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Connecting Borders Through Offshore Hydrogen: Infrastructure and Financing in the North Sea

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Connecting Borders Through Offshore Hydrogen: Infrastructure and Financing in the North Sea

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EXECUTIVE SUMMARY

This policy brief examines the development of offshore hydrogen infrastructure in the North Sea, highlighting its potential contribution to Europe's energy security, decarbonisation, and competitiveness. The region offers several advantages, including most importantly a high renewable energy production potential due to favourable wind conditions, and shallow waters being beneficial for the installation of wind turbines. Developing North Sea hydrogen infrastructure reduces the need for extensive electricity grid expansion, as well as land pressure onshore, and addresses significant energy storage challenges.

However, the development of this infrastructure faces several challenges, including regulatory, financial, technical, and spatial barriers. The substantial initial capital expenditure (CAPEX), coupled with national preferences and a fragmented regulatory landscape that involves non-EU Member States, complicates cross-border projects, which could delay investments.

Careful planning and forecasting are imperative to ensure that offshore infrastructure is commensurate with future demand, making sure that every euro invested privately and publicly delivers maximum value. Given the significant risks inherent in hydrogen projects, policymakers need to establish and support the mechanisms that mitigate them. Facilitating cost-efficient development by 'going big' right from the start to benefit from economies of scale and deploying advanced technologies will be equally crucial. Achieving a balance between state aid and market forces is necessary to underpin infrastructure development, while avoiding any distortion of fair competition.

Policy options that can address the lack of demand and spatial constraints include strengthening regional cooperation among future transmission system operators (TSOs), harmonising permitting processes, and implementing minimum regulatory requirements for interoperability. Issues relating to the financing of these ambitious projects can be tackled by setting clear, ambitious offshore hydrogen production targets, alongside innovative financing models, which significantly boost private investment and mitigate financial risks.

I.
INTRODUCTION

As Europe embarks on an ambitious path to decarbonise its economy while ensuring competitiveness and energy security, green hydrogen will be crucial. Electricity and hydrogen fulfil complementary roles, with electricity prioritised for direct applications due to its efficiency, while hydrogen serves as a vital low-carbon alternative in hard-to-abate sectors where electrification is impractical, such as energy-intensive industries, aviation, and shipping. The North Sea, with its abundant wind resources in deep and shallow waters, is a prime region for green hydrogen production, offering significant potential to boost Europe's energy security and resilience.[1] As resilience becomes a higher priority in political agendas, offshore hydrogen production in the North Sea should attract greater political and financial support, reinforcing its role in Europe's energy transition.

Compared to their inland counterparts, offshore wind farms can tap into stronger and more stable wind resources to maximise electricity production, which can then be converted into hydrogen through electrolysis. Offshore electrolysers split desalinated sea-water into oxygen and hydrogen, which is then compressed, stored in tanks, and transported to shore via pipelines.[2] Hydrogen can be stored, transported, and used across borders.

Developing offshore hydrogen infrastructure, particularly in the North Sea, offers multiple benefits, inter alia reducing the need for extensive electricity grid expansion, reducing land pressure, addressing energy storage challenges, and leveraging existing offshore energy expertise and infrastructure.

"The North Sea [...] is a prime region for green hydrogen production, offering significant potential to boost Europe's energy security and resilience."

This policy brief outlines the benefits, challenges, and policy options for developing offshore hydrogen infrastructure in the North Sea. To this end, it provides actionable steps to enhance regional cooperation, streamline regulation, incentivise domestic offshore hydrogen production, and de-risk and secure investment in offshore infrastructure through a range of policy measures.

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[1] Durakovic, et al., Powering Europe with North Sea offshore wind (2023); Glaum, et al., Offshore power and hydrogen networks for Europe's North Sea. Applied Energy (2024); TNO Innovation For Life, Offshore hydrogen for unlocking the full energy potential of the North Sea (2022)

[2] OYSTER: Offshore hydrogen from shoreside wind turbine integrated electrolyser; HOPE: Hydrogen Offshore Production for Europe; H2Mare: Offshore

II. BENEFITS

The North Sea offers significant benefits for advancing Europe's decarbonisation efforts. Offshore wind plants in the North Sea have significantly higher capacity factors than most onshore ones (50% versus between 30% and 45%), ensuring more consistent and efficient energy production.[3] Using offshore wind energy for hydrogen reduces spatial and environmental pressures for inland renewable energy production as well as the high political, financial, and environmental costs associated with importing energy.

