Netherlands Innovation Network

Connecting Innovation Worldwide

Fons KLEIN TUENTE
Senior Officer for Innovation, Science & Technology

July 2025

Netherlands Innovation Network

ABOUT THE NETHERLANDS

Do You Know?

6th **happiest** country on the planet

we are the **number one** flower exporter **in the world**

90% of us speak fluent English

4th **most innovative** country in the world

tallest people on the planet

Netherlands Innovation Network

Objective: to strengthen Dutch innovation-power by connecting companies, research institutes and governments worldwide.

Target groups:

- Innovative and knowledge-based companies
- Research Institutes
- Relevant government bodies (national/local)

Netherlands Innovation Network Worldwide

São Paulo / Guangzhou / Peking / Shanghai / Tokio / Taipei / Mumbai / Bangalore / New Delhi / Singapore / Seoel / Tel Aviv / Istanbul / Moskou / Boston / San Francisco / Washington including Canada / Berlin including Switzerland / München / Parijs / Stockholm / Londen


国际论坛
世界氢能经济实践与展望论坛
INTERNATIONAL FORUM
PRACTICES AND PROSPECTS OF HYDROGEN ECONOMIES WORLDWIDE


加氢站
HYDROGEN STATION
全球环境基金
联合国开发计划署
科学技术部 MoST


kiwa


Vergaderzaal 1


TBSA&MTA

2019 Climate Agreement

- Hydrogen was a recurring theme
- Ambition 2030: 3-4 GW

2020 Government H2 Strategy

- Systemic role of hydrogen recognized
- Clear policy agenda: focus on ramping up & cost reduction of electrolysis

2020-2024 Implementation

- Expanded funding for R&D and demonstration projects
- Transport infrastructure development plan
- International cooperation and establishment of international supply chains

Dutch Hydrogen Roadmap

NWP Nationaal Waterstof Programma

2022-2025

Production
600 MW electrolysis capacity; use of CCS in the existing production

Imports
First imports of hydrogen, primarily as ammonia

Infrastructure and storage
Hydrogen network under construction, connects production with demand. First storage cavern

2025-2030

Production
80 PJ renewable hydrogen and the use of CCS too

Imports
Development of large-scale imports including transit

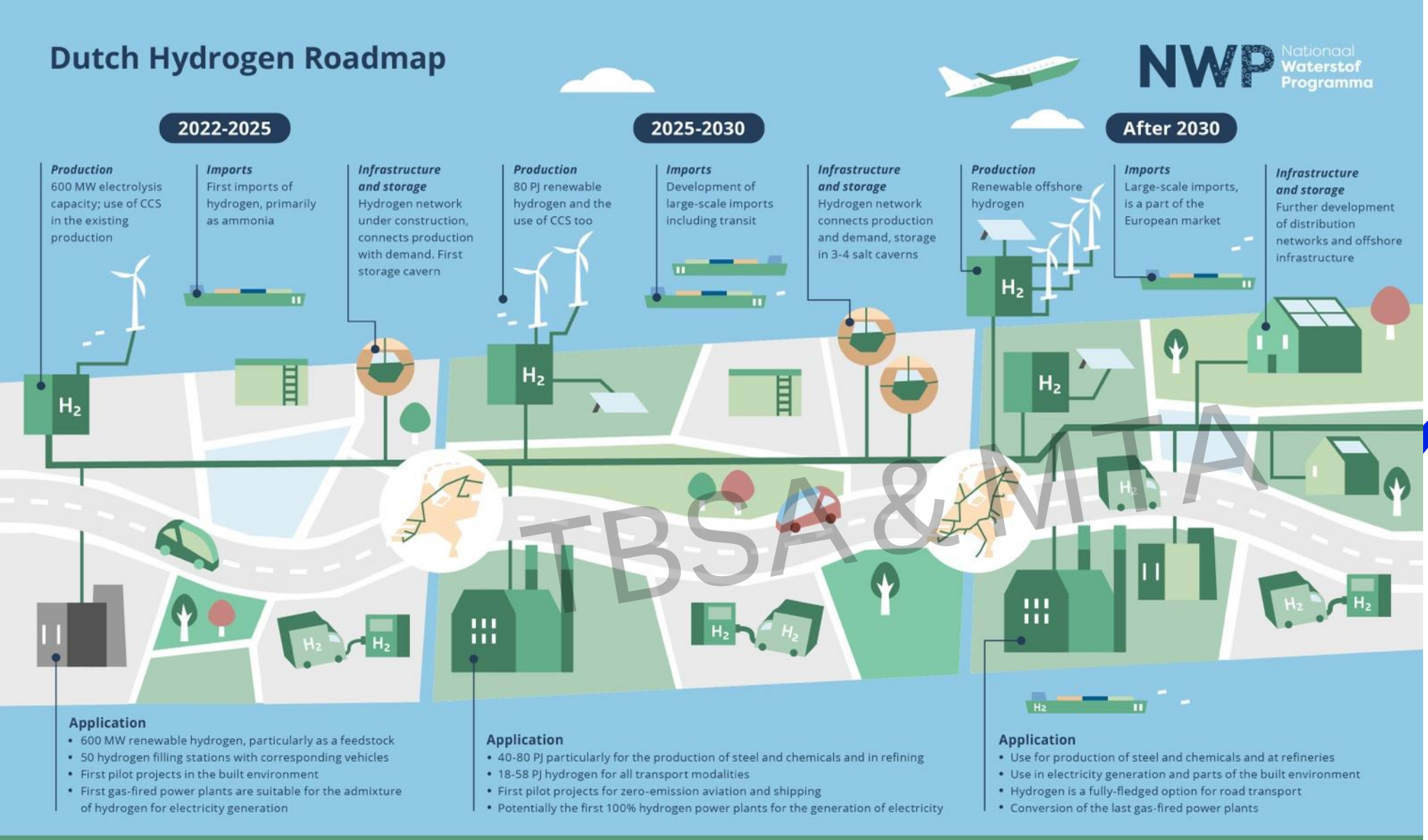
Infrastructure and storage
Hydrogen network connects production and demand, storage in 3-4 salt caverns

