approach must clearly define how commercial developers and other relevant stakeholders are involved. This accounts for third-party project promoters, to clarify the interface with their infrastructure solutions, as well as to wind farm developers and relevant non-governmental organisations. Clarity regarding the involvement of commercial developers and how to consider their project ideas is therefore key.

Joining forces for Northern Seas network planning

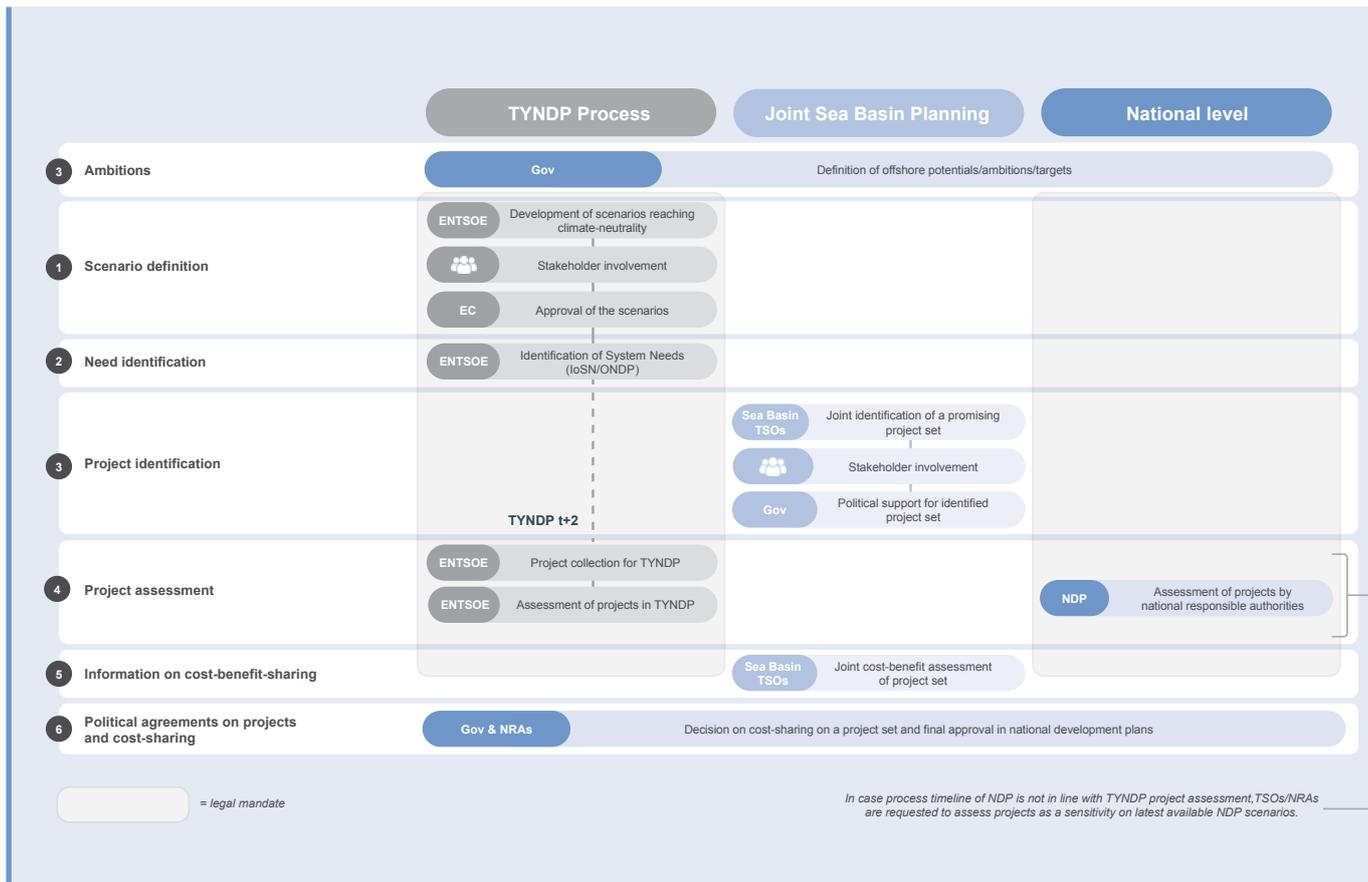
Adding to a uni- or bilateral ideation exercise, an additional regional planning approach needs to be embedded into an appropriate framework such as the NSEC. Substantial progression towards a more coordinated regional infrastructure development is seen as a good opportunity. While the current planning and governance framework at the EU level provides a solid basis to build upon, the OTC benefits from having all countries including the UK on board.

In essence, complementing current processes with additional regional planning can be described simply: in addition to individual proposals addressing the TYNDP and ONDP infrastructure needs presented in the Infrastructure Gaps Report, system operators from around the sea basin conduct joint analyses and compare different approaches regarding how the identified transmission corridors might be configured.

The results of the joint analysis culminate in a joint promising set of projects, containing a combination of projects that help to realise the common ambition in the most efficient way possible.