Denmark, the Netherlands, France, Germany, Ireland, Luxembourg, Norway, and the UK have already set ambitious targets to expand offshore wind electricity generation, aiming for 120 GW of installed capacity by 2030 and 300 GW by 2050.[4] Given the current capacity of less than 30 GW (less than 20 GW in the EU), this goal reflects a significant ambition. There are clear benefits in converting some of this offshore electricity into hydrogen via offshore electrolysis and transporting it via hydrogen pipelines to the shore. The benefits can be summarised as follows:

- Producing hydrogen within Europe supports EU energy security and resilience. It resolves uncertainties about the proper measurement of hydrogen's carbon intensity and questions about the meaning of strategic autonomy for hydrogen imports. Offshore hydrogen pipelines are particularly beneficial, allowing access to high-wind areas far offshore and enabling connections with countries like Norway, which can supply surplus low-carbon hydrogen. The UK's leadership in offshore wind energy and proximity to neighbouring EU nations make it well-positioned to export hydrogen to mainland Europe through pipelines, something the UK government is already considering.[5]

- Offshore hydrogen and hydrogen produced onshore in North Sea countries can be soon transported to the consumption centres via onshore infrastructure. The German hydrogen core grid, located in the middle of Europe, is about to be confirmed by the Federal Network Agency. It will be 10,000 km long by 2032, and provides connections to important European import corridors, as well as linking to neighbouring Member States. Hydrogen can be transported over long distances without significant losses, making it a versatile energy carrier for balancing supply and demand.[6] For far-offshore

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3 WindEurope, Wind energy in Europe – 2023 Statistics and the outlook for 2024-2030 (2024); European Commission (2023)

4 Ostend Declaration on the North Seas as Europe's Green Power Plant (2023)

5 DESNZ, The potential for exporting hydrogen from the UK to continental Europe (2024)

6 Patonia et al., Hydrogen pipelines vs. HVDC lines (2023)

wind plants (i.e. starting from 100–150 km from the onshore connection), offshore hydrogen transport is more cost-effective than high-voltage direct current (HVDC) electricity cables.[7] Given the significant delays in grid development and the vast investments required, integrating hydrogen infrastructure – particularly offshore – can ease grid congestion, provide long-term energy storage, and support the broader integration of variable renewable energy sources (VRES). Reducing the rising costs of electricity grid infrastructure is crucial, as evidenced by Germany's recent Network Development Plan, which anticipates offshore electricity grids costs at approximately €157.5 billion by 2045. This includes around €145.1 billion for long-term offshore network expansion and an additional €12.4 billion for ongoing offshore grid projects in the North Seas.[8]

- Hydrogen can also be stored in large volumes without significant losses, and the North Sea has a massive salt-cavern potential, ideal for hydrogen storage.[9] Converting offshore electricity into hydrogen allows the use of offshore hydrogen storage facilities and provides flexibility to the onshore electricity system. This conversion not only helps to be prepared for the so-called dark doldrums, but also helps alleviate the growing pressure on the onshore electricity network.

- Offshore hydrogen infrastructure development also helps to minimise the use of scarce offshore and coastal space. A 10 GW pipeline has five times the capacity of a conventional submarine cable system and takes up considerably less space.[10] Locating electrolysis offshore can save space onshore and may simplify permitting and environmental issues. Furthermore, an alternative to a connection via power cable or pipeline, a combination of an electrical and a pipeline connection concept could also be applied and should be explored in this context. This connection system, defined as 'mixed connection system', consists in a combination of various types of transport infrastructure, including hydrogen pipelines and offshore cables. The mixed connection concept maximises the socio-economic benefits and requires the least socially shared costs.[11]

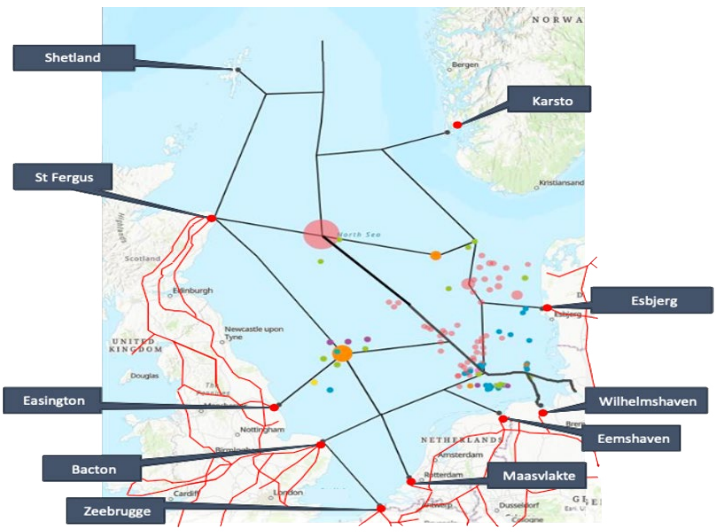

Figure 1: Hydrogen pipeline projects in the North Sea (DNV, 2023)

