Synergies between hydrogen and offshore wind – challenges and opportunities in the North Sea Region

Summary:

- Large deployments of offshore variable renewable energy are required in the North Sea in order to limit the global temperature rise to 1.5 °C.
- Hydrogen emerges as one promising alternative to meet 2050 targets in the North Sea region, due to its potential use in energy intensive industries, mobility and build environment, among others.
- As of today, the North Sea hosts around 5000 wells, 500 oil and gas platforms and 10,000 kilometres of pipelines. Most of this infrastructure is planned to be decommissioned in 2030-2050.
- Synergies between hydrogen and offshore wind will permit the re-use of offshore assets, therefore lowering decommissioning costs, and also enabling the integration of larger installed capacities.

Introduction

In the following years the share of variable renewable energy sources is planned to increase largely in Europe and particularly in the North Sea region (NSR). Most countries around the NSR have set ambitious targets, especially regarding offshore wind deployments. In this regards, for 2030, UK plans to deploy 30 GW, Germany 11 GW, Denmark 10 GW, Netherlands 11.5 GW, and Norway 3.7 GW [1].

Although the increase of offshore wind capacity will help to decarbonize the energy sector, its intermittency will compromise the operation of the power system if no measures are taken. In the case of the NSR, hydrogen emerges as an attractive alternative to provide flexibility if the integration of large scale offshore wind is facilitated. As an example, the National Climate Agreement [2] of the Netherlands has pointed out that in mid and long term hydrogen will be relevant as a feedstock for the process industry, as an energy carrier for high temperature heat, as a controllable carbon free capacity, as a fuel for mobility and for built environment.

The interaction of hydrogen and offshore wind will also be helpful for the re-use of assets (such as platforms or pipelines) after the cease of operation of most oil and gas related activities in the different shelves of the North Sea, which is expected for the period 2030-2050 [3]. Multiple opportunities arise from the offshore wind-Hydrogen interaction: offshore Hydrogen storage in gas fields, offshore blue hydrogen production with CCS or offshore green Hydrogen production placing electrolysers in platforms are some examples of this synergy. Some of these ideas are already being tested, like the Neptune Q13 oil and gas platform [4], which is a pilot project to produce green hydrogen from wind and solar energy and should be operational in 2021.

This policy brief from the ENSYSTRA [5] project aims to underline the economic, technical and stakeholder engagement barriers to the interaction between large scale offshore wind and hydrogen production, and to provide recommendations addressed to policy makers in the region in order to facilitate the transition towards a more integrated energy system.

Challenges identified

In this regard, the ENSYSTRA project has identified, among many others, four challenges that are considered major barriers to the effective interaction between large-scale offshore wind and hydrogen.

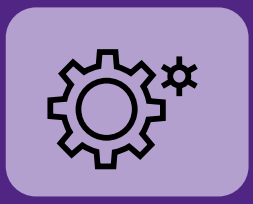
The integration of offshore wind and hydrogen presents challenges from the economical point of view. The competitiveness of green hydrogen in a liberalized market is a perfect example. The cost of producing green hydrogen is substantially higher than producing hydrogen by steam methane reforming (SMR) of natural gas (with or without CCS). The cost of producing hydrogen with SMR varies from USD 1/kgH2 to USD 2/kgH2 depending on the geography, whereas the cost of green hydrogen varies from USD 6/kgH2 to USD 10/kgH2 [6].

Other barriers are related to the technical challenges of the offshore installations. The key locations for the offshore hydrogen production would be the result of a clear vision for the link between the large scale offshore wind

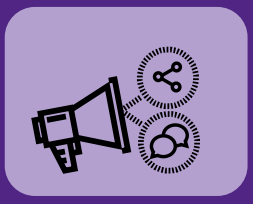
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No: 765515.

Economic
→ High price of green hydrogen production compared to grey/blue alternatives

Technical
→ On-site logistics of the hydrogen production
→ Transportation and link to consumers



Stakeholder engagement



The possibility to produce hydrogen on existing offshore O&G platforms, in a financially feasible way, is directly linked to the availability and management of floor space on the platform [7]. This is because adding more floor space to a platform is highly costly. Another challenge is the availability of technically ready pipelines. In the case of transport of hydrogen, the existing natural gas evacuation pipelines present great potential. The routing and reconnecting of the existing gas pipelines need to be the subject of strategic planning, in strong collaboration with offshore and onshore consumers (potentially shipping or industry). Also, a higher load factor will lower the cost of green hydrogen production. Therefore, the access to a large scale offshore wind farm development for reliable supply of electricity is essential. With the scaled-up of hydrogen production, spatial conflicts with other activities offshore could occur, depending on space requirements and safety regulations (e.g., safety zones, maintenance and operation activities, etc.).

The third barrier which should be addressed, as part of a strategic planning of an effective hydrogen production from large-scale offshore wind farms, is the weak stakeholder engagements. The potential opportunities and bottlenecks of producing, storing and transporting hydrogen using the offshore infrastructure (existing or planned) can be the result of transparent, collaborative efforts of stakeholder engagement groups. While an early consultation of the relevant participants (governmental entities, TSOs, O&G operators, wind operators) is essential in defining a clear shared strategy and vision, the particularities of each project would demand the later involvement of other influenced actors (other users of the North Sea: fisheries, shipping, environmental NGOs). A clear understanding of the benefits as well as the risks and responsibilities of all involved participants could enable a shared commitment of interested parties, as well as minimize the possibility for delays as a result of opposing parties.

Inputs for policy formulation

In order to respond to the barriers identified, we propose a set of policy recommendations, listed as follows:

- Development of EU level grants or support schemes in order to encourage investment in hydrogen, easing the development towards large-scale implementation.
- Coordinate the strategic planning of offshore H2 production roadmap, taking into account the financial benefits of linking hydrogen production with the future large-scale OWF.
- Facilitate the interaction between the producers of hydrogen offshore (from OWF), offshore assets owners (O&G) and potential end users (such as industry), for the identification of barriers and opportunities towards a shared vision.
- Create a coherent and transparent legal framework which enables the acceleration of hydrogen production offshore.

References

[1] Gusatu, Yamu, Zuidema, Faaij. A Spatial Analysis of the Potentials for Offshore Wind Farm Locations in the North Sea Region: Challenges and Opportunities. ISPRS Int J Geo-Information 2020; 9:96. https://doi.org/10.3390/ijgi9020096.
[2] National Climate Agreement of the Netherlands, 2019
[3] Nexstep: Re-use & Decommissioning of oil & gas platforms Report 2018
[4] www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-fuels-and-feedstock/hydrogen-for-a-sustainable-energy-supply/world-first-an-offshore-pilot-plant-for-green-hydrogen/
[5] Ensystra.eu
[6] The Future of Hydrogen, Seizing today's opportunities. Report prepared by the IEA for the G20, Japan
[7] Meier K. , Hydrogen production with sea water electrolysis using Norwegian offshore wind energy potentials: Techno-economic assessment for an offshore-based hydrogen production approach with state-of-the-art technology. Int J Energy Environ Eng. 2014;5(2-3):1-12. doi:10.1007/s40095-014-0104-6

Main Author and Contact Information
Rafael Martínez Gordon
University of Groningen
r.martinez.gordon@rug.nl

Contributing Authors
Abhinav Bhaskar, University of Stavangr; Laura Florentina Gusatu, University of Groningen; Harry Moncreiff, University of Edinburgh

This policy brief can be downloaded from www.ensystra.eu