After 2030

Production
Renewable offshore hydrogen

Imports
Large-scale imports, is a part of the European market

Infrastructure and storage
Further development of distribution networks and offshore infrastructure



Application

- 600 MW renewable hydrogen, particularly as a feedstock
- 50 hydrogen filling stations with corresponding vehicles
- First pilot projects in the built environment
- First gas-fired power plants are suitable for the admixture of hydrogen for electricity generation

Application

- 40-80 PJ particularly for the production of steel and chemicals and in refining
- 18-58 PJ hydrogen for all transport modalities
- First pilot projects for zero-emission aviation and shipping
- Potentially the first 100% hydrogen power plants for the generation of electricity

Application

- Use for production of steel and chemicals and at refineries
- Use in electricity generation and parts of the built environment
- Hydrogen is a fully-fledged option for road transport
- Conversion of the last gas-fired power plants

Preconditions: essential if the objectives are to be achieved

Policy framework

Safety

Innovation

Social acceptance

Manufacturing industry

Human capital agenda

Dutch government supports hydrogen in the next years with €7-8 billion

- Electrolysis onshore: € 3.4 bn
  - 2023: € 0.25 bn (contracted)
  - 2024: € 1.0 bn (Oct)
  - 2025: € 2.1 bn (next year?)
- Electrolysis offshore: € 0.6 bn
- Industry support: € 0.6 bn
- **Infrastructure**: € 1.05 bn
  - Backbone onshore: € 0.75 bn
  - Backbone offshore: € 0.05 bn
  - Storage: € 0.25 bn
- **IPCEI** (EU subsidy): € 1.6 bn
- **Import**: € 0.3 bn (H2Global)

Government support for R,D&D (1.2 - 1.5 Bn for 2021-2028)

Hydrogen: great opportunities for our economy

Facts and figures on the Dutch hydrogen ecosystem

180 Petajoules

The Netherlands has a large potential of reducing carbon emissions by transitioning from being Europe's second largest hydrogen producer, with an annual production and usage of 180 PJ of (fossil-based) hydrogen, to becoming a hub for clean hydrogen.

3-4 GW / 2030

To enable large-scale production of renewable hydrogen, the Dutch ambition is to have installed at least 3-4 GW of electrolyser capacity by 2030 (± 10% of the total EU target for that year) and 8 GW in 2032. The northern region of the Netherlands alone is aiming for an annual production of 65 PJ of clean hydrogen by 2030.

21 GW / 2030

Offshore wind is a crucial enabler of scaling up the production of carbon-neutral hydrogen. Planned projects in the Dutch zone of the North Sea add up to 21 GW of offshore wind capacity by 2030, while there is enough space for a further scale-up to 40 GW in 2040 and 75 GW in 2050.

136,000 km

The Netherlands, together with Belgium and France, already has over 1,000 km of dedicated hydrogen pipeline. The country's dense natural gas grid (136,000 km of high quality pipeline) can -partially- be retrofitted to transport hydrogen at an acceptable cost. This will accelerate the development of an open access and regulated 'national hydrogen backbone', which should be ready in 2030.

The Netherlands is strategically located at the heart of the European hydrogen infrastructure proposed by 11 European grid operators. Addressable regional demand in North-western Europe alone is estimated at 400 PJ by 2030.

The second gas revolution

Over 60 years ago, large natural gas reserves were discovered in the Netherlands. As a result, one of the world's most extensive and sophisticated gas grids was developed. A second gas revolution is well underway with the introduction of renewable and low-carbon hydrogen.

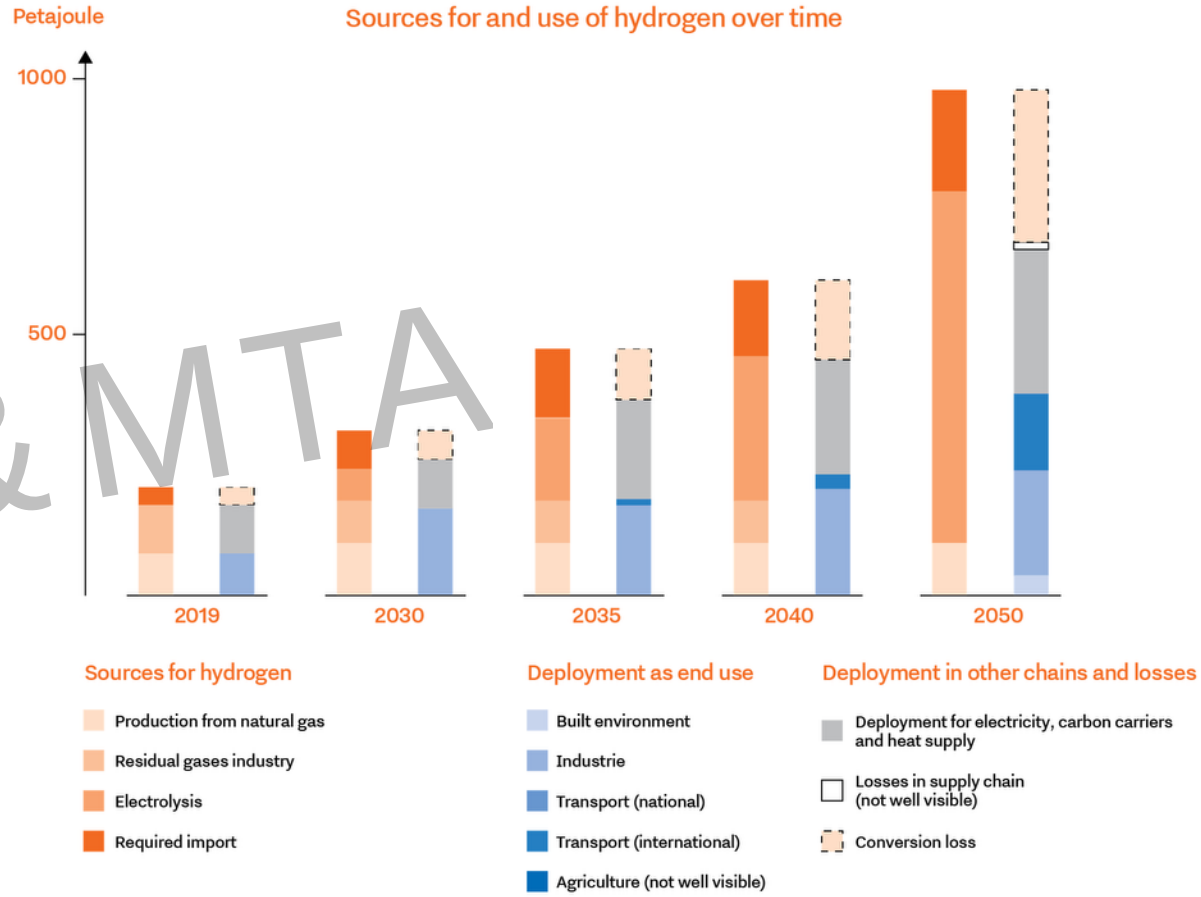
Next to its use as feedstock or fuel, hydrogen can, as an energy carrier, solve systemic issues by enabling further integration of renewable energy in our energy system. Although challenges lie ahead, fostering the development of hydrogen is key to making the energy transition a success.