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[7] Van Wingerden et al., Specification of a European Offshore Hydrogen Backbone (2023)

[8] Netzentwicklungsplan Strom 2037 mit Ausblick 2045 (2023)

[9] Caglayan et al., Technical potential of salt caverns for hydrogen storage in Europe (2019)

[10] E-BridgeStudy, "Assessment of connection concepts for Germany's far out North Sea offshore wind areas for an efficient energy transition" (2024)

[11] Ibid.

Offshore Hydrogen Production and Innovation Projects in the North Sea

Project	Involved actors (non-exhaustive)	Countries	Financial status	Planned capacity	Timeline
AquaDuctus	Gascade's Aqua Ductus is part of the Aqua Ventus initiative to develop SEN-1 as a green hydrogen plant	Germany, Denmark, the Netherlands, the United Kingdom, and Norway	Qualified as IPCEI (under Hy2Infra Projects)	Pipeline Capacity 20 GW. Design pressure DP 120 bar with a landing pressure of 70 bar(g) at German shore. The pipeline aims to be a back-bone of a pipeline network that connects hydrogen production areas in Germany in two steps Step 1: 200km offshore SEN1 with 1GWel (part of German Core Grid) Step 2: Next 200km offshore to connect the EEZ with a potential of 10GWel, but also to other neighbouring countries in the North Sea.	Operational by 2030
H_2opZee	TKI Wind op Zee; RWE; Neptune Energy	The Netherlands	Supported by the Dutch Government	300-500 MW electrolysers far off land to produce hydrogen (demonstration) and 10-12 GW (deployment).	Operational by Q4 2030
VindØ	Copenhagen Investment Partners; Shell; DEME; Boskalis; MT Højgaard	Denmark, Belgium, the Netherlands and Germany	Private investment within Denmark	Connect 3 GW (in a first phase) to 10 GW (in a second phase) of offshore wind to electrolysers.	Island to be established by 2033
Pleione and Neptunus	OX2; Ingka Investments (IKEA)	Sweden	Ingka acquired 49% stake for €20 million	Total of 2.9 GW. Pleione to produce 1 GW offshore wind farm producing 0.12 MtH2 per year. Neptunus to produce 1.9 GW offshore wind farm producing 0.225 MtH2 per year.	Pleione operational by 2030 Neptunus operational by 2032
HOPE	Lhyfe; ERM, Plug Power; EDP	France, Belgium and the Netherlands	€20 million in EU funding	Developing and testing the first 10 MW offshore green hydrogen production system and demon-strating the feasibility of large-scale concepts for deployment.	Demonstra-tion by 2028
Åland Energy Island	Copenhagen Infrastructure Partners (CIP); Lhyfe; Flexens	Finland	CIP funded	Supporting gigawatt-scale offshore wind and hydrogen production off the Finnish coast	Still in ex-ploration status
H_2Mare	Siemens Energy; Salzgitter; Fraunhofer Institut; RWE	Germany	€2 million public funding in total (EU, DE)	Research project divided into OffgridWind and H2Wind. Direct integration of electrolysers into offshore wind turbines, research advances in high-temperature and seawater electrolysis.	Operational between 2021 and 2025
OYSTER	Siemens Gamesa; Ørsted, Element Energy	France	€5 m from the EU FCH2-JU	Research project for marinised electrolysers integrated with offshore wind turbines to pro-duce 100 % renewable hydrogen.	Operational between 2021 and 2025
DOSTA	University of Groningen, Utrecht University NGT; NOGAT; Ocean Grazer; Siemens Energy; Smartport; Tennet; TNO; Vattenfall	The Netherlands	€1.1 million in public funding	Research project to develop offshore storage and trans-portation alternatives from a multidisciplinary perspective (infrastructure optimisation, legal and regulatory research, marine spatial planning, environmental impact, policy recommendations).	Operational between 2020 and 2024

