POLICY BRIEF
12 August 2022

Hydrogen Production & Bunkering

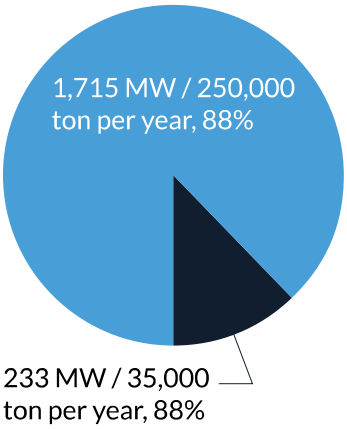
The objective of this brief is to provide an overview of green hydrogen production and bunkering development in North Sea Region small and regional ports.

THIS BRIEF

1. Identifies ports with existing and planned hydrogen infrastructure, specifying production intended for maritime usage and bunkering locations
2. Compares hydrogen development in ports with the offshore wind locations and the proposed European Hydrogen Backbone
3. Explains how this data is used to accelerate collaboration between NSR ports

Small & Regional Ports Lead Hydrogen Development for Maritime

It was found that 88% of all planned hydrogen production intended for maritime usage is in small and regional ports. This amounts to 1.7 GW of electrolyser capacity, or 250,000 tons of hydrogen per year.



88% of planned hydrogen for maritime use is in small and regional ports

Regional ports

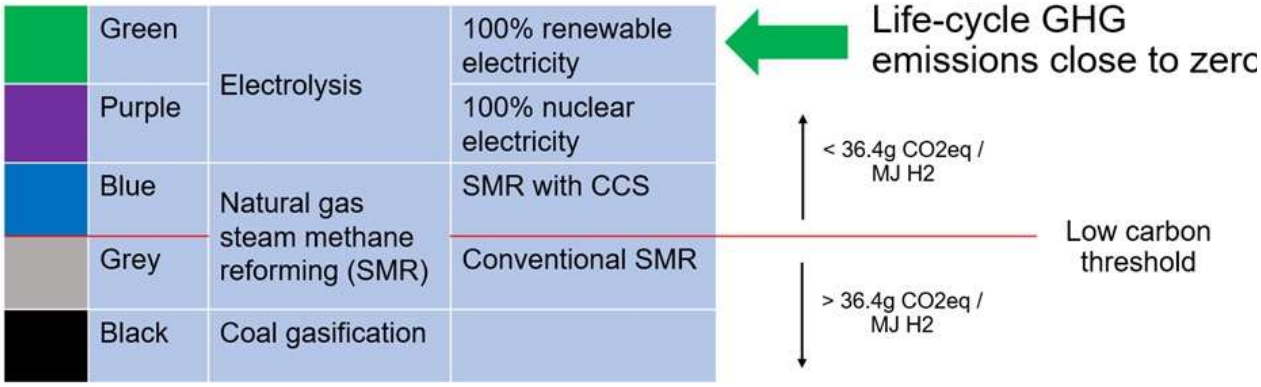
Large ports

*Map of NSR hydrogen bunkering and production in small and regional ports**

Hundreds of companies are moving into the hydrogen space in NSR.

*Large ports are not included in this map: Amsterdam, Antwerp, Copenhagen, Hamburg, Immingham, London, North Sea Port (Gent, Terneuzen, Vlissingen), Oslo, Rotterdam, Teesport.

Only green hydrogen, which has close to zero life-cycle greenhouse gas (GHG) emissions (according to the EU Certifhy definition), is considered in this brief.