On Friday 27 October, his Majesty the King of the Netherlands performed the official ceremony to start work on the construction of a national hydrogen network in the Netherlands. From 2030, the national hydrogen network will connect the Netherlands' major industrial areas to each other and to Germany and Belgium. The Dutch government commissioned Gasunie in 2022 to develop the hydrogen network.

Downstream - USPs

Existing hydrogen market

- Currently the 2nd largest existing hydrogen market in europe with a total demand of over 9 million m3 per year.



Netherlands

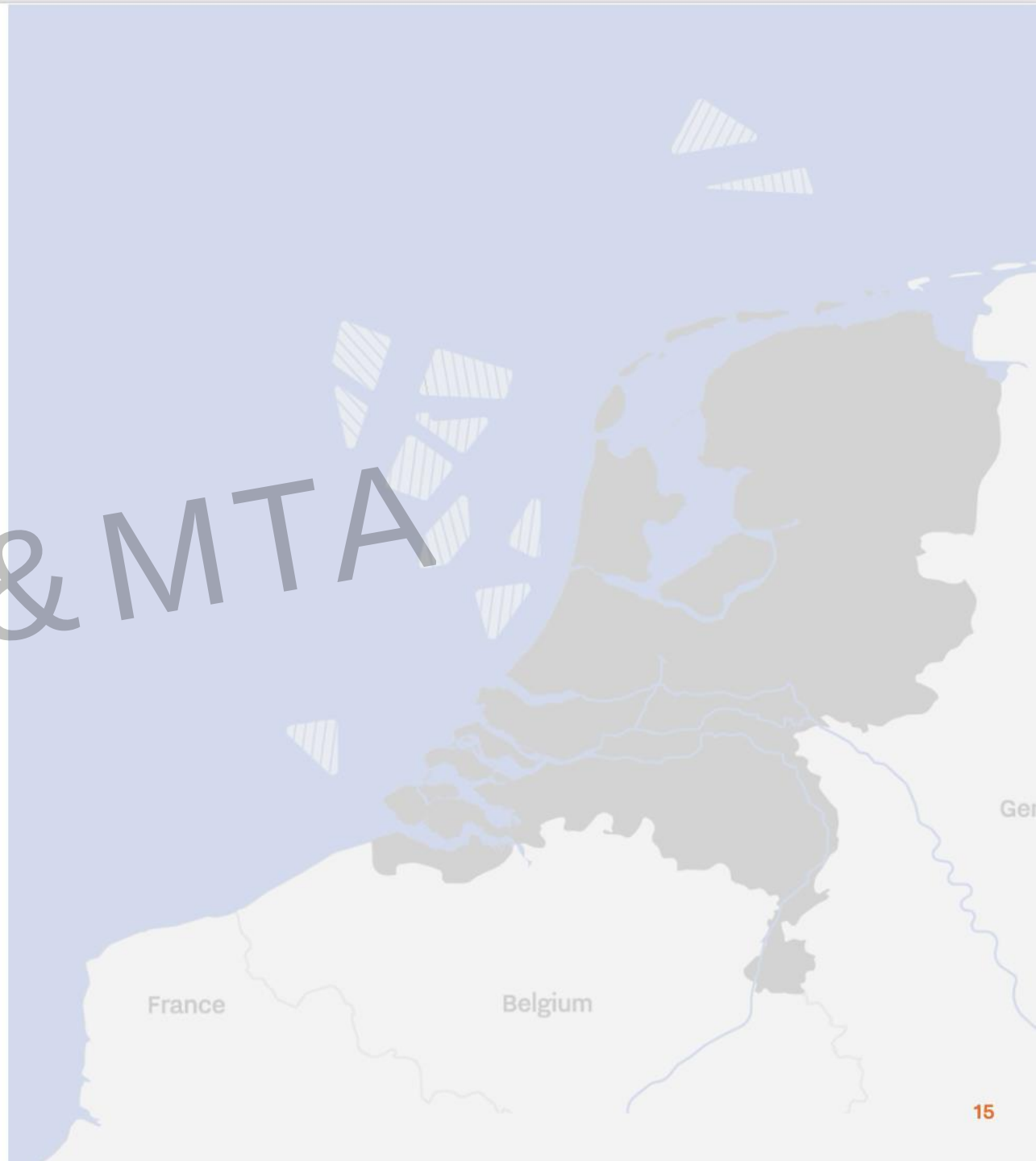
Midstream - Imports: shipping & conversion

Imports are crucial for large scale decarbonisation of (North-West) European industries.