III. CHALLENGES

Permitting and Spatial Constraints

Overall, offshore hydrogen is not sufficiently recognised in national plans.[12] Future expansion of areas often remains largely unclear, while no explicit targets for offshore hydrogen production exist. The regional regulatory fragmentation hinders the establishment of a unified hydrogen market, limiting economies of scale and increasing transaction costs. Similarly, there are discrepancies between EU Member States, the UK, and Norway regarding the procedures and timelines for rolling out permits.[13] Additionally, the North Sea is a highly utilised maritime area and home to various industries, such as fishing, shipping, defence, and oil and gas extraction. Therefore, the introduction of large-scale hydrogen production facilities adds another layer of spatial competition. Meteorological conditions are also a factor. Sweden and Finland have only 192 MW and 71 MW of installed offshore wind capacity, respectively.[14]

Differing regulations also exist on the allocation of space for hydrogen production and infrastructure. Regarding infrastructure, seabed allocation often involves multiple jurisdictions across national and international waters, complicating regulatory approval processes. Acquiring the necessary permits and licenses can be a complex and lengthy process involving multiple regulatory bodies.

> *"Offshore hydrogen is not sufficiently recognised in national plans."*

The EU has sought to address this obstacle most notably through RePowerEU, which streamlines regulatory processes for renewable energy projects.[15] It designates hydrogen infrastructure as a key project of common interest (PCI), giving it priority status. The revision of the Trans-European Networks for Energy (TEN-E) regulation supports cross-border hydrogen networks, reducing bureaucratic hurdles.[16] Additionally, the EU has encouraged Member States to simplify permitting through harmonised standards, digitalised applications, and coordination with local authorities, ensuring faster project

[12] Appell: Offshore-Wasserstoffwirtschaft fordert klare Ziele für die Elektrolyse auf hoher See in der Nationalen Wasserstoffstrategie (2023)

[13] European Commission, Guidance to Member States on good practices to speed up permit-granting procedures for renewable energy projects and on facilitating Power Purchase Agreements (2022)

[14] WindEurope, Wind energy in Europe - 2023 Statistics and the outlook for 2024-2030 (2024)

[15] European Commission, REPowerEU Plan (2022)

[16] European Commission, Guidelines for trans-European energy infrastructure (2022)

deployment to meet green hydrogen targets and support offshore wind-hydrogen integration. In Germany, the Hydrogen Acceleration Act *(Wasserstoffbeschleunigungsgesetz)* aims to expedite hydrogen infrastructure by simplifying planning, approval, and procurement processes. It introduces maximum deadlines for water law approvals, shortens appeal processes, accelerates procedures, and grants hydrogen projects "overriding public interest" status for faster approval.[17] However, pipelines are currently excluded from integrated infrastructure planning, and fall directly in the German Energy Industry Act (EnWG).

However, the report on EU competitiveness by Mario Draghi insists that permitting still represents a significant bottleneck for developing renewable energy and infrastructure, often taking years. It highlights efforts to streamline the process, including emergency regulations and updates to the Renewable Energy Directive (RED) to speed up procedures, such as by improving environmental impact assessments and simplifying bureaucratic hurdles, aiming to reduce the time needed for permits.[18] At a national level, countries face additional issues, considering also the fact that not all countries in the North Sea region are in the EU. For example, in the UK, the seabed is owned by the Crown Estate, influencing project costs, investment attractiveness, revenue generation, and the broader economic impact of offshore renewable energy infrastructure. Developers face significant upfront costs for acquiring leases, which can impact the financial viability of projects, especially during the initial stages of development.[19] Additionally, ongoing rental payments contribute to the overall operational costs of offshore renewable projects.

Another substantial obstacle for infrastructure development in the North Sea includes a fragmented regulatory framework in the areas within the individual European Economic Zones (EEZ) and special environmental features such as the ones present in the Wadden Sea. There are also limited landing spots on North Sea coasts, due to environmental protected areas. (Planned) onshore infrastructure, such as the German core grid, must also be taken into account. Careful planning and optimisation of the existing coastal areas are needed to accommodate the needs of offshore hydrogen projects, as well as offshore electricity production.

"Permitting still represents a significant bottleneck for developing renewable energy and infrastructure."

Transporting hydrogen from offshore production sites to onshore demand centres requires either repurposing available gas pipelines or developing new infrastructure. At first glance, the conversion of existing natural gas pipelines for the transportation of hydrogen seems advantageous, also with a view to the costs.