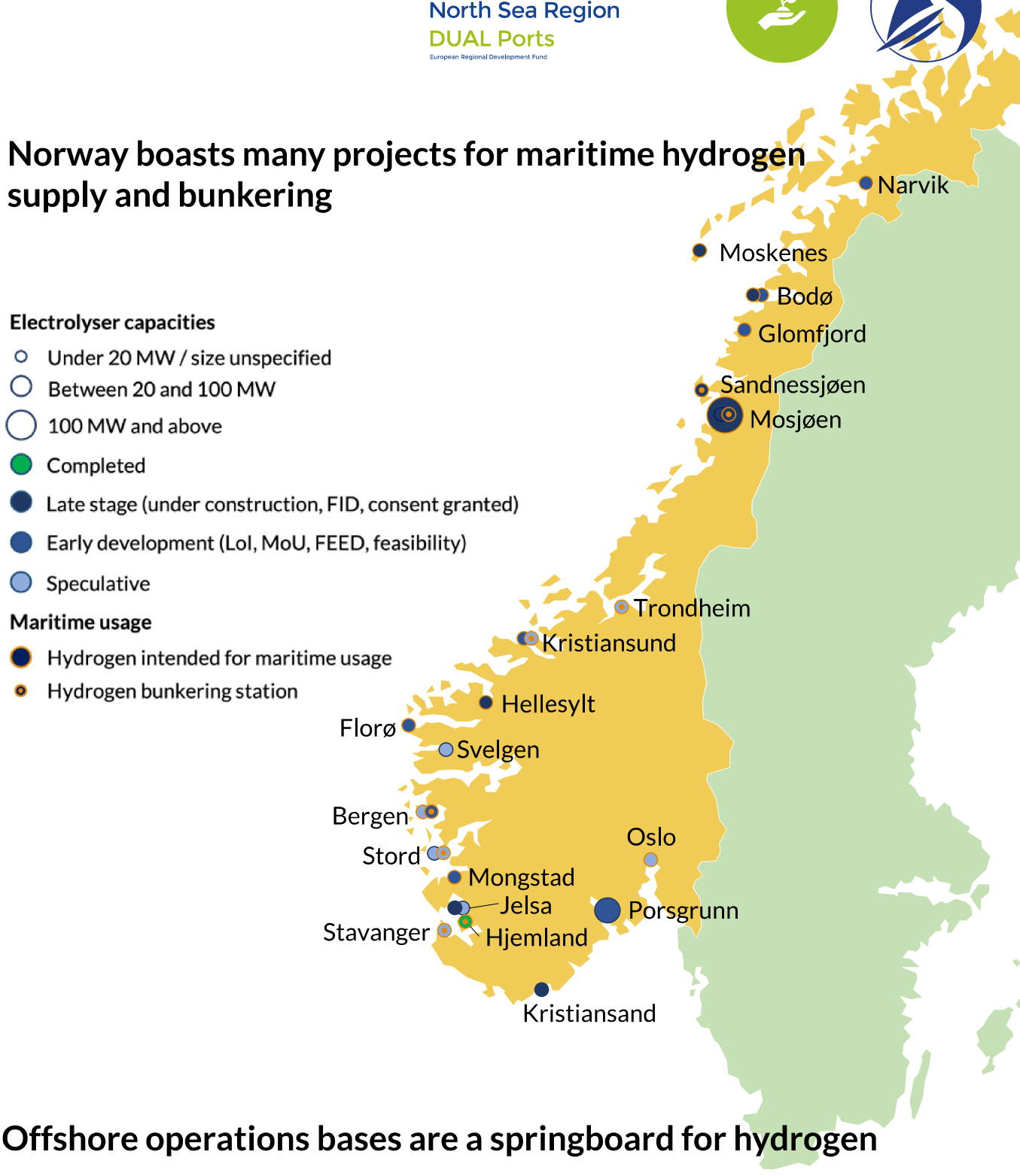
Information for each project includes details on development stage, electrolyser capacity (MW), production rate (tons/year), expected year in operation, fuel storage type (e.g. gaseous or liquid hydrogen). Data for bunkering projects may or may not also include dedicated hydrogen generation.

Not all projects included intend to supply hydrogen for the maritime sector but it is reasonable to assume that this may change as hydrogen shipping matures. Similarly, projects where the green hydrogen is used to produce e-fuels (such as e-ammonia, e-methanol) have been included because they may find that directly supplying hydrogen is preferable to producing e-fuels.

There are 4 development stages (for detailed definitions see appendix):

Completed electrolysers: Generally small scale, demonstrators and tests. Emmen (NL) has a 4 MW electrolyser and EMEC on Orkney (UK) is 1.5 MW, used for storage and road transport and soon planned to power the HySeas III and HyDIME hydrogen ferries.
Late stage projects: Over 1.6 GW of electrolyser capacity under construction or consented in small and regional ports, including 15,250 t/year of compressed gaseous hydrogen supply to ferries in Mosjøen (NO) by Gen2 Energy, expected 2025.
Early stage: Over 2.7 GW in development, of which 86 MW dedicated to maritime
Speculative: Many more plans in the region, including announcement for 1.5 GW electrolyser in Shetland's ORION project for maritime usage.