Our approach

- Implementation of crucial import and export corridors
- Create infrastructural, legal and safety conditions
- Diversification of routes and streams
- Increase international cooperation

Memorandum Of Understanding



Netherlands

Midstream - Infrastructure

Transport, distribution and storage play a key role in scaling-up hydrogen.

2021

Dutch government commits to a national hydrogen network backbone.

2022-2025

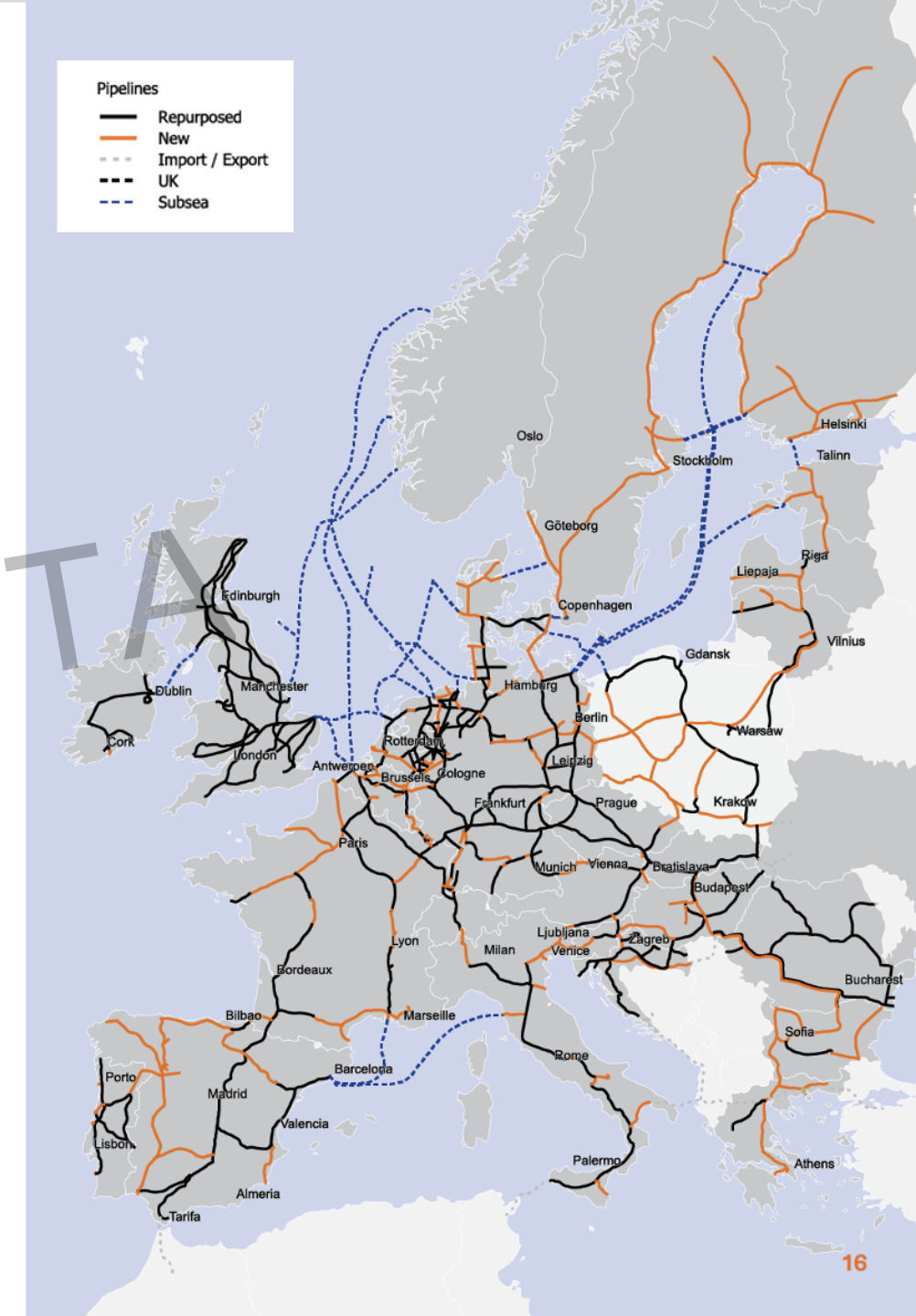
Construction of network starts.
First storage cavern created.

2025-2030

Network connects supply and demand areas.
3-4 caverns for storage.

2030-….

Offshore infrastructure in development.



Midstream – Unique Selling Points

Infrastructure

Underground storage capabilities

Strategically located import hub

Netherlands

Midstream - USPs

Infrastructure

- 750-1000 km of dedicated hydrogen transport network in 2030.
- Ability to repurpose large parts of the existing gas grid to hydrogen. In the Netherlands, we have the advantage of the existing natural gas infrastructure and storage network and the knowledge and experience that comes with it. Currently there are over 136,000 km of existing gas pipelines. 85% of the new hydrogen gas network could be made up by reused pipelines.
- Potential to expand offshore wind energy with offshore energy hubs and neighbouring countries

Netherlands

Midstream - USPs

Underground storage capabilities

- Integrated in the national transport network for flexibility
- Energy storage will be required to manage the mismatch between supply and demand over time. For this reason we plan to develop large scale storage facilities in 3 to 4 depleted salt caverns, which should be ready in 2030 and should have a total storage capacity of 750 to 1000 GWh.
- HyStock, which is a subsidiary of state-owned Gasunie is currently developing the salt caverns for onshore hydrogen storage. The first storage facility in Zuidwending (close to Veendam) is expected to be operational in 2028.

