INVEST IN Holland

The Netherlands: prospect for hydrogen companies

Ecosystem for your European activities

HYDROGEN TECHNOLOGY IN THE NETHERLANDS

What we have to offer

- Introduction
- Value chain
- Innovation Strategy
- Important H2 projects
- Network & Partnerships
- Knowledge Centres
- Lab Facilities & Tech Hubs
- Talent
- Fiscal climate & incentives
- Business community & support

HYDROGEN IN THE NETHERLANDS

Introducing the Dutch hydrogen ecosystem

- Due to its closeness to North Sea offshore wind farms and natural gas pipelines, the Netherlands is well positioned for a renewable or low-carbon hydrogen economy. Rotterdam is Europe's largest container harbor and industrial center, and a source of hydrogen demand. Dutch salt caves and depleted natural gas supplies could store hydrogen.

- Renewable energy in the Netherlands is a top priority. The Dutch government has adopted a **Hydrogen strategy** to boast production and use of low carbon hydrogen.

- The Netherlands houses Europe's first '**Hydrogen Valley'** after receiving European funding in 2019.

- We offer a **highly developed manufacturing industry**, with hundreds of companies in all parts of the value chain, from hydrogen production, distribution and storage.

HYDROGEN IN THE NETHERLANDS

Introducing the Dutch hydrogen ecosystem

- Some recent additions to our hydrogen cluster:
  - **Ørsted** - One of the World's Largest Renewable Hydrogen Plants in the Netherlands
  - **DNV** - Hydrogen innovation center of DNV GL on Campus Groningen
  - **Nedstack** - Advanced Fuel Cell Manufacturing Centre

UNIQUE SELLING POINTS

The Netherlands

Efficient logistics services empowered by
innovation and collaboration

#2 producer of green hydrogen in Europe

Strong logistics sector
#1 logistics hub in Europe

Competitive cost
for labor, real estate and transport

Proximity to European markets
170 million consumers
within a 500 kilometers radius

3 mainports
for air, data and sea

Excellent connectivity
to Europe and all continents

World class and competitive business environment:
no VAT payment at import

FACTS AND FIGURES

The Dutch hydrogen ecosystem

9 million m³

The Netherlands is Europe's 2nd largest hydrogen producer, with an annual production of over 9 million m3 of (fossil-based) hydrogen.

4 GW / 2030

To enable large-scale production of carbon-neutral hydrogen, the Dutch goal is to have installed 4 GW of electrolyser capacity by 2030 (10% of the total EU target for that year). The Northern Netherlands alone is aiming for annual production of 65 Petajoules (PJ) of clean hydrogen by 2030.

11 GW / 2030

Offshore wind power is a crucial enabler of scaling up the production of carbon-neutral hydrogen.
Planned projects in the Dutch sector of the North Sea add up to 11 GW of offshore wind capacity by 2030, while there is enough space for a further scale-up to 20-40 GW.

136,000 km

The Netherlands already has over 1,000 km of dedicated hydrogen pipeline. The country's natural gas grid (136,000 km of pipeline) can be retrofitted to transport hydrogen at acceptable cost. This will accelerate the development of a 'national hydrogen backbone', which could be ready by 2026.

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

Hydrogen Value Chain

DUTCH VALUE CHAIN FOR HYDROGEN TECHNOLOGY

Ecosystem

HyGear
Hystock
RWE
Engie
Air Products
HCC Hydrogen
Chemistry Company
Orsted North Seaport
Nouryon
Port of Rotterdam
Port of Amsterdam
HyCC
ABB
Vestas
North Sea Port
VoltH2
SeaH2Land
Roger Energy
Circul8
Veolia
Neptune Energy
Nobian
Hygro
H2gateway

Gasunie
Port of Amsterdam
Port of Rotterdam
Groningen Seaports
Port of Eemshaven
Northsea Port
Airproducts
Vattenfall
TenneT
Hanwha
Engie
Eneco
RWE
Shell
BP
Total
Air Liquide
Vopak
Nord Sea Port
Bol van Staveren
Westfalen
Nproxx
Fountain Fuel

University Delft
University Eindhoven
University Twente
University Groningen
University Maastricht
TNO Faraday Lab
TNO Helmond / Holst
Automotive Campus - Helmond
Connectr Arnhem
HAN University of Applied Sciences
HZ University of Applied Sciences
KWR
Kiwa
EnTranCe
Hydrogen Delta
WUR
Brightlands Chemelot
JRC
AMOLF
CWI
RWTH University Aachen (D)
Fraunhofer (D)
Meet Munster (D)

Nedstack
Hyet
Hydron Energy
HyMove
Hymatters
Holthausen
VDL Energy
DAF
Ebusco
Schaeffler
Tata Steel
Air Liquide
MTSA
Brightlands
Dow
Nouryon
Engie
Siemens Energy
Thyssenkrupp
EBN
Hauzer techno coating
PEM-Motion
WAviatER
Yara

Thomassen energy
Hanwha
Automotive Campus Helmond
HAN Automotive
Remeha
Mitsubishi power
Siemens
Bredenoord
Yara
H2arvester,
H2Trac
Nefit
Worley Engineering
McDermott Engineering
Plug Power Electrolizers
Ionbond

DNV H2 InnovationCentre
DEKRA
Tüv Rheinland
KIWA
IPKW Arnhem
UL
NLR
Forschungscentre Julich (D)
HySolar
Hydrohub MegaWatt Test Center