Figure 4:
Northern Seas Network Planning
– Joint Sea Basin Planning

Building upon the joint analyses, the involved TSOs submit the project set for wider assessment and validation in the upcoming planning cycles at European (non-binding TYNDP/ONDP) and national level (NDPs).



In the following section, each of the respective planning steps is described in more detail, alongside the link with the process of cost and benefit sharing when applied to the jointly defined sea basin plan. Next to these process steps, OTC has developed a timeline for the joint cost and benefit data delivery by the Northern Seas TSOs to feed into the cost-sharing discussion.

- **Scenario definition**

Building upon the joint targets set by the Northern Seas countries, and following the guidelines developed by ACER, ENTSO-E builds scenarios in line with the EU’s 2030, 2040 and 2050 non-binding joint Member States’ offshore targets, the NECPs and the 2050 climate neutrality objective method. Extensive stakeholder engagement is in place in the drafting process, in line with the TEN-E Regulation. The scenarios are submitted

to the European Commission for approval. The scenarios also provide the basis for the subsequent joint TSO planning exercise. Relevant step in the upcoming planning cycle: TYNDP 2026 Scenarios (to be published in Q1 2026) as a basis for joint analysis.

- **Needs identification**

Based on the approved scenarios, ENTSO-E assesses the infrastructure gaps of the electricity sector in the formal Infrastructure Gaps Report and TYNDP/ONDP framework (same as ENTSOG for the gas and future ENNOH for the hydrogen sector). Prior to publishing its respective reports, ENTSO-E conducts an extensive consultation process involving all relevant stakeholders, including ACER, the European Commission and Member States. Eventually, ENTSO-E adapts the reports in line with the EU Commission's and Member States' opinions for final publication. Relevant step in the upcoming planning cycle: TYNDP 2024 Infrastructure Gaps Report (published in February 2025 for consultation by mid-March 2025, final version is envisaged in Q3 2025) as a basis for joint analysis. Up to this point, all steps referred to are embedded in the existing framework.

- **NEW: Joint Northern Seas Offshore Grid Planning**

OTC TSOs see opportunities in joint analyses at regional level in addition to uni- and bilateral considerations and the regional planning in ENTSO-E. These analyses lead to a set of projects at seabasin level, including also the UK, and will not consider a mere compilation of individual projects which are deemed to be beneficial but also look at the interrelation between projects and across sectors and the socio-economic welfare effects they create, leading to a more efficient project configuration overall.

After discussion with the relevant authorities the set of projects would be agreed upon jointly by system operators and proposed to the NSEC as well as to the relevant Northern Seas countries' authorities. Reflecting upon the previously described need for a governmental buy-in, an essential element of this new planning stage would be regular touchpoints with relevant public authorities along the way, such as the North Seas Energy Cooperation. It is crucial that the authorities back the general approach and commit time and resources according to their role. Their buy-in would ensure consideration of that set of projects in the national development plans and could be applied as the first use case for cost-sharing. The National Development Plans (NDP) will look closer at the related onshore development. The authorities' involvement from the start would allow for full transparency regarding the development of projects and the benefits they can bring to the region. If executed appropriately, the approach could function as a catalyst for realising projects of European value through the joint backing of the results. Such an acknowledgement would be, among other things, key for cost-sharing negotiations and the allocation of European financial support when applied to the projects that are included in the scope of the joint plan.

- **Project Assessment**

Once the project cluster has been defined by system operators and proven its synergetic benefits to the regulatory authorities, it will be fed into the relevant European and national grid planning processes. Once assessed as beneficial in the TYNDP, a possible next step for project promoters will be to seek the label of 'Project of Common Interest' or 'Project of Mutual Interest' for projects with third countries.

Connection with the further discussion on cost-sharing

One of the issues that has often been a blocker for the implementation of hybrid interconnectors is the question of cost-sharing and financing. The practical decision on cost-sharing itself is a crucial but ultimately a political decision. To achieve this outcome relevant authorities should be comprehensively supported by transparent data provision allowing them to apply an effective cost sharing method.

Typically, TSOs partnering in cross-border project development carry out a project-specific cross-border cost allocation (CBCA) together, based on project-specific aligned data and assumptions, though national specificities remain. When third party TSOs are not included from the beginning of the planning process of a project, this complicates cost-sharing steps needed at later stages if benefits for hosting countries are lower than their costs. In addition to project-specific CBCA, the TEN-E regulation assigns the task of performing a non-binding and informative calculation on sea basin cross-border cost-sharing (SB-CBCS) to ENTSO-E. This quantitative assessment is based on the TYNDP IoSN 2024 output rather than on concrete projects and therefore is not directly applicable for effectively making cost-sharing decisions.

More precise information related to a concrete project set could be provided through a sea basin offshore grid planning exercise, done in cooperation with sea basin authorities. This could therefore serve as a logical starting point for further steps in the process towards a potential cost-sharing decision at the political level.

To have a solid starting point for the political decision on cost-sharing negotiations between sea basin governments and NRAs, an important input would be for interested OTC TSOs to jointly deliver cost and benefit data. These could be directly applied to identified project subsets, providing specific references for governments and NRAs to eventually align on cost-sharing.