However, pipeline conversions also entail several uncertainties. Both the technical suitability for hydrogen transport, particularly due to the advanced age of the pipelines, and the question of when one of the pipelines can be taken out of the natural gas import system without jeopardising the resilience of the natural gas supply need to be clarified

[17] Deutscher Bundestag, Acceleration law for hydrogen ramp-up discussed (2024)

[18] Draghi, Mario, The future of European competitiveness (COM) (2024)

[19] Senedd Research, Who owns the seabed, and why it matters (2021)

conclusively. Parallelly stands the issue that compressors of current pipelines are not suited for hydrogen.

"Especially where offshore hydrogen production is located more than 100-150 km away from the shore, the use of pipelines is indeed more suitable from both a cost and environmental perspective."

The early stage of infrastructure development would imply comparatively higher costs for the entire hydrogen production chain. The advanced technology required for offshore hydrogen production, such as electrolysis units, compressors, and specialised offshore pipelines, is significantly more expensive compared to onshore installations. The harsh marine environment and corrosive saltwater require robust, durable materials, and specialised equipment for construction and maintenance, which further raise costs temporally. However, over time there will be a significant cost-degression and 'learning spill overs', which will bring down costs. This means that early projects will find it more difficult to monetise their investments, but in the long-run, new pipelines will be more competitive. Limited initial support can address the temporal issue.

On the other hand, converted pipelines can offer only limited capacities, potentially below the production potential, preventing complete infrastructure development. Especially where offshore hydrogen production is located more than 100-150 km away from the shore, the use of pipelines is indeed more suitable from both a cost and environmental perspective.[20]

[20] van Wingerden et al. Specification of a European Offshore Hydrogen Backbone (2023)

IV.
POLICY OPTIONS

Accelerating Offshore Hydrogen Infrastructure in the North Sea

Establishing an offshore hydrogen backbone in the North Sea requires several key challenges to be addressed. These include selecting strategic maritime zones for hydrogen production, identifying consumers who will benefit most from green hydrogen, creating a financial framework to equitably distribute costs, and focusing on CO2 abatement in both the conversion of renewable energy and its end use. Crucial to integrating hydrogen production and its infrastructure into the EU's broader energy strategy and meeting decarbonisation goals is achieving the following milestones:

1. Implementing the concept of an overall energy system combining electrons and molecules into EU energy strategies (including offshore hydrogen targets and offshore energy storage targets). Some national laws of Member States already allow mixed grid concepts, but these should be harmonised at the European level.

2. Implementing a common energy infrastructure plan for both offshore and onshore, integrating electricity and hydrogen infrastructure to maximise VRES integration in the North Sea.

3. De-risking offshore hydrogen investments by establishing mechanisms such as government guarantees and long-term offtake agreements.

4. Ensuring cost-efficient infrastructure development through economies of scale and advanced technologies.

5. Balancing state aid with market principles to support infrastructure development without distorting competition.

6. Encouraging public-private partnerships to leverage investment potential.

7. Incentivising offshore auction designs that include system integration considerations (as non-price criteria) or defining specific offshore hydrogen development zones.

Advancing Regulatory Alignment Through Collaboration

Developing offshore hydrogen infrastructure in the region requires extensive coordination and cooperation between the bordering countries. The North Seas Energy Cooperation (NSEC) has nine members (Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Norway and Sweden), and an MoU signed with the UK in December 2022. It focuses on several critical areas regarding hydrogen and offshore renewable energy development.[21] The NSEC can be the platform that effectively addresses these challenges by fostering greater cooperation and alignment across the North Sea region. By working towards a more cohesive regulatory framework, the NSEC can simplify cross-border projects and by doing that facilitate the creation of a unified hydrogen market, which would reduce risks for investors and developers. This streamlined approach would also enhance the flexibility needed to accommodate technological advancements while ensuring safety and performance standards. Moreover, by promoting consistency in financing models and regulatory practices across countries, the NSEC can attract greater investment and accelerate the development of a robust offshore hydrogen infrastructure.