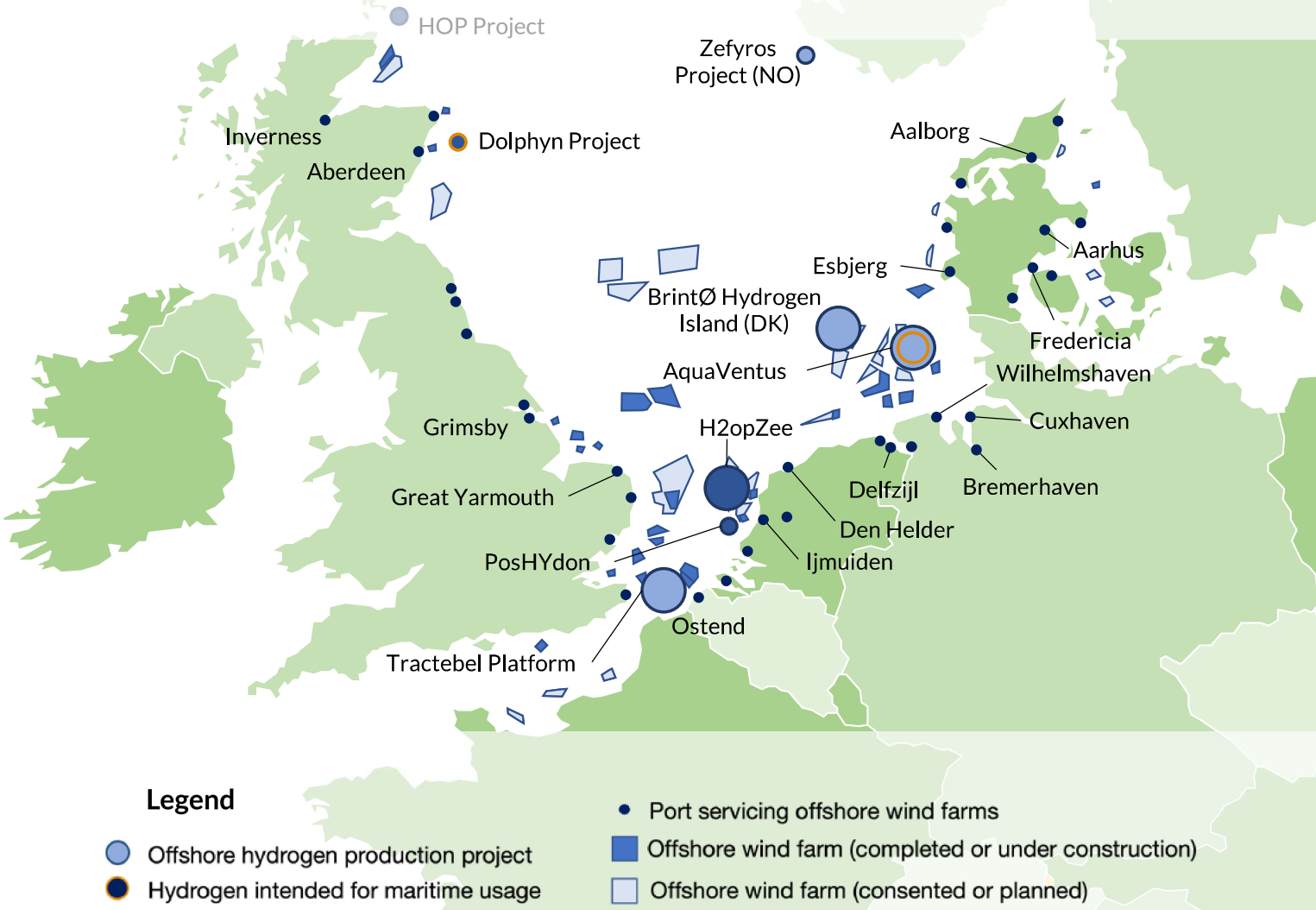
Norway boasts many projects for maritime hydrogen supply and bunkering



Offshore operations bases are a springboard for hydrogen

The NSR region is in an excellent position to exploit large-scale renewables and there is a large growth in scale of offshore generation. This map shows the planned and existing offshore wind farms in the North Sea – this is a springboard for cheap hydrogen generation.

