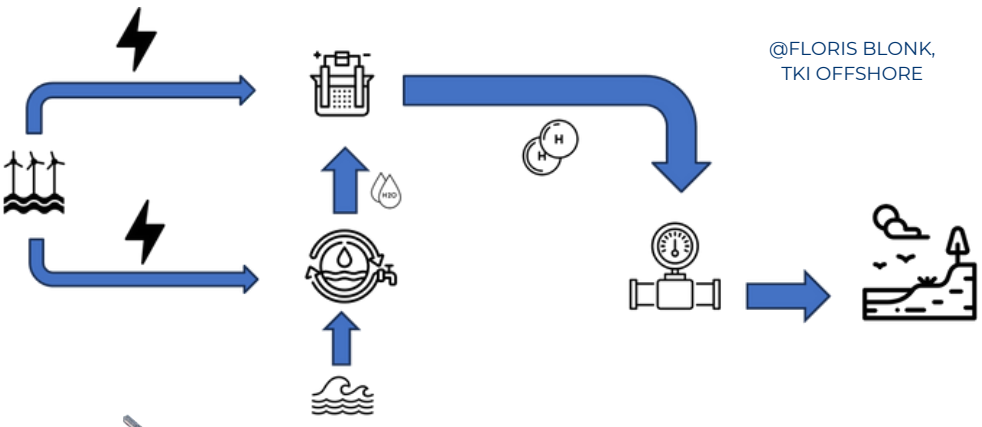
DEEP DIVE

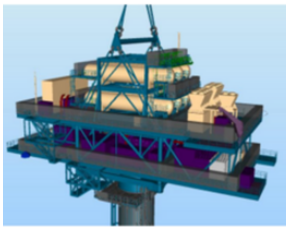
ENVIRONMENTAL IMPLICATIONS OF OFFSHORE GREEN HYDROGEN PRODUCTION


@STEFAN JANSEN, DELTARES

OFFSHORE HYDROGEN PRODUCTION

There is an increasing focus on producing green hydrogen from offshore renewable energy sources and desalinated seawater through the proces of electrolysis. Building on existing and proven technology, this concept holds potential to evolve into a viable system to transport the increasing amount of energy produced offshore to land.


@FLORIS BLONK, TKI OFFSHORE

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INTRODUCTION

Transitioning Dutch industry and society to sustainability requires ample renewable energy. The North Sea is crucial in this effort with offshore wind farms, yet efficiently transferring energy ashore and managing wind fluctuations pose challenges. Offshore green hydrogen is recognised as a promising future energy source, but storing and transporting it face hurdles. Various hydrogen supply chains are being explored to find viable deployment options, though studies on their environmental impacts are lacking. In **DMEC's Deep Dive** on 2 April 2024, we examined current and future offshore hydrogen demonstrations in the Netherlands, research on environmental impacts of large-scale offshore energy, and a case study on brine water disposal and seawater uptake.

CURRENT STATUS OFFSHORE HYDROGEN IN THE NETHERLANDS

PosHYdon

Located 13 km off the Scheveningen coast, existing offshore platform, 1MW electrolyser.

- Production of H2 offshore using seawater
- Co-use of existing infrastructure
- Impact of (simulated) offshore H2 production
- Expected realisation 2024.

Crosswind baseload power hub

2.5 MW electrolyser, Hollandse Kust Noord, with battery storage and fuel cell.

- Hydrogen to balance electricity supply and demand
- Demonstrate long and short term storage at production site in relation to electricity demand
- Expected realisation 2025.

AmpHytrite flagship demonstrator

10 MW PEM electrolyser, Connected to Haliade X WTG.

- How to derisk future large scale H2 production
- Realisation depends on Final Investment Decision

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Two more hydrogen demonstration projects are in the pipeline. In these demonstration projects, electrolysers (installations for hydrogen production) will be built at sea.

Demo project 1

Demo project 1 involves an electrolyser with a capacity of less than 100 megawatts. The Dutch government has announced the preferred locations for project 1 is in or near a wind farm in the Hollandse Kust region planned after 2027

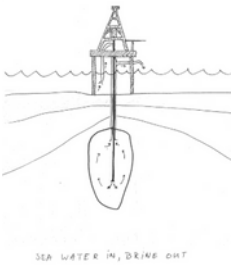
Demo project 2

Demo project 2 has a capacity of about 500 megawatts. The preferred location for project 2 is a wind farm 'Ten Noorden van de Waddeneilanden I' to be developed. This project is planned around 2031.

KEY OPPORTUNITIES FOR ECOLOGICAL INNOVATIONS

The demonstration projects mentioned above present an excellent opportunity to experiment with different innovations in offshore hydrogen production processes. These processes encompass the release of oxygen, brine (residual saline water from electrolysis), and potential rise in local seawater temperature resulting from cooling water technology. Since **large-scale offshore hydrogen production in the short term is not imminent,** it offers an excellent chance to establish necessary research infrastructure and gain insights from existing practices in offshore wind and oil and gas industries. This includes addressing challenges such as **offshore infrastructure installation and mitigating underwater noise from compressing hydrogen gas for transportation to shore**, thereby ensuring readiness for future deployment.

Brine Disposal



@MART VAN DER LINDEN

Salinity levels in the North Sea is a well-researched field, with Dutch institutions bolstering some of the most advanced models on forcing mechanisms such as climate change that can cause variations. While there is no scientific evidence to suggest that offshore hydrogen production needs to be considered a significant forcing mechanism, future research could provide insight into smarter brine discharge strategies. The study *"Environmental effects of brine disposal and seawater usage for offshore green hydrogen production and storage in the Dutch North Sea."* by Mart van der Linden, research intern at TNO, indicates that brine discharge is manageable, dissolving completely within 900 metres if disposed undiluted to the seafloor. But the study also highlights the importance of looking at alternatives for disposal, including energy production from salinity gradient energy, industrial extraction of salt and minerals, and other feedstock applications.

Oxygen

In current designs for the offshore production of hydrogen, oxygen is wasted by venting in the air. While this venting is not expecting to cause significant environmental impact, further research could turn this waste stream into something ecologically valuable. For instance, improved models and empirical testing can help determine whether this byproduct of hydrogen provides a solution for localized deoxygenation.

Heat Disposal

Another opportunity for research and innovation is heat disposal from electrolysers. Cooling water usage can influence seawater stratification and surface temperatures. More insights in these effects could strengthen the development of smart solutions that implement environmentally friendly cooling systems such as air cooling, a combination of air and seawater, or closed-loop systems that consume less sea water.

Future: The next decade will provide ample opportunity to further study and validate potential (cumulative) environmental effects of offshore hydrogen production. Physical pilots and demonstrations will enable researchers to closer examine these effects, their significance and how to mitigate or compensate them.

DMEC'S SERVICES

As an accelerator for offshore renewable energy solutions, DMEC supports the development of **offshore power-to-x innovations, including green hydrogen technology, and nature-inclusive design** solutions. For more information about our services and offshore hydrogen production, please contact:

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ABOUT THE DEEP DIVES

In our quarterly Deep Dives, we share knowledge & ideas and explore topics related to offshore renewable energy. Do you want to be invited? Please sign up for our **Community here.**