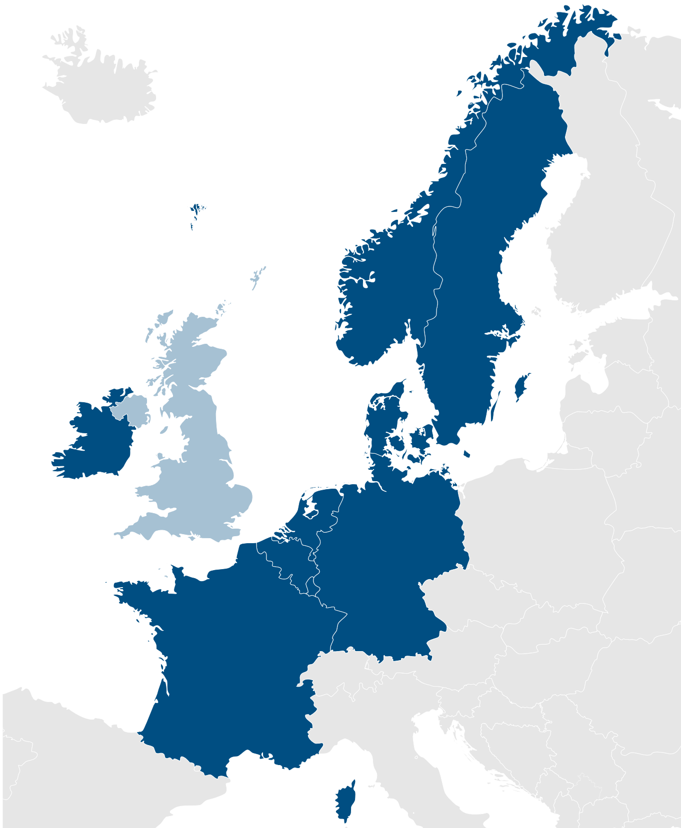

Figure 2: North Seas Energy Cooperation Members

- NSEC Members
- MoU signed with the NSEC in December 2022

"Developing offshore hydrogen infrastructure in the region requires extensive coordination and cooperation between the bordering countries."

Establishing a conducive environment for the growth of hydrogen infrastructure in the North Sea includes promoting interoperability and efficient use of resources. Integrating hydrogen production with existing industrial hubs can help mitigate space constraints, ensuring efficient use of the limited available landing spots. This allows for efficient energy storage and balancing, leveraging existing assets to create a more resilient and cost-effective energy system, crucial for a low-carbon transition.

To achieve a harmonised approach to hydrogen infrastructure development, strengthening cooperation between the European Network of Transmission System Operators for Electricity (ENTSOE) and the European Network of Network Operators for Hydrogen (ENNOH) is

[21] The objectives of the NSEC include streamlining and harmonising regulations across the region to facilitate cross-border projects and reduce bureaucratic hurdles. They also focus on integrating hydrogen production with offshore wind infrastructure to optimise renewable energy use and enhance efficiency. The NSEC supports connecting production sites with demand centres to ensure a reliable supply chain. Additionally, establishing a unified hydrogen market is a priority to drive investment and scale production, aligning these efforts with broader EU decarbonisation goals to boost energy security and reduce carbon emissions.

essential, along with liaising with the European Network of Transmission System Operators for Gas (ENTSOG). These organisations, along with Member States (and relevant National Regulatory Agencies), should work towards aligning permitting processes and regulatory frameworks in the North Sea.

Potentially, drawing inspiration from the UK-Norway Framework Agreement, Member States should also focus on bilateral and multilateral treaties as effective models for cross-border cooperation. First-moving 'champions' are essential to kick-start a regional process to increase the amount of (market) participants going forward. Additionally, minimum regulatory requirements should be implemented to incentivise the creation of a regional hydrogen market, while avoiding over-regulation. Such an approach should focus on:

- Coordinating regulations and product standards to enable seamless integration of hydrogen infrastructure across borders.
- Standardising technical specifications and safety protocols for hydrogen production, and transportation and storage equipment.
- A long-term strategic vision to facilitate the exchange of best practices and technological innovations, with coordinated planning between the EU and neighbouring states, aimed at meeting targets and capacities needed beyond 2030.

Addressing the Challenge of Infrastructure Financing

The EU's Hydrogen and Decarbonised Gas Market Package, adopted by the European Parliament and the Council in May 2024, **allows for different financing models across countries that contribute to cross-border inconsistencies**. These include subsidising hydrogen projects through natural gas tariffs, intertemporal cost allocation models and cross-subsidisation.[22]

> *"The EU's Hydrogen and Decarbonised Gas Market Package [...] allows for different financing models across countries that contribute to cross-border inconsistencies."*

Dedicated hydrogen tariffs would involve the costs being borne exclusively by the beneficiaries of the hydrogen infrastructure.[23] While this ensures cost reflectivity, it also poses significant risks of stranded assets and financial liquidity challenges during the ramp-up phase. Dedicated tariffs are the norm for natural gas and electricity. The major drawback is that these tariffs might result in higher costs for initial users, hampering early-stage adoption and investment. These, therefore, need to be avoided in the ramp-up phase.