Plans for offshore hydrogen production are coming into focus, using existing oil & gas platforms and pipelines. Neptune Energy's PosHYdon project has reached FID and will establish a pilot 1 MW electrolyser on a platform off Scheveningen (NL). The lessons learnt will feed into the 400 MW H2opZee Joint Development Agreement between

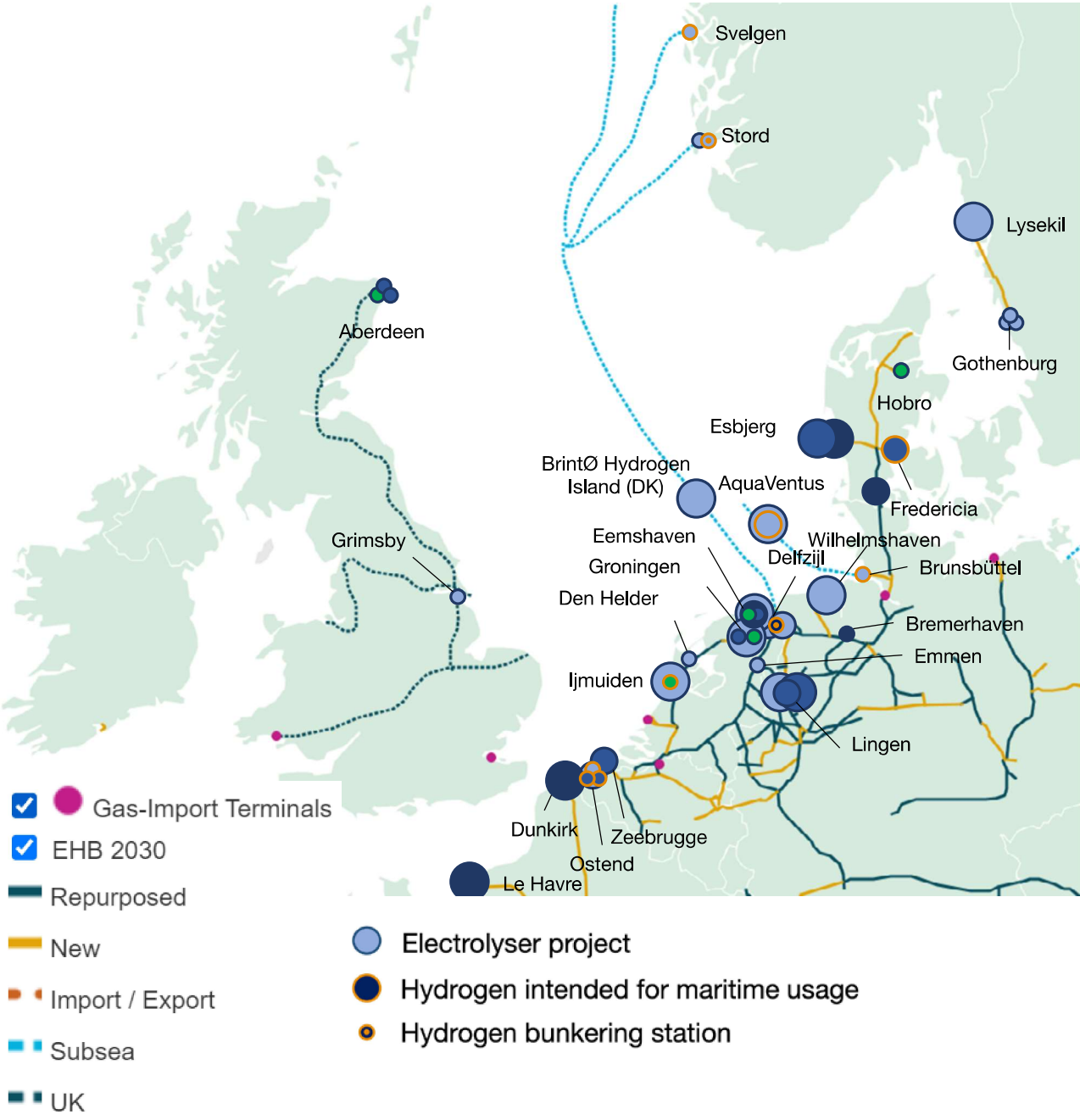


Neptune Energy and RWE. This is expected by 2030 and will include an existing gas pipeline with capacity of 10-12 GW to send compressed hydrogen to shore. The HOP project off Orkney (UK) has completed financial feasibility but the electrolyser capacity is not yet specified. Further projects have been announced: the 400 MW Tractebel platform, AquaVentus off Heligoland (DE) and BrintØ Hydrogen Island (DK).

Offshore operations & maintenance bases are poised to produce hydrogen for the maritime sector. Substations, where offshore electricity makes landfall, offer potential for economic hydrogen production, with offshore production being even more attractive. Offshore operations & maintenance bases are generally located in small & regional ports.