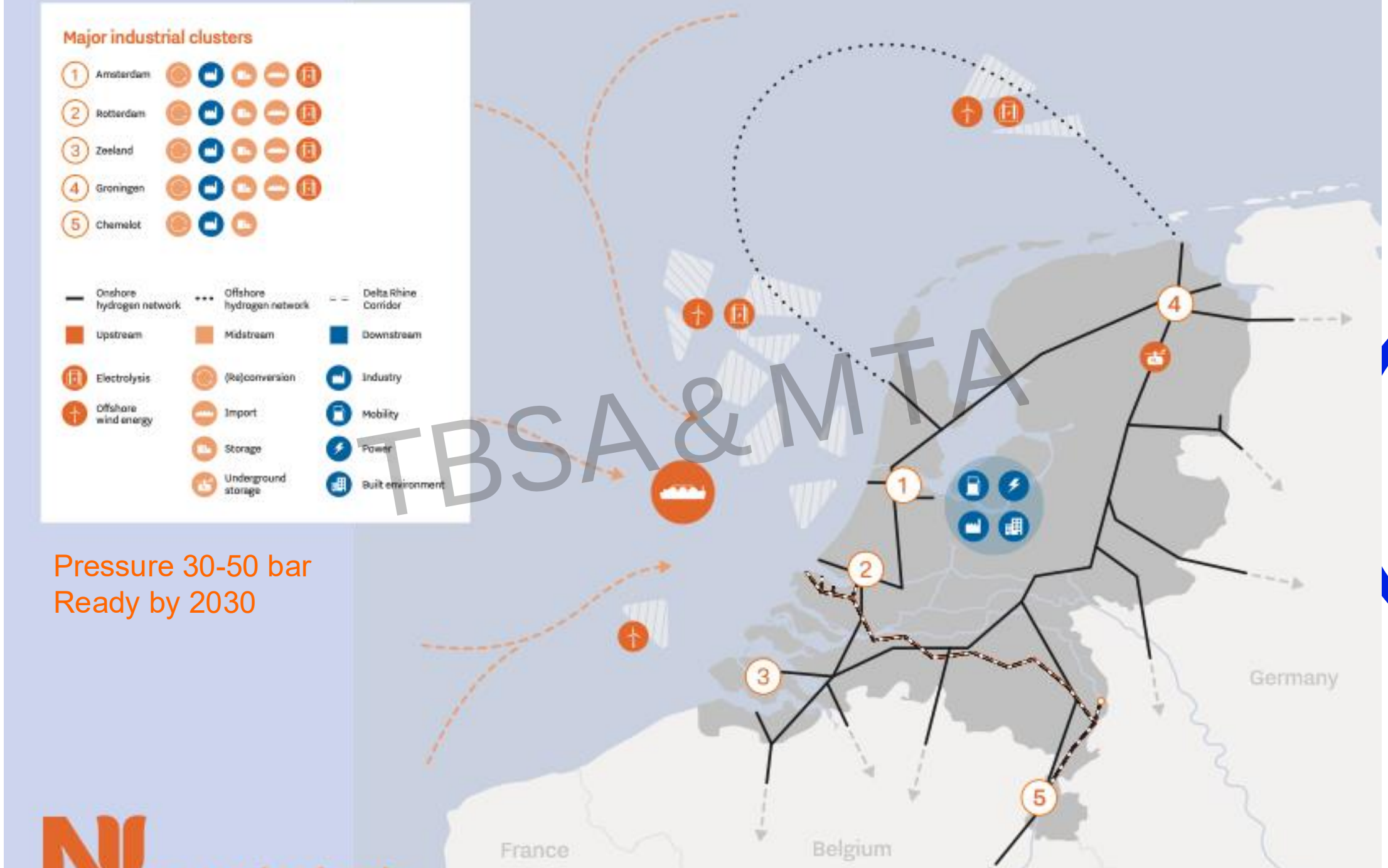
Netherlands

Midstream - USPs

Strategically located import hub

- Northwest-Europe up to 60% of EU demand
- Major port facilities able to receive and convert all hydrogen carriers