[22] Regulation on common rules for the internal markets for renewable gas, natural gas and hydrogen (COM), (2024)

[23] Florence School of Regulation, Discussing the future tariffs for hydrogen and low-carbon gases (2022); Yafimava, From natural gas to hydrogen: what are the rules for European gas network decarbonisation and do they ensure flexibility and security of supply (2024)

The **Regulated Asset Base (RAB) model with subsidy** involves subsidies to cover the revenue gap during initial stages. It facilitates network development by allowing cross-subsidisation (revenues from existing natural gas users could potentially be used to support the financial viability of hydrogen infrastructure during its early development phase) and reduces risks by covering the full revenue gap with the subsidy. However, the effectiveness of this model depends heavily on who bears the subsidy and the potential burden on taxpayers.[24] This model only makes sense if one assumes gas network companies to be the same as hydrogen network companies.

The intertemporal cost allocation model, to be used in Germany's envisioned hydrogen core grid, shifts depreciation costs to the future, lowering initial charges and spreading costs over time. It involves the regulator capping network tariffs and securing investment risks through liquidity payments to network operators in the initial years to cover costs as long as they are exceeding revenues due to initial low tariffs. These payments are tracked in an intertemporal cost allocation account ("amortisation account") and have to be paid back once, with increasing network utilisation, revenues exceed annual cost, until the amortisation account is back in balance.[25] It aims to avoid placing an excessive burden on the first network users and to balance costs and revenues, thereby reducing financial liquidity risks. Nonetheless, there remains a risk of asset stranding, as future network users bear a share of the initial costs, and it is still difficult to assess future demand.[26]

The **cross-subsidisation model** involves using natural gas tariffs to subsidise hydrogen projects. In October 2023, the UK passed the Energy Act, allowing for a levy on natural gas network users to finance the subsidy of hydrogen production and infrastructure. This helps in repurposing natural gas assets and mitigating early-stage financial risks but places additional burdens on gas consumers and may face challenges due to a shrinking natural gas user base. However, the new EU gas package allows cross-subsidisation only in the form of a temporary dedicated charge.[27] Some national regulations also prohibit using profits from gas or electricity infrastructure to fund hydrogen infrastructure, such as in the Netherlands. The cost of repurposing gas pipelines could be passed on gas tariffs. Repurposing can significantly lower decommissioning costs.[28]

Although these measures have yet to be implemented at a large scale to fully support a single model, a solution for North Sea hydrogen infrastructure financing could be a combination of the RAB model with subsidies and the intertemporal cost allocation model. The RAB model can provide liquidity during the ramp-up phase through subsidies and cross-subsidisation from natural gas users, while the intertemporal model spreads costs over time, reducing early

[24] GOV.UK, Development costs and the nuclear Regulated Asset Base (RAB) model (2022)

[25] Bunderministerium der Justiz, Electricity and Gas Supply Act (Energy Industry Act - EnWG), § 28r Principles of financing the hydrogen core network and fee formation; Federal Network Agency's power of derogation and right of termination; determination authority (2024); Bundesnetzagentur, Grand Ruling Chamber for Energy GBK-24-01-2# 1: The determination of provisions on the setting of network tariffs to be charged for access to hydrogen core network and on the establishement of a payback mechanism effective for a certain period (2024)

[26] Rogerson, Intertemporal Cost Allocation and Investment Decisions (2008)

[27] Yafimava, From natural gas to hydrogen: what are the rules for European gas network decarbonisation and do they ensure flexibility and security of supply (2024)

[28] Florence School of Regulation, Discussing the future tariffs for hydrogen and low-carbon gases (2022)

tariffs and risks of stranded assets. This hybrid approach balances initial financial viability and long-term sustainability, avoids placing excessive burdens on early users, and mitigates the uncertainty of future hydrogen demand, ensuring a smoother transition to hydrogen infrastructure development. However, as all models have ad-hoc advantages and downsides, the preferred finance regime may vary on a project-to-project basis, also considering potential viabilities in the different jurisdictions.

De-risking Offshore Hydrogen Investments Through Policy

The success of the European Commission's Wind Power Action Plan can provide learnings for the development of offshore hydrogen infrastructure. Establishing clear, ambitious, and achievable production targets is a critical first step, signalling commitment and adding market certainty for investors. NSEC members and the UK should conduct a thorough assessment of the North Sea's hydrogen production potential, considering wind energy availability, transportation costs, and existing infrastructure. This data-driven approach ensures that targets are grounded in realistic and achievable metrics. A broad range of stakeholders should be included in this effort, i.e. government bodies, private sector companies, research institutions, and local communities. This helps set targets that are ambitious and practical, considering technological, economic, and environmental perspectives.