European Hydrogen Backbone

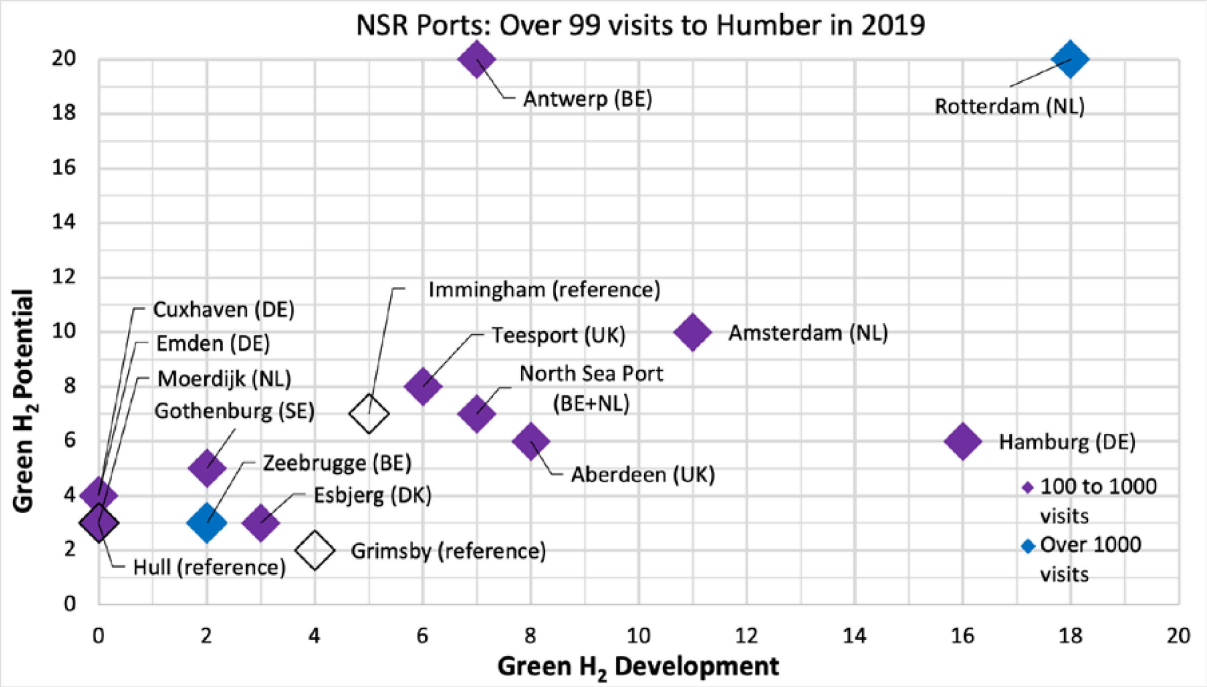
> The hydrogen generation identified is woven into the planned European Hydrogen Backbone, which includes plans for over 40,000 km of hydrogen pipelines and is focussed in the NSR. Production will feed into pipelines and regional ports will provide crucial points of generation and supply, also enabling the reuse and regeneration of oil & gas assets for renewable hydrogen production onshore and offshore.



Accelerating collaboration between ports

Collaboration is crucial to accelerating hydrogen supply in the NSR. Bespoke Collaborator / Competitor charts can be produced by combining maps of hydrogen supply development with data on port facilities and operations, informing ports of potential partnerships and risks that exist in the emerging regional hydrogen community.

Below is an example of the Collaborator / Competitor chart undertaken for the port of Grimsby (UK). Ports with high vessel visits to Grimsby are compared by their hydrogen Development and Potential.



Further Information, Explanation and Methodologies:

For methodologies used for data collection and analysis of port data, see Section 4.2 of the full report - Marinized Hydrogen in the North Sea Region.

For the full results of the Competitor / Collaborator Analysis for Grimsby, see Section 4.3 and analysis in Section 4.4.

For a collection of all the maps, see the NSR Hydrogen Production & Bunkering presentation.

Appendix: Development Stage Definitions

Stage	Detail	Description
Speculative	Speculative	Intent expressed, plans announced
Early stage	LoI	Letter of Intent (LoI) signed
	Feasibility completed	Feasibility study completed successfully
	MoU	Memorandum of Understanding (MoU) signed or Joint Venture Partnership, Joint Development Agreement
	FEED	Front-End Engineering and Design (FEED) completed successfully
Late stage	Consent granted	Planning consent granted
	FID	Final Investment Decision (FID) made
	Under construction	Construction work begun
Completed	**Completed**	**Site completed and operational**

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