Compared to a project-specific CBCA, all relevant parties for cost-sharing would be jointly at the table from the start and could negotiate a voluntary agreement for overall cost-sharing applying a regional focus, instead of looking at the viability of individual projects.

At the time of writing, elements such as data quality, model quality, national and regional specificities, and considerations impacting cost-sharing methodologies are still under discussion. OTC TSOs will provide perspectives on the advantages and disadvantages of various cost-sharing methods and aim to achieve a common view which will be included in a follow-up expert paper in the lead-up to the Hamburg Summit later 2025. The objective is to provide this as input for the cost sharing decisions eventually to be made at political level.

In preparation for the next paper covering this topic of cost sharing, OTC welcomes intermediate exchanges with stakeholders, such as governments, regulators, and wind developers, to inform this assessment. Regarding an adequate framework for alignment between system operators and public authorities, the North Seas Energy Cooperation appears to be as a promising forum. This also accounts for validation of the system operators' work.

In addition to cost-sharing, the planning and implementation of a hybrid offshore grid infrastructure also involves financing issues. OTC is therefore also looking at the idea of an offshore financing facility and will bring forward its ideas in a next paper.

Infrastructure security will become a game changer in the next decade

Since security is a growing concern in Europe, and as TSOs are accountable for the planning, construction and operation of critical infrastructure, security is seen as a top priority. The implementation of offshore network infrastructure - including an increasing amount of hybrid elements in the Northern Seas - is a key step towards strengthening Europe's energy resilience and autonomy.

However, it is essential that this energy supply is protected against cyber-attacks and physical threats in the future. We believe that intensive cooperation between TSOs, security authorities and political stakeholders is crucial to ensure the future security of this vital infrastructure, and as the OTC with a focus on the Northern Seas, we aim to contribute to this process in 2025, alongside ENTSO-E and the Governments.

IV. Outlook

Regional planning and coordination at sea basin level by TSOs is an important step for advancing the development of a hybrid offshore grid infrastructure. However, further complex challenges need to be addressed to make the proposed projects a reality. At the OTC, we will therefore continue to work on the next steps in the coming months to contribute with ideas and advice to current political discussions.

Offshore market design for hybrid infrastructures

In developing this paper, we deliberately excluded other important issues, although we continue to work on these and are incorporating them into political discussions. A hybrid offshore grid infrastructure can only be established with an appropriate offshore market design in place. In order to achieve the EU's ambitious offshore targets and realise hybrid projects in the Northern Seas as early as in the next decade, a workable solution for the market set-up with UK is absolutely required. It is essential that an efficient and well-known mechanism, i.e. implicit price coupling, is re-established by the UK and EU/EEA institutions, to maximise benefits for EU, Norwegian and UK consumers and to enable future investments and turn the Northern Seas into a power plant for Europe.

In addition, the Carbon Border Adjustment Mechanism (CBAM) also needs a pragmatic solution to avoid negative consequences on electricity trading and clean energy investments in the Northern Seas and to ensure that hybrid interconnectors can realise their full potential for cross-border electricity exchanges and deliver maximum benefits for society. We would like to encourage the EU and the UK government to start discussions on linking UK and EU ETS as soon as practicable to avoid negative impacts of the EU CBAM for Northern Seas grids and common net zero objectives, and to maximize benefits of the Northern Seas cooperation for both European and British citizens.

Technical harmonisation

Technical standardisation and harmonisation are prerequisites for building and operating hybrid interconnectors and energy hubs. We are working on establishing close coordination between TSOs and manufacturers to jointly advance the development of technical innovations. In addition, better coordination in regional system planning will help frontload investments, provide visibility, predictability and transparency to the supply chain and increase manufacturing capacities, and it will enable long-term framework agreements and a more coordinated cross-border approach. The OTC TSOs are working together to progress these ideas further in the context of the Northern Seas.

Hydrogen as part of the picture

Finally, there is the prospect of the close integration of hybrid, electricity and hydrogen infrastructure in the Northern Seas. We appreciate that various hydrogen TSOs have committed to this; they have joined forces to support cross-border developments. As the OTC, we are working closely with HyNOS to slowly bring both types of infrastructure closer together, to identify promising interfaces, and to coordinate and create the necessary framework conditions.

“It’s good to put lines on maps and plan. And to think about what grid needs to be built where and when and how big it should be to connect all the offshore wind farms Europe is going to build. Decisions on all this can only be taken with the full involvement of the offshore wind farm developers, governments and regulators. But it’s good the leading TSOs have started thinking about what doable and desirable from their perspective.”



Giles Dickson
Chief Executive Officer WindEurope

“The approach to develop jointly a portfolio of projects in the North Sea region can accelerate progress.”



Leonardo Meeus
Director
Florence School of Regulation

“It is a good initiative that OTC is taking up the results from our European Process and complements the process with a regional perspective and investigation of projects in greater detail.”



Sonya Twohig
Secretary-General ENTSO-E



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