Resato
H2 Fuel
Everfuel
Sulzer Turbo Services
Orangegas
Hynetwork Services
Holthausen Energy points

HYDROGEN IN THE NETHERLANDS

Using our existing infrastructure

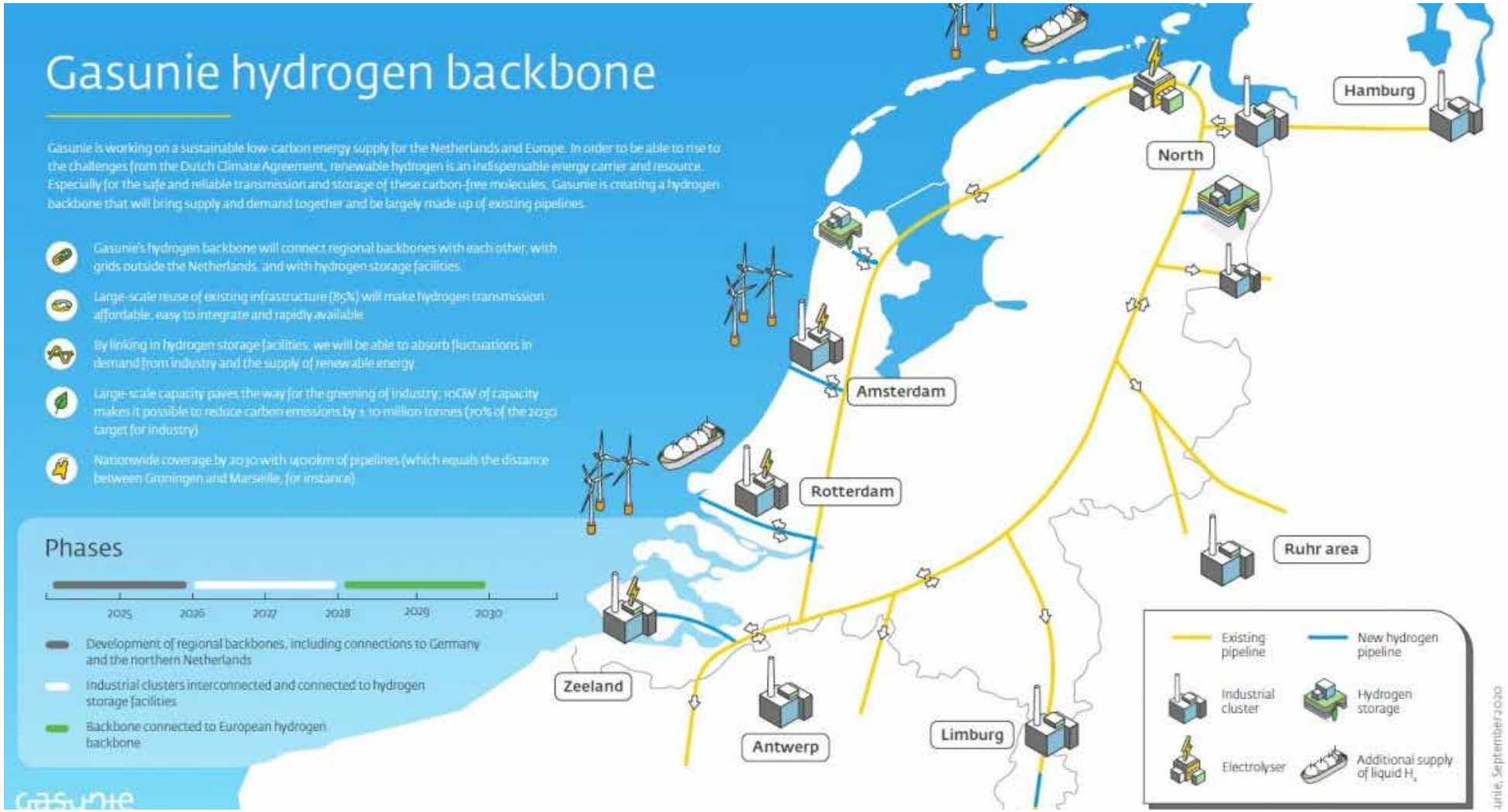
The Netherlands' 136,000 km of gas pipelines offer unique opportunities to develop a **hydrogen backbone**. The network that is being developed will connect regional backbones with each other, with large clusters of industrial consumers and port facilities, also at the North Sea, as well as with storage facilities and grids outside the Netherlands. 85% of the backbone is expected to consist of **reused gas infrastructure**.

Examples:

- An existing oil and gas platform off the Dutch coast is being converted to the **world's first offshore hydrogen platform**. Electricity generated by offshore wind turbines will be used to convert seawater into demineralized water and to power a 1 MW electrolyser producing clean hydrogen.
- In the province of Zeeland an existing, 12-kilometer **natural gas pipeline has been adapted to transport (residual) hydrogen** from Dow Chemical's production site in Terneuzen to Yara's fertilizer plant in nearby Sluiskil. The initiative has allowed the two chemical companies to achieve CO2 savings of 10,000 tonnes per year.