The targets should be broken down into smaller, incremental milestones, focusing on yield, rather than on installed capacity. These can be aligned with stages of technological development, funding cycles, and market readiness to ensure steady progress and allow for adjustments based on ongoing learnings and advancements. Accordingly, the countries in the region should implement robust monitoring and reporting mechanisms to track progress against set targets. Regular reporting ensures transparency, accountability, and the ability to make data-informed adjustments to strategies and actions as and when they are needed.

Government guarantees can be a complementary measure that should be implemented in the region, if allocated with a market-oriented approach. Governments could provide guarantees on loans taken by hydrogen infrastructure developers. This would reduce the financial risk for lenders, making it easier for developers to secure financing at lower interest rates. If the project fails or defaults, the government covers part of the outstanding loan amount. Similarly, insurance policies could cover various risks such as construction delays, natural disasters, or technological failures. Regional governments are usually not leading to government spending. Burden-sharing actions transfer specific risks to insurance companies, reducing the overall risk exposure for investors and developers.

"The success of the European Commission's Wind Power Action Plan can provide learnings for the development of offshore hydrogen infrastructure."

To mitigate the risks associated with large-scale hydrogen projects, providing long-term revenue security and agreements with consumers is essential. Long-term agreements, such as a harmonised rollout of temporary carbon contracts for difference (CCfDs), can offer price stability and revenue assurance, thereby reducing investment risk for initial investment and CAPEX. By guaranteeing a minimum revenue stream, these agreements can attract investors and financial institutions, fostering confidence in the hydrogen market and accelerating infrastructure development. EU funds such as the Modernisation Fund and the new European Competitiveness Fund should support a harmonised CCfD roll-out across the region, focusing on emissions-intensive industries widely concentrated in Northern Europe.

Establishing **hydrogen purchase agreements** (HPAs) is another strategic measure to create a stable demand for green hydrogen. HPAs involve long-term contracts between hydrogen producers and consumers, ensuring a steady market for the produced hydrogen. These agreements can be particularly effective in securing demand from industrial sectors that are hard to electrify, such as steel, chemicals, aviation, and shipping. By guaranteeing a market for green hydrogen, HPAs can drive investment in production facilities and infrastructure, promoting economies of scale, and reducing production costs over time. Infrastructure would hence benefit from investment, because developers would gain more certainty *vis-à-vis* the use of the hardware they establish.

Public support is yet crucial to bridge the gap between the cost of fossil fuels and hydrogen. This should happen in two credible complementary strategies. First, a public body should financially cover the gap between low carbon hydrogen costs and current energy supplies – either by subsidising production, or demand, or both. Second, governments should strengthen the regulatory framework with clear 'sticks' and sufficient incentives for companies to switch away from current energy supplies.

Policymakers in Brussels should also create the conditions to push **green 'lead markets'** to drive forward the hydrogen economy from end-use. Public procurement, which accounts for **14%** of the EU's GDP, can significantly drive demand for low-carbon products such as green steel and ammonia. The German proposal for climate-friendly labelling in sectors such as metals and chemistry can serve as a model, ensuring transparency and boosting hydrogen adoption.[29] These measures can reduce costs, accelerate the hydrogen transition, and strengthen the EU's global leadership in low-carbon technologies.

Combining these policy measures can create a robust framework to support the hydrogen economy. Targeted support and tax incentives can kick-start the development phase, making initial projects financially viable. Temporary CCfDs – as featured in the German Hydrogen Strategy – provide the necessary financial security to attract large-scale investments, complementing HPAs, which ensure a consistent market, driving demand, and facilitating stable supply. Governments and industry stakeholders should collaborate to establish harmonised HPAs, focusing on sectors where hydrogen can be a key decarbonisation tool.

[29] BMWK, Leitmärkte für klimafreundliche Grundstoffe (2024)

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ABOUT US

EPICO is an independent climate and energy policy think tank based in Berlin and Brussels. Founded in 2021 by Dr Bernd Weber, EPICO has a social market-oriented approach to promote a socially cohesive and environmentally sustainable transition to climate neutrality. Supported by its broad-based Advisory Council, EPICO provides a platform and network for diverse stakeholders from politics, academia, industry, and civil society to exchange and find majorities for ambitious climate policies.

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