Netherlands



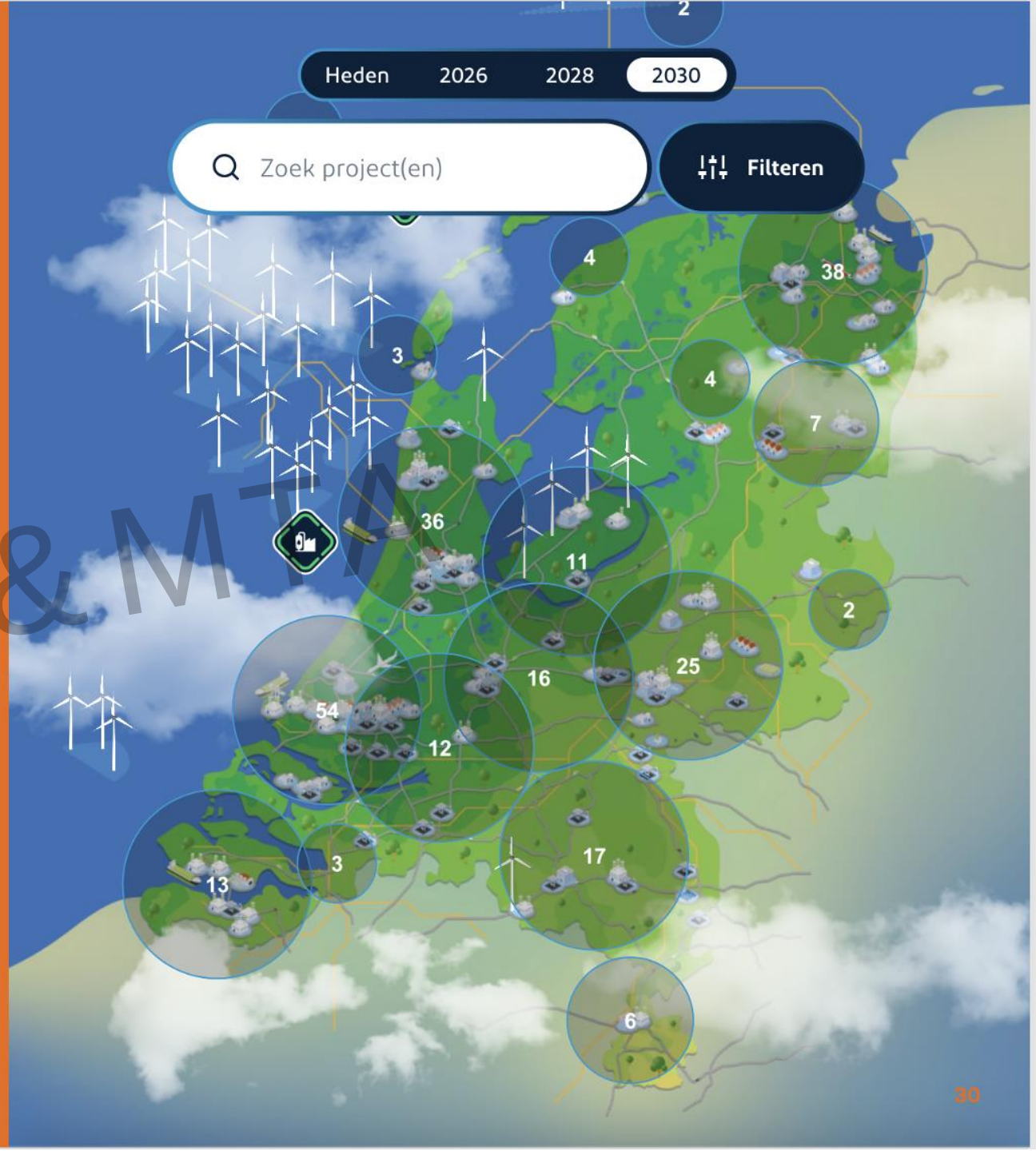
Pressure 30-50 bar
Ready by 2030

Downstream - USPs

Field labs and Innovative projects

- More than 400 Hydrogen projects in the Netherlands
- Room for experimentation and demonstration

For example: Mission H2



Netherlands

Dutch hydrogen flagship projects

Flagship projects in the Netherlands show our efforts to improve current technologies of hydrogen production in different ways. These technologies could help solve issues in the global development of hydrogen by working together in partnerships with foreign industries, governments, research institutions and businesses. That way, our shared challenge of limiting the effects of climate change can be tackled together with partners all over the world.

Sinnewetterstof

Duration: Operational since 2022

Partners: Alliander and Groenleven

SinneWetterstof means solar hydrogen in Frisian. This pilot project is a collaboration between network company Alliander and renewable energy developer GroenLeven. Right next to the 50MW solar park developed by GroenLeven, there is an electrolyser with a capacity of 1.4 megawatts. Alliander realizes the complete installation of the electrolyzer and leases it to GroenLeven, which buys the energy and sells the hydrogen. Both companies are investigating how hydrogen can play a role in areas where the capacity of the electricity grid is not sufficient to return large-scale generated solar energy. DEP Duurzaam Energie Perspectief has supervised the design, engineering, and realization from start to finish. The control system is designed and implemented by DEP with the aim of being maximally flexible in controlling the installation to optimize the experiments. In March 2022, the installation producing renewable hydrogen was opened. GroenLeven will supply the hydrogen to Orange Gas, which will supply hydrogen filling stations with tube trailers. It is expected that 100,000 kilograms of hydrogen can be produced annually. This amount is good for approximately 10 million clean kilometers with a passenger car. Daan Schut, CTO of Alliander: “By using the generated electricity from the solar park to produce hydrogen and using it as a fuel to drive cars, our grid is less burdened and no green generated energy is lost.”

www.sinnewetterstof.nl

H2 Barge 2

Duration: Completion in 2024

Partners: Future Proof Shipping, Ballard, VTT, Air Liquide, SEAM, Holland Shipyards, Oechies Elektrotechniek.

The H2 Barge 2 is an ambitious project by Future Proof Shipping (FPS) to launch the first hydrogen-powered vessel that will ship goods completely emission-free on the Rhine between Rotterdam (NL) and Duisburg (DE). This project will be a key milestone in the decarbonization of Rhine shipping where roughly 80% of cargo flows are between Rotterdam and Duisburg. The H2 Barge 2 is part of EU-funded FLAGSHIPS project, and the Interreg-funded ZEM Ports NS.

The H2 Barge 2 will also be one of the first commercial pilot vessels for a carbon insetting programme that is being pioneered in collaboration with the CONDOR H2 project and RH2INE initiative.