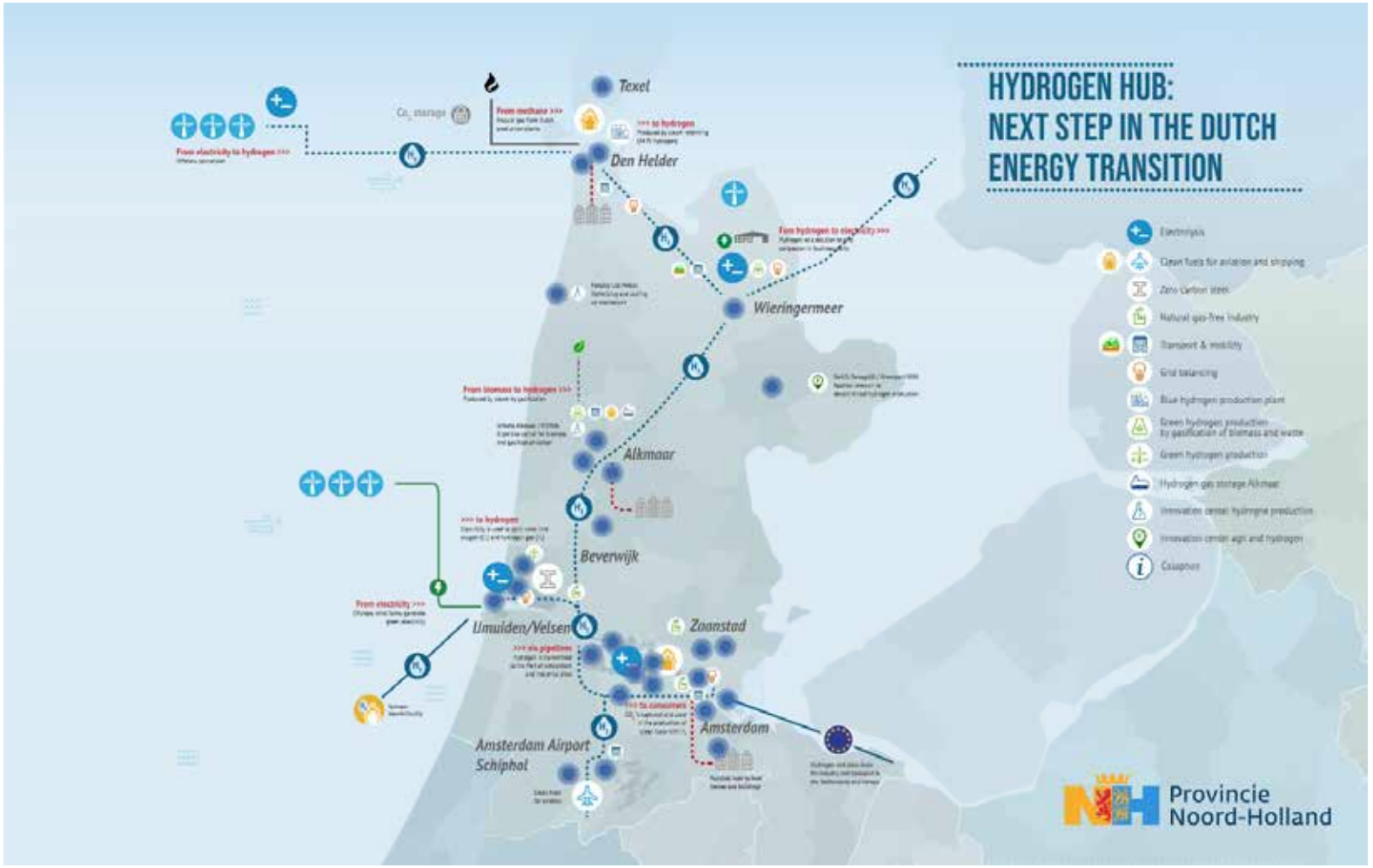
HYDROGEN IN THE NETHERLANDS

Using our existing natural gas infrastructure



HYDROGEN IN THE NETHERLANDS

Using our existing infrastructure & North Sea wind



Innovation Strategy

DUTCH HYDROGEN INNOVATION STRATEGY

Leading in 7 areas

The Netherlands aims to be a significant contributor to the European industry by acting as a major player in bringing hydrogen technology to the market in seven predominant areas:

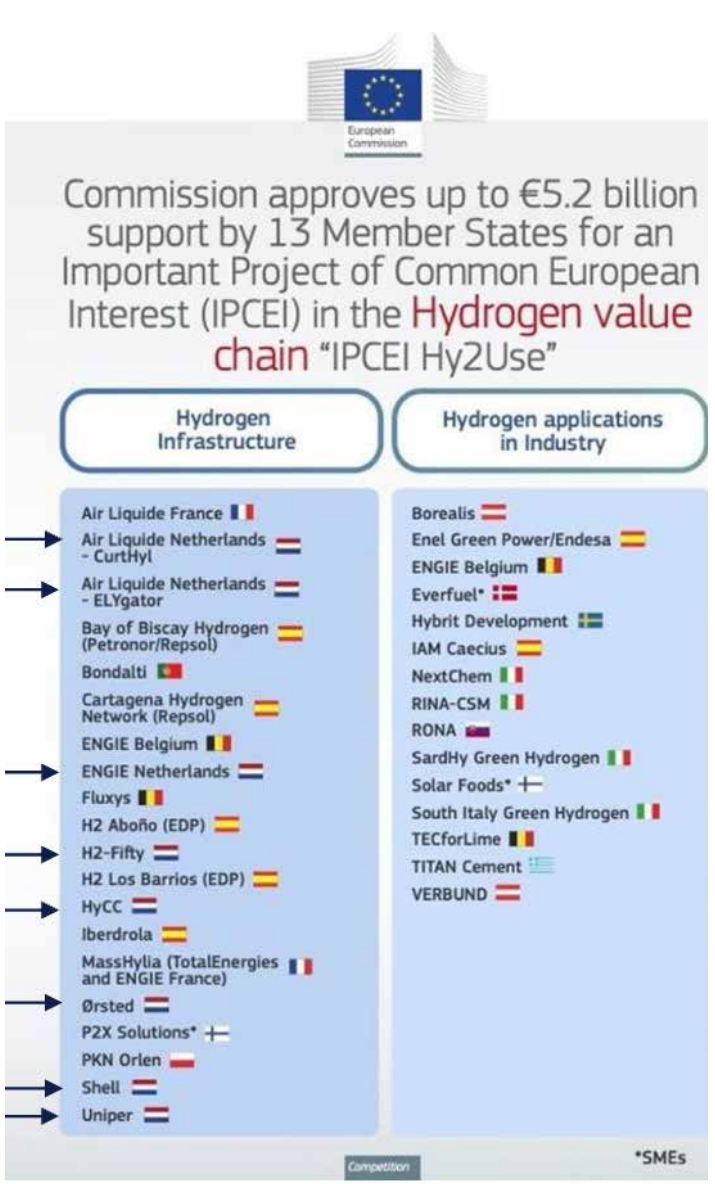
1. Hydrogen production on and offshore
2. Re-using existing Oil Gas infra
3. Hydrogen Import
4. Hydrogen distribution and storage
5. End use industry, mobility and built environment
6. Safety and data security (incl. testing)
7. Hydrogen networks and Partnerships

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

In July 2022, Shell **announced** FID on Holland Hydrogen I, a 200MW electrolyser project at the Port of Rotterdam. This is the first commercial-scale hydrogen project to be given the green light in the Netherlands and the first large-scale renewable hydrogen scheme that Shell has progressed to this stage. The renewable hydrogen produced at Holland Hydrogen I, will supply the Shell Energy and Chemicals Park at Rotterdam, by way of the HyTransPort pipeline 1.

A bunch of other onshore hydrogen production projects are underway – some in feasibility studies, some in concept stage, some are close to FID. Large companies (Supply/Trade, Port Authorities, Industries) are involved in this projects



DUTCH HYDROGEN INNOVATION STRATEGY

Harness the power of the North Sea

The **North Sea Wind Power Hub** is developing a solid knowledge base to **unlock the offshore wind potential of the North Sea**.

North Sea Wind Power Hub

North Sea Wind Power Hub Programme

A Transnational and Cross-sector Approach to Harness the Power of the North Sea

The North Sea Wind Power Hub is developing a solid knowledge base to ensure that countries choose the right solution to unlock the offshore wind potential of the North Sea. The consortium's work is based on research, stakeholder interaction and experience from earlier projects. Its cross-sector approach includes system integration between the power system and future green hydrogen solutions. The current insight is that 'Power to Gas' will play a crucial role in integrating vast amounts of offshore wind into the European energy system. This role is at least threefold: it will provide flexible options for the RES-based power system, decarbonise industry, transport and dispatchable power, and optimise infrastructure investments on- and offshore.

Category:	offshore, knowledge
Capacity:	scalable
Process phase:	Programme execution
Project period:	2018 – 2030
Project costs:	€28 million < 2024
Contact:	https://northseawindpowerhub.eu/

Partners: TenneT Taking power further, gasunie, ENERGINET

Important H2 Projects

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

Shell Hydrogen Holland I

Realisation of a 200 MW Electrolyser in Rotterdam

The green hydrogen produced will initially be used at the Shell refinery in Pernis to partially decarbonise the production of fossil fuels. This saves a minimum of 200,000 tonnes of CO_2 per year. This hydrogen can later be used to decarbonise trucks in the transport sector.

Category:	production of hydrogen
Capacity:	200 MW / 50,000 kg H_2/day
Process phase:	FEED-study, FID 2022
Project period:	2020 - 2024
Project costs:	unknown
Contact:	www.shell.nl

Partners:

Port of Rotterdam

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

Hynoca Alkmaar

Hynoca® by Haffner Energy

Decentral Green Hydrogen Production for Local Application

Hynoca is the first of more to follow hydrogen production facilities where certified biomass residues will be converted into green hydrogen and biochar (certified carbon sink). To cut the hydrogen price and CO2 footprint associated with biomass and hydrogen transportation, the decentral production facility is located near biomass availability sites and hydrogen offtakers. Hynoca conducted a LCA that determined to avoid at least 12 kg CO2 emission per kg of H2 produced. The project will start operations in 2023.

Category:	decentral production of H_2
Capacity:	240t – 1.300t H_2/year
Process phase:	demonstration preparation
Project period:	end 2023 (test & demonstration)
Project costs:	7 M€
Contact:	info@hydevco.eu

Partners: HYDEVCO, ABEL, Haffner Energy Making Hydrogen Super Green, holland, gp groot, INVESTA EXPERTISE CENTRUM, New Energy Coalition

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

Djewels-2

Realisation of a 40 MW Electrolyser in Delfzijl

Operated by HyCC, it will provide 6 ktpa hydrogen per year to be used by DSL-01 to produce sustainable aviation fuel. Part of the "Hydrogen Valley", a broad coalition of public and private parties to realize large-scale production, storage, and distribution of green hydrogen, as a raw material for industry, the built environment and mobility.

Category:	production of hydrogen
Capacity:	40 MW
Process phase:	FID in 2023
Project period:	2020 -
Project costs:	1.5 mln EUR subsidy
Contact:	www.hyCC.com

Partners:

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

VoltH2 - Terneuzen

Hydrogen Production in Terneuzen with Dedicated Storage

In collaboration with Virya Energy, VoltH2 is developing a 25 MW green H_2 production plant on the Axelse Vlakte in Terneuzen, using electrolysers powered only by renewable energy. The permit for the facility is awarded in April 2022, and it will have a dedicated H_2 storage, access to pipeline infrastructure as well as multimodal transport systems in support of H_2 distribution further afield. The feasibility of installing an onsite HRS for the supply of H_2 for heavy road, utility and light duty vehicles as well as inland waterway transport is being considered. The project is scalable in phases, up to 80 MW capacity by 2030.

Category:	production of H_2
Capacity:	25 MW
Process phase:	FEED / Tendering
Project period:	2021 – 2025
Project costs:	50-60M
Contact:	www.volth2.com

VOLT H2 North Sea Port virya energy

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

H2 Conversion Park

Building First 2 GW Conversion Park for Large Scale Hydrogen Production on the Maasvlakte in Rotterdam

Several large-scale hydrogen factories will produce hydrogen on this central location and share at least electricity and hydrogen infrastructure. From this central location hydrogen will be transported via the open-access Hydrogen Network Rotterdam towards companies in the Port area of Rotterdam. The first electrolysers announced in the conversion park are the 200 MW of Shell (2024) and 250MW of H2-Fifty (BP and HyCC; 2025).

Category:	production of H_2
Capacity:	1-2 GW
Process phase:	FEED-study and FID
Project period:	2020 – 2050
Project costs:	unknown
Contact:	rfm.weterings@portofrotterdam.com

Partners: Deltalings, Air Liquide, Shell, bp, HyCC, Port of Rotterdam

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

H_2ero

Hydrogen out of Energy of Renewable Origin for Zeeland

The project comprises the development of a 150 MW electrolyser on the site of Zeeland Refinery in Vlissingen. This location is particularly suitable given its location in an already highly hydrogen-intensive region with many opportunities for setting up and scaling up a 'low-carbon' hydrogen value chain. An annual production of 21 kT of green hydrogen can be expected with the installation, which is equivalent to an avoided CO_2-emission of approximately 200 kTa compared to H_2 production through the conventional fossil route.

Category:	production of H_2
Capacity:	150 MW
Process phase:	Pre-FEED
Project period:	2021 – 2026
Project costs:	unknown
Contact:	koen.van-leuven@zrefinery.nl

Partners: Zeeland Refinery, TotalEnergies, Litasco Group

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

FUREC

Hydrogen Production Plant by ‘waste-to-chemicals’ on Chemelot

The project plans to transform residual waste into raw material pellets, which are then converted into hydrogen at industrial park Chemelot. FUREC (Fuse Reuse Recycle) uses existing waste streams, partly of biogenic origin, so that they do not have to be landfilled or incinerated. FUREC saves the equivalent of 140.000 households of natural gas use. In addition to local sales at Chemelot, the hydrogen can eventually be transported to industry in Rotterdam and the German Ruhr area. The CO_2 released during the production of hydrogen can be either captured and stored or used as a raw material in the future.

Category:	production of H_2
Capacity:	600 Mio m³ H_2
Process phase:	Feasibility-study
Project period:	2021 – 2025
Contact:	Jacob.Rookmaaker@rwe.com

OCI RWE chemelot provincie limburg

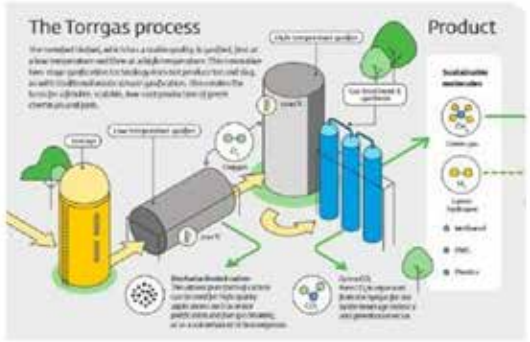
DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

BrigH2

Production of H_2 through Gasification of Torrefied Biomass

Company Brigh2 aims to demonstrate commercial hydrogen production (50MW) by gasification of torrefied biomass, with carbon ending up as biogenic CO_2 and BioChar. Technology is provided by Torrgas. Timing is 2024.



Category:	production of H_2
Capacity:	50 MW
Process phase:	FEED-study
Project period:	2020 – 2025
Project costs:	unknown
Contact:	willemjan.vanasselt@brightlands.com

Partners: torrgas Brightlands

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

SeaH2Land

Linking GW-scale Electrolysis to Large Industrial Demand in the Dutch-Flemish North Sea Port Cluster Through an Envisaged Regional Cross-Border Pipeline.

SeaH2Land is a vision for gigawatt-scale electrolysis and offshore wind landing points on both sides of the river Scheldt after extension of the 380kV grid, turning the cluster into a true hydrogen hub. Containing a 1 GW electrolyser to produce renewable hydrogen and 2 GW of new offshore wind capacity linked to the electrolyser and the regional and national hydrogen pipelines. This includes the cross-border connection between the Netherlands and Belgium to exchange hydrogen between industrial players in the region.

Category:	production of green H_2
Capacity:	1 GW
Process phase:	Feasibility-study
Project period:	2020 – 2028/2030
Project costs:	unknown
Contact:	https://seah2land.nl/

Partners: Ørsted, YARA, Zeeland Refinery, DOW, North Sea Port

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

Hydrohub GW

The Hydrohub GigaWatt Scale Electrolyser

Conceptual design of an electrolyser system of gigawatt size, the size that bridges large-scale renewable power production in offshore wind parks and industrial-scale use of hydrogen for feedstock and energy purposes.

Category:	production of H_2
Capacity:	1 GW
Process phase:	FEED-study completed with report
Project period:	2018 - 2022
Project costs:	TKI subsidy
Contact:	carol.xiao@ispt.eu

Partners:

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

H2-Fifty

H2-Fifty ROTTERDAM

Building a 250 MW Electrolysis Plant in Port of Rotterdam

The new factory will be able to produce 45,000 tons of green hydrogen annually. Because the hydrogen is produced from water with sustainable electricity, CO_2 emissions can decrease by 350,000 tons annually. BP will use the green hydrogen to desulphurise products and for mobility projects. The H2-Fifty project will be in the so-called Conversion Park, a special site that the Port Authority is building on the Maasvlakte for electrolysers from various companies.

Category:	production of H_2
Capacity:	250 MW
Process phase:	FEED-study
Project period:	2019 – 2023 (FID)
Project costs:	225 - 300 M
Contact:	hgj.regeer@portofrotterdam.com

Partners: bp, Port of Rotterdam, HyCC

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen Production On and Off shore

GldH2

A Hydrogen Value-Chain with Multi Purpose in Zutphen

Integral use of locally generated green hydrogen in Zutphen, among others for industrial and mobility use, including heavy transport and public transport. Another focus is heating current homes in the city center, using existing gas pipelines and hydrogen-fired central heating boilers.

Category:	production and deployment
Capacity:	2 MW electrolyser
Process phase:	execution
Project period:	2020 - 2023
Project costs:	unknown
Contact:	info@gldh2.nll

Partners

DUTCH HYDROGEN INNOVATION STRATEGY

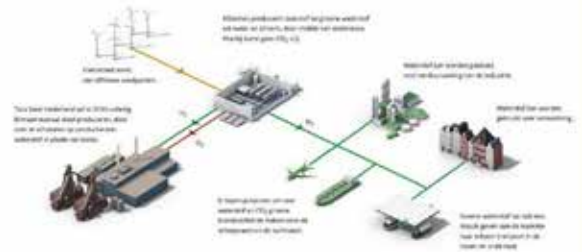
Hydrogen Production On and Off shore

H2ermes

H2ermes

Building a 100 MW Hydrogen Plant in Amsterdam for Tata Steel

Deployment of hydrogen delivered by a 100 MW electrolysis plant to produce fuels and / or basic chemicals with the carbon monoxide (CO) and carbon dioxide (CO_2) in the residual gases from the steel production at Tata Steel.



Category:	production of green hydrogen
Capacity:	100 MW
Process phase:	FEED-study
Project period:	2021 - 2025
Project costs:	150 M€
Contact:	https://h2ermes.nl

Partners: Port of Amsterdam, TATA STEEL, HyCC

DUTCH HYDROGEN INNOVATION STRATEGY

Re-using existing O&G infrastructure

- Project PsHydon, the purposing existing offshore infrastructure.
- An existing oil and gas platform off the Dutch coast is being converted to the world’s first offshore hydrogen platform. Electricity generated by offshore wind turbines will be used to convert seawater into demineralized water and to power a 1 MW electrolyser producing clean hydrogen.
- PosHYdon integrates three energy systems in the North Sea: offshore wind, offshore gas and offshore hydrogen and will take place on Neptune Energy's Q13a-A platform.
- This producing production platform is the first fully electrified platform in the Dutch North Sea.

- Poshydon | Green Hydrogen Energy

DUTCH HYDROGEN INNOVATION STRATEGY

Re-using existing O&G infra structure

PosHYdon

POSHYDON

Hydrogen Production from North Sea Water on an Offshore Platform

PosHYdon seeks to validate the integration of three energy systems in the Dutch North Sea: offshore wind, offshore gas and offshore hydrogen and will involve the installation of hydrogen-producing plant on the Neptune Energy-operated Q13a-A platform. The Q13a-A is the first fully electrified platform in the Dutch North Sea, located approximately 13 kilometres off the coast of Scheveningen (The Hague). The green hydrogen will be mixed with the gas and transported via the existing gas pipeline to the coast. The 1 MW electrolyser will produce a maximum of 400 kilogrammes of green hydrogen per day.

Category:	Offshore, production of H_2
Capacity:	1 MW
Process phase:	pilotplant, demonstration
Project period:	2019 - 2025
Project costs:	DEI+ subsidy 3.6 M€
Contact:	patrice.hijsterborg@neptuneenergy.com

Partners:

DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen

- Since hydrogen gas is not suitable for long-range transportation, suppliers can (1) liquefy hydrogen, (2) convert it to ammonia, (3) or bind it to a liquid organic hydrogen transporter (LOHC). If each stage of the value chain uses green energy (fuel and/or electricity) and hydrogen is produced from low-carbon sources, all three transport carriers can be considered low-carbon.
- The optimal choice of a carrier depends on the intended end use, purity requirements and transport and storage needs. Several carriers are under investigation

- Ammonia
- Sodium Borohydride
- LOHC
- Methylcyclohexane

DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen by Ammonia

ACE Terminal

Green Ammonia as a Hydrogen Import Carrier in Rotterdam

Green ammonia as a hydrogen carrier will play a vital role in the import of green hydrogen to meet future demand. After hydrogen bonds with nitrogen in the form of ammonia, it can be transported simply and safely in large volumes, and then stored and reconverted into green hydrogen. Green ammonia is also immediately usable as CO2-free fuel, for example, for shipping or as a raw material for the production of fertiliser.

In addition to the ACE import terminal for green ammonia at the Maasvlakte (2026), import terminals for other hydrogen carriers like Liquid Hydrogen (LH2) and LOHC (Liquid Organic Hydrogen Carriers) are anticipated in northwest Europe. Expected future import terminal locations are in Rotterdam, Eemshaven, Zeeland, Amsterdam, and Brunsbüttel.

Category:	import
Capacity:	scalable
Process phase:	Feasability-study
Project period:	2021 – 2026
Project costs:	confidential
Contact:	info@gasunie.nl

Partners:

gasunie crossing borders in energy

HES International

Vopak

DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen by Ammonia

H2A [formerly H2Gate]

Import of Megatons of Green Hydrogen in Amsterdam

H2Gate focuses on the development of large-scale hydrogen imports to the Amsterdam port region (1 million ton per year). The project focuses on several hydrogen carriers that match the infrastructure in the port. The consortium has started a new phase where the partners develop and proof safe and cost-effective hydrogen carriers technologies, supported by clear pilot projects in hard-to-abate transport and industry sectors. The aim for the realization of the combined import terminal is around 2030.

Category:	import, storage
Capacity:	1 Mton/year
Process phase:	demonstration
Project period:	2022 – 2030
Project costs:	unknown
Contact:	Eduard.de.Visser@portofamsterdam.com

Partners: Port of Amsterdam, EVOS, Electriq Global, hydrogenious LOHC TECHNOLOGIES, HYSILABS

DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen by Sodium Borohydride

H2Fuel

A Technique for the Production, Storage and Release of H_2

The storage takes place under atmospheric conditions in a powder and the release takes place without added energy with very clean water. Hereby not only 100% of the hydrogen stored in the powder is released, but also the same amount of hydrogen from the water is harvested. Plant One Rotterdam is currently running a proof-of-concept project for extracting (unpacking) hydrogen from sodium borohydride (NaBH4).

Category:	storage
Capacity:	scale up
Process phase:	FEED-study/proof of concept
Project period:	2019 - 2030
Project costs:	unknown
Contact:	https://h2-fuel.nl

Partners:

H2FUEL-SYSTEMS
Making Hydrogen work

Solid Hydro. Re.Gen

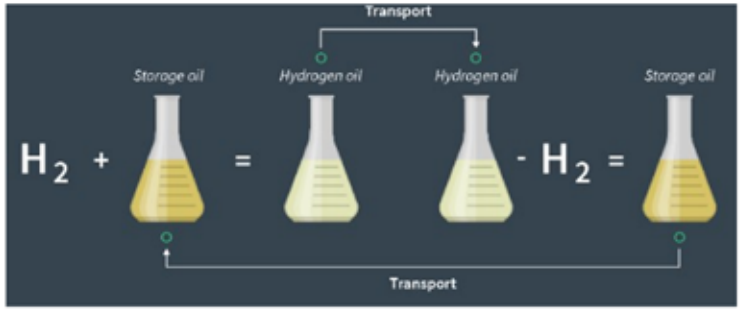
DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen by LOHC

Hydrogen Oil

Liquid Organic Hydrogen Carriers as a Maritime Fuel

The fuel is produced through a process where Hydrogen and a liquid that we call Storage Oil are combined by applying heat and pressure in a patented process. Being a liquid, the Hydrogen Oil can easily be transported and refueled into a maritime vessel. Onboard of the vessel, the Hydrogen is released from the Hydrogen Oil by applying heat and pressure in the reverse process. When we release hydrogen, the liquid becomes Storage Oil which can be charged again for its next usage. This is tested in this pilot in IJzendoorn.



Category:	storage
Capacity:	scalable
Process phase:	execution
Project period:	2020 - 2023
Project costs:	1 M€
Contact:	www.voyex.nl

Partners: VOYEX Dekker SOLARDUCK

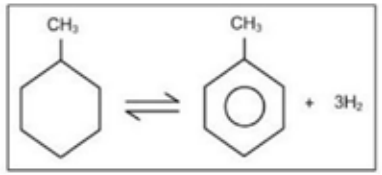
DUTCH HYDROGEN INNOVATION STRATEGY

Import of Hydrogen by methylcyclohexane

MCH

Transporting Hydrogen Based on Methylcyclohexane (MCH)

The Port of Rotterdam Authority will look at how it can import hydrogen for commercial purposes on a large scale. The technology under investigation is the transport of hydrogen based on the substance methylcyclohexane (MCH). That is easier than other options such as transporting hydrogen at a temperature of minus 253 degrees or form ammonia. The ambient temperature is less important when using MCH and existing ships and infrastructure can be used.



