Offshore hydrogen transportation through re-used natural gas pipelines

Smart acceleration towards large-scale green hydrogen production on the North Sea

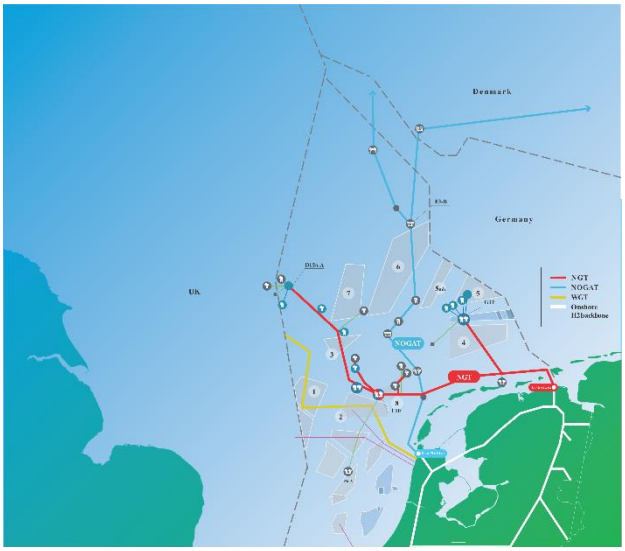
Introduction

The ambitions for wind energy from the North Sea, and for hydrogen production, have recently been raised. By 2050, the goal is to have 70 GW of wind power generated in the Dutch sector of the North Sea. Besides electricity, offshore green hydrogen production will play an important role for locations further from the coast, as indicated in the Parliamentary Letter Offshore Wind Energy 2030-2050 dated September 16th, 2022. Hydrogen production from wind energy offshore will be cheaper and more efficient than hydrogen production onshore, because several electricity conversion steps can be skipped. In addition, over larger distances hydrogen transport through pipelines is a cheaper and more efficient way to transport energy, when compared to electricity transport through cables.

In the Dutch North Sea there are a number of large pipelines (36-inch diameter) that are suitable and can be re-used for hydrogen transport. These pipelines are conveniently located in relation to the wind (search) areas (see a figure in the appendix) and are already connected to gas fields that could potentially be re-used for large-scale hydrogen storage in the future.

Transportation of hydrogen produced offshore through re-used existing pipelines has a number of important advantages over new pipelines: we can move faster towards the roll-out of large-scale production, and it is cheaper saving hundreds of millions of euros additional investment in new infrastructure. Above all, re-use has a smaller footprint and is better for ecology and the environment (the landfalls and all interconnections are already in place) ultimately benefiting society and consumers.

In order to ensure that the ambitious roll-out of offshore wind energy coupled with hydrogen production at sea, transportation of the hydrogen to land, and onshore distribution are well connected, the operators of the offshore pipelines will be working with all relevant stakeholders, such as the Ministry of Economic Affairs, ACM, Gasunie, and EBN, to ensure the benefits set out in this paper are fully examined and maximized. This will enable us to make concrete steps towards large-scale green hydrogen production in the North Sea even before 2030.



Overview of existing offshore pipelines and wind (search) areas.
Red: NGT | blue: NOGAT | yellow: WGT

Properties, characteristics and benefits of hydrogen transportation through re-used natural gas pipelines

Facts & Figures

1 The NGT and NOGAT offshore gas pipelines are suitable for hydrogen transportation. Bureau Veritas recently issued both pipelines 'Certificates of Fitness' to transport (pure) hydrogen.

2 NGT and NOGAT estimate the costs of making the pipelines suitable for hydrogen to be less than 10% of the cost of a new pipeline (including additional inspections) which will benefit society and end-users significantly.

3 The NGT pipeline landfalls at Eemshaven in Groningen, and the NOGAT pipeline at Den Helder in North Holland. Thus, no new landfalls need to be created through vulnerable natural areas. Moreover, there are already existing connections to the onshore natural gas network.

4 The hydrogen transport capacity of the NGT pipeline is estimated to be up to 10-14 GW, and of the NOGAT pipeline up to 10-12 GW.

5 By producing hydrogen at sea instead of on land, and then bringing this energy to shore via NGT and NOGAT, investments in up to 6-8 new DC power lines (2 GW per line) can be saved.

6 One of the two pipelines could be freed up for pure hydrogen transport prior to 2030. The existing natural gas production that is currently transported by NGT and NOGAT can all be accommodated, for example, by the NOGAT pipeline through re-routing (see below).