About FLAGSHIPS:
The FLAGSHIPS consortium includes 12 European partners. The FLAGSHIPS project will take zero-emission waterborne transport to an entirely new level by deploying two commercially operated hydrogen fuel cell vessels.),

About ZEM Ports NS:
The ZEM Ports NS project consortium consists of seven organizations from Europe and the UK. The project facilitates the use of zero emission fuels (electric and hydrogen) in the NSR ports and maritime sector. The project looks at the role of ports in the interface between zero emission vessels and port infrastructure. It especially addresses the integration of zero emission fuels into the port refuelling infrastructure and local energy systems as well as port and on-ship energy storage.

www.Flagships.eu
www.northsearegion.eu/zem-ports-ns

PosHYdon

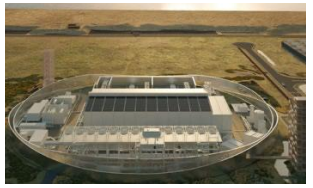
Duration: Completion 2024

Partners: Nel Hydrogen, InVesta, Hatenboer, Iv-Offshore & Energy, Emerson Automation Solutions, NexStep, TNO, Neptune Energy, Gasunie, Noordgastransport (NGT), NOGAT, DEME Offshore, TAQA, Eneco

The pilot PosHYdon is the ultimate example of system integration in the North Sea. It is a world’s first that green hydrogen will be produced offshore on an operational platform. Together with our partners, we believe that green hydrogen is vital to the energy transition. PosHYdon will teach us a lot about the next steps needed to be taken towards safe, large-scale green hydrogen production at sea. Offshore green hydrogen production will enable large-scale wind farms to be developed far out at sea. Wind energy is then directly converted to green hydrogen and can be transported through the existing gas infrastructure. As a result, offshore wind projects can be realised faster at significantly lower costs for the end users. PosHYdon aims to integrate three energy systems in the North Sea: offshore wind, offshore gas and green hydrogen. All by producing green hydrogen from demineralised seawater on Neptune Energy’s Q13a-A platform.

“The Netherlands is in a special position as, in addition to an extensive gas infrastructure network, we can harvest large amounts of wind energy in the North Sea, quantities that are also important internationally. The wind energy can be used to produce hydrogen, which can then be transported onshore along with natural gas via existing pipelines for industry, the transport sector and Dutch homes. PosHYdon is key to accelerating this.”

www.poshydon.com/en/home-en/



Holland Hydrogen I

Duration: Completion 2025

Partners: Over 150 partners, e.g. Thyssenkrupp, Worley, Gasunie, Port of Rotterdam, Visser & Smit bouw, Evides, Howden, Conpacksys, Siemens, Kraayvanger, Volker Energy Solutions, FBM Hudson

Shell, together with contractors and vendors, is building the first big renewable hydrogen plant of Europe (200 MW). Once operational in the second half of this decade, it will produce up to 60 tons of hydrogen per day. This is the equivalent of what 2,300 hydrogen trucks will need and is powered by offshore wind produced at the North Sea.

The Holland Hydrogen 1 (HH1) factory rises behind the dunes of the Dutch coast, at the Tweede Maasvlakte plains near Rotterdam, on land reclaimed from the sea. This is a significant Shell investment with financial support from the Dutch government and the European Union through IPCEI, and an endeavour involving more than 150 contractors and vendors.

The project provides an answer to the need for cleaner energy in heavy-duty cargo and industries, sectors that have limited options for other renewable solutions. The design incorporates circular materials wherever possible. The space around the plant will be turned into green retreats for birds and other small animals – to showcase how factories can be, and should be, built.

The HH1 project kickstarts the hydrogen economy of the Netherlands and will speed up society on its path to net-zero emissions by 2050 or earlier, including Shell’s own operations and that of Shell clients and partner companies.

www.shell.nl/energie-en-innovatie/waterstof/welkom-waterstof.html

Fountain Fuel Amersfoort

Duration: Operational since 2023

Partners: Fountain Fuel, Allego, Linde

Fountain Fuel develops a network of 100% zero-emission energy stations where e-charging and green hydrogen are combined. Our first station in Amersfoort is operational since May 2023 and already has an uptime of 98.35%. The Fountain Fuel Amersfoort project acts as the blueprint for our future stations in Europe. In Amersfoort, Fountain Fuel controls and combines technique, exploitation, realisation and operations. Leading to a reliable, outspoken and flawless experience at our station.

Key features of the Amersfoort-project are the separation of both light- and heavy duty traffic, with 350 and 700 bar refuelling and a fully redundant design.

- By working together with OEMs to stimulate the supply of vehicles, whilst simultaneously realizing reliable hydrogen refuelling infrastructure, we effectively break through the ‘chick-or-egg’ problem. This results in scale- and costs advantages for all parties in the supply chain.
- Through the HyVan project (completed in Q4 2023), which was a collaboration between Fountain Fuel – Allied Waters – Renault Hyvia – and Stellantis, we have taken the first hydrogen-powered business vans of The Netherlands in operation together with regional entrepreneurs. The project was made possible by EFRO.
- The next zero-emission energy stations, Nijmegen and Rotterdam, are scheduled for completion in Q1 2025. These projects will adhere to the new SAE refuelling standard, further accelerating the adoption of the hydrogen economy and allowing businesses to work towards zero-emission logistics solutions.

With the insights and knowledge from this station and the linked projects, we will roll out a network of zero-emission energy stations throughout Europe – connecting the entire value chain from industry, to fleet-owner, to manufacturer, to government, to supplier.

www.fountainfuel.com/en/

Offshore electrolysis

- Large industry consortium
- 15 partners
- Installed Sept ’24
- Capacity: 1 MWe
- 400 kg H2/day
- 13 km off the coast

Pilot alkaline multicore electrolyser (XINTC)

- XINTC is a R&D company that focusses on realising an electrolyser for decentral hydrogen production.
- Research on a low pressure alkaline pilot installation of 0,5 kW.
- Minimum usage of CRM's and almost all parts of electrolyser of plastic materials.
- Electrolyser optimised for direct coupling to solar installation, minimising high voltage electronics.

Smart Hydrogen Hub (Battolyser)

- Battolyser Systems is a R&D company that focusses on realising a combined battery and electrolysis technology, now demonstrating 1 MW.
- By using nickel iron electrodes the system has both a battery function as a hydrogen production function, offering maximum flexibility in operation.
- Stack efficiency of up to 85% at 30 barg output pressure.

Hydrohub MegaWatt Test Center

- Test facility for MW scale electrolysers in industrial relevant conditions.
- Open innovation lab for performing tests on both alkaline and PEM technology.
- Accessible infrastructure for electrolyser manufacturing industry
- Collaboration between government, large industry, knowledge institutes and SME.

HyPRO

- **HyPRO**, funded by the **GroenvermogenNL** growth fund, is the **largest hydrogen research project** ever in the Netherlands.
- The consortium is coordinated by **TNO** and includes:
  - **11 universities** and **5 universities of applied sciences**
  - Over **100 researchers** involved
- The **private sector** is represented by:
  - **Hydrogen users and producers**
  - **Component developers**
  - **Stack and system manufacturers**
  - **System integrators**
- Out of **41 participating companies**, **18 have headquarters outside the Netherlands**
  - Countries include: **UK, Italy, Denmark, France, Germany, Brazil, Japan, and the US**
  - This highlights the importance of **international collaboration** to accelerate hydrogen technology development
- **17 promising Dutch startups** are also involved
- The **entire hydrogen production and usage chain** is represented
- Goal: to ensure **faster market adoption of innovations**

Triple Helix

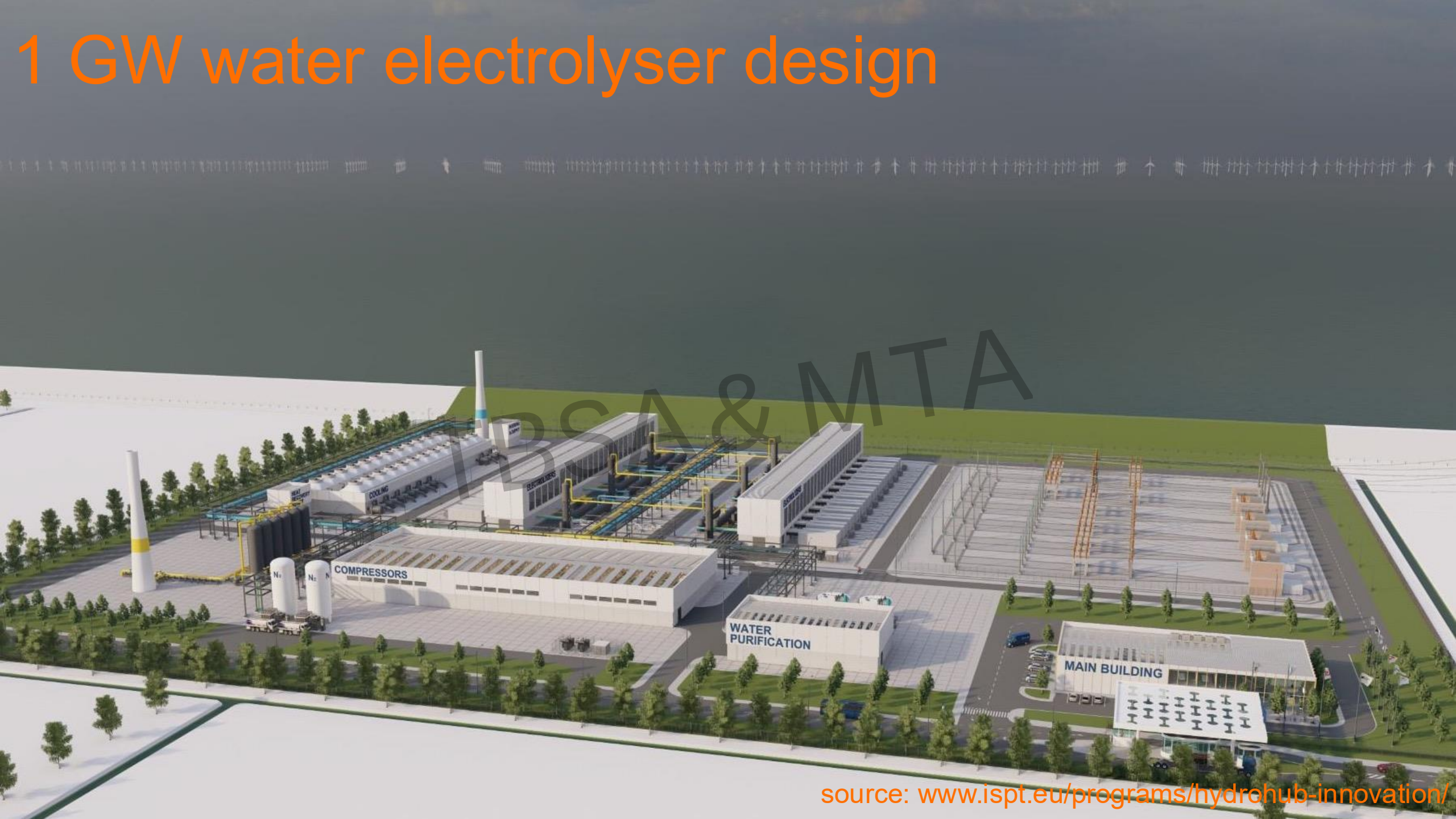
Public Private Partnerships

- Demand driven joint programming

Improves:

- R&I
- Internationalization
- Human Capital
- Regulation

1 GW water electrolyser design



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International Hydrogen Guide 2025


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Government of the Netherlands

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https://www.linkedin.com/company/netherlands-innovation-network-china

E-mail:

fons.kleintuente@minbuza.nl