Category:	import, transport of H_2
Capacity:	400 kton a year in 2030
Process phase:	Feasibility-study
Project period:	2022-2023
Project costs:	unknown
Contact:	hgj.regeer@portofrotterdam.com

Partners: Port of Rotterdam, MITSUBISHI POWER, koole TERMINALS, CHIYODA CORPORATION

DUTCH HYDROGEN INNOVATION STRATEGY

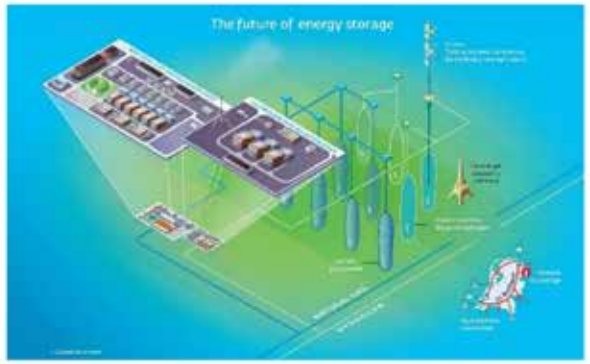
Hydrogen storage

HyStock

Development of An Underground Hydrogen Storage

There is a need for large-scale, underground storage of hydrogen because hydrogen supply and demand are not constant. That is why Gasunie subsidiary HyStock is developing hydrogen storage in a salt cavern in Zuidwending, near Veendam.

The installation in the first cavern (≈ 200GWh) is expected to be operational in 2027. It is estimated that four caverns will be needed for hydrogen storage by 2030 in order to meet market demand for hydrogen. The hydrogen storage will be accessible to all parties who want to store hydrogen, for the short or long term. Initially, this will run through a connection to the Hydrogen Network Noord-Nederland, and soon after through a connection with the Hydrogen Network Netherlands.



Category:	storage
Capacity:	scalable
Process phase:	FEED-study
Project period:	2018 – 2030
Project costs:	confidential
Contact:	info@gasunie.nl

gasunie
crossing borders in energy

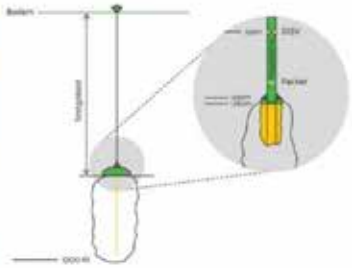
DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen storage

A8 - HyStock Demonstration project

Insights into Hydrogen Storage in Salt Caverns

In 2021 and 2022, Gasunie subsidiary HyStock is using borehole A8 at Zuidwending as a demonstration project of hydrogen storage in salt caverns. The project will provide valuable insights into safety, mechanical integrity, pressure, working methods and microbiology. These insights will be used to develop the first full-scale hydrogen storage in the Netherlands: cavern A5 at the Zuidwending site. The existing A8 borehole will also eventually become a salt cavern and will then be used for hydrogen storage.



Category:	storage
Capacity:	scalable
Process phase:	Construction
Project period:	2020 – 2022
Project costs:	confidential
Contact:	info@gasunie.nl

gasunie
crossing borders in energy

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen storage

FODEO

TKI URBAN ENERGY
Topsector Energy

Flexible Storage, with Local Energy Exchange, of Sustainable Energy in Almere Oosterwold

The goal of FODEO is to contribute to optimizing the self-sufficiency of energy at the neighborhood level. This offers opportunities for a new market for local trading and storage of sustainably generated energy. Within the project we also look at organizational and legal issues. For example, we look at which amendments to legislation and regulations are necessary to make local energy communities possible.

Category:	storage
Capacity:	scalable
Process phase:	Feasibility-study
Project period:	2021 – 2023
Project costs:	450 k € TKI subsidy
Contact:	leovanbemmel@villaville.nl

Partners: HUYGEN, ideate, Villa Ville, ABB, Poinselot, SPECTRAL, J-OB, Nedstack

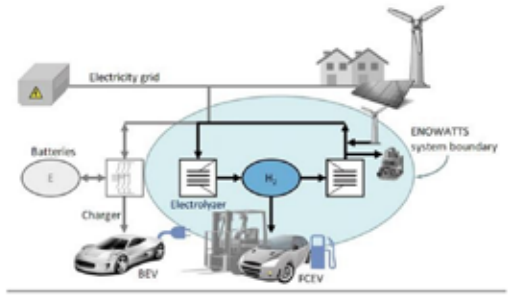
DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen storage

Enowatts

Hydrogen Technology on Industrial Park de Kleefse Waard

Enowatts focusses on storage of excess wind energy in hydrogen, as well as local hydrogen applications at industrial park Industriepark Kleefse Waard (IPKW) in Arnhem, by means of systems modelling, development and testing.



Category:	storage
Capacity:	scalable
Process phase:	Feasibility and FEED-studies
Project period:	2020 - 2022
Project costs:	700 k€ (300k€ grant)
Contact:	sustainable.energy@han.nl

Partners: HENCON, Liander, WINTERSOL, HYSTER-YALE, HYGEAR, provincie Gelderland, HyMatters, HAN, SAXION, TU Delft, Prowind, QCONCEPTS, XINTC, HyET Hydrogen, Arnhem, kiemt, NWBA, SEECE, QUANTILLION, TOYOTA, Bronkhorst, Industriepark Kleefse Waard, Bredenoord

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen storage

H2 Bunkerstation

Development of a Liquid Hydrogen Bunkerstation in Den Helder

Liquid Hydrogen will become one