Possible scenario for potential new pipelines (dashed red) to re-route gas from NGT (green) to NOGAT (red through).

The NGT pipeline could then be made ready for hydrogen transport before 2030. This would enable wind-powered green hydrogen production from wind (search) areas 7 and 3 possible sooner. Another scenario would be to first make the NOGAT available for hydrogen and continue gas production via NGT for longer. This is subject study work to be performed and subject to all required approvals.

7 Re-use of the pipelines can help to enable the early realization (before 2030) of green hydrogen at sea from wind demonstration projects.

8 Empty gas fields, potentially suitable for hydrogen storage, are already connected to the NOGAT and NGT infrastructure. There are also salt rock formations (e.g. domes) near the pipelines that could be used for the construction of offshore salt caverns for hydrogen storage.

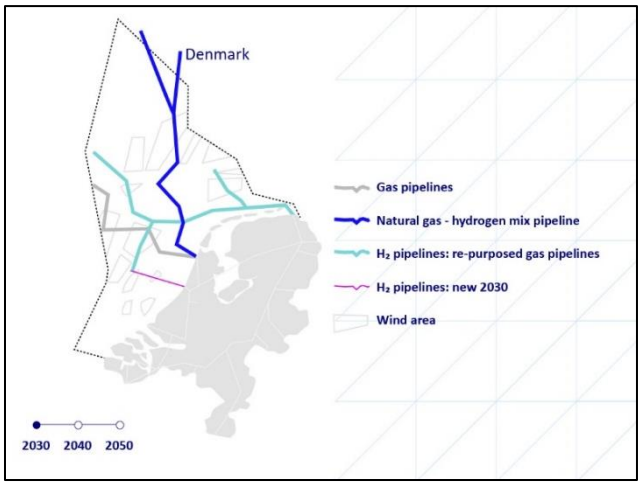
9 Storage of hydrogen at sea in empty gas fields and/or salt caverns will enable balancing of weather/seasonally-related production fluctuations, allowing the same volume of hydrogen (baseload) to be transported to land every hour of the year all year round.

10 Baseload hydrogen transport to land allows an even larger offshore wind/hydrogen production capacity to be connected to the NGT and NOGAT pipelines; approximately 17-24 GW.

11 By linking re-used natural gas pipelines for hydrogen transportation with the surrounding North Sea countries, such as the United Kingdom, Denmark and Germany, international exchange, import and trade of hydrogen can be developed and promoted.

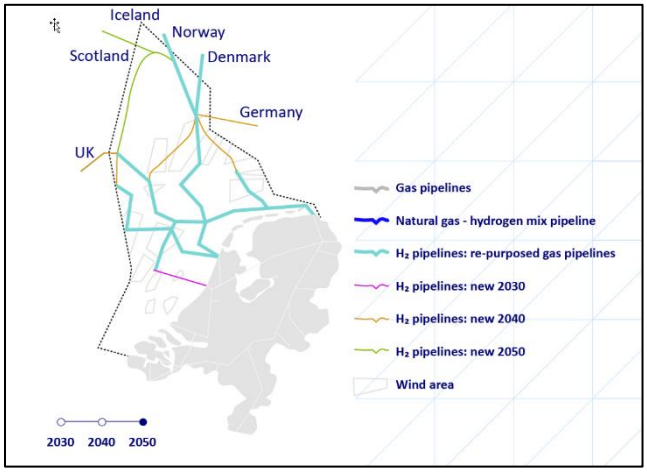
12 Re-use of physical assets (i.e. pipelines, platforms, and empty gas fields), as well as the organizational and human assets of a standing organization, that can organize and perform re-use, installation, maintenance, operational and administrative tasks, enables a fast, cheap and reliable transition to hydrogen.

Possible scenarios for offshore hydrogen production through smart re-use



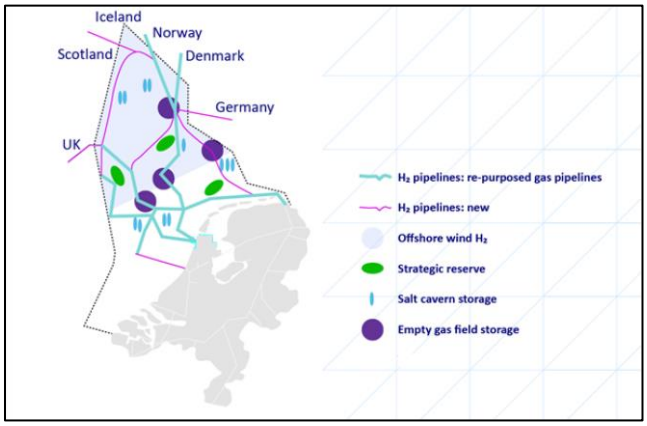
Development to 2030

Figure 1: 2030 hydrogen infrastructure through re-use of existing natural gas pipelines; NOGAT pipeline in blue, NGT pipeline in turquoise and WGT/LOCAL pipeline in grey.



Development 2030-2050

Figure 2: 2050 hydrogen infrastructure through re-use of existing natural gas pipelines, construction of pieces of new hydrogen pipelines in the northern part of our North Sea and with interconnections to other parts of the North Sea.



Development of hydrogen at sea until 2050

Figure 3: 2050 hydrogen production sites, hydrogen infrastructure at sea with connections to other parts of the North Sea and potential hydrogen storage sites in empty gas fields and salt domes. In 2050, hydrogen production of 4 Mton, as well as import from other parts of the North Sea of an additional 4 Mton is expected, a total of 8 Mton.

Appendix: NOGAT and NGT - Facts & Figures

NGT B.V.

- Owner and operator of a 176 km 36" pipeline running from L10 from west to east on the North Sea and landing at Uithuizen; a 65 km 18" extension to the G-blocks. Operator of the NGT extension: a 140 km 36" pipeline from D15 to L10.
- Owner of a riser platform (L10-AR) and a compressor platform (L10-AC).
- NGT treatment plant in Uithuizen has a capacity of 50 M Nm3/d and a condensate treatment capacity of 800 m3/d.
- Neptune Energy, Rosewood, XTO, OFI (abrdn) and PensionDanmark are shareholders of NGT B.V.
- NGT B.V., ASI and EBN are joint venture partners in the NGT extension.
- NGT has a connection to the GTS network and can import gas into the low, as well as the high-calorific network.

NOGAT B.V.

- Owner and operator of the ~250 km pipeline running north to south on the North Sea o24" from F3-FB to L2 and 36" from L2 to land (Den Helder).
- NOGAT already has a connection with Denmark via the 26" pipeline from Tyra to F3-FB (90% of Danish offshore gas runs through Tyra) and Germany and Denmark via the 20" A6-B4 to F3-FB.
- NOGAT B.V. owns the treatment plant (gas and condensate) in Den Helder. This is the same location as the WGT and LOCAL pipelines. NAM is operator for this treatment station where the three systems exit.
- NOGAT can transport 36 M Nm3/d of natural gas and has a condensate treatment capacity of 600 m3/d.
- Neptune Energy, EBN, PGGM and Spirit Energy are shareholders of NOGAT B.V.
- The NOGAT treatment facility has a connection to the GTS network (high-calorific) and is located nearby BBL

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About NGT B.V.

NGT B.V. owns and operates a pipeline infrastructure in the North Sea of approximately 500 kilometers. For almost 50 years, NGT has been bringing about 30% of the natural gas produced in the Dutch North Sea ashore. After gas treatment at its plant in Uithuizen, NGT delivers the gas to the national gas transmission grid. This releases so-called natural gas condensate, a substance similar to gasoline.

In the future, NGT plans to use its offshore infrastructure to enable large-scale green hydrogen production and to accelerate the energy transition. The existing infrastructure can be re-used and transformed into an integrated offshore hydrogen backbone. NGT will continue to bring energy ashore. - www.noordgastransport.nl

About NOGAT B.V.
NOGAT B.V. (Northern Offshore Gas Transport) has been transporting natural gas from various locations in the Dutch sector of the North Sea, via its own subsea pipeline system, to the onshore gas treatment station in Den Helder since 1992.

The pipeline system runs from production platform F3-FB in block F3 via a 24" pipeline to platform L2-FA in block L2 block. From there, the natural gas is further transported via a 36" pipeline to the gas treatment station in Den Helder, where the gas is brought to specification.

The pipeline system on the Danish continental shelf is connected to the NOGAT pipeline via the Tyra West - F3 pipeline. This 100-kilometer subsea natural gas pipeline connects the Danish continental shelf with the Dutch continental shelf, facilitating the export of Danish gas to northwestern Europe.

The pipeline system on the German continental shelf is also connected to the NOGAT pipeline system through the A6-F3 connection. This 20” subsea pipeline has a total length of 118 kilometers. – www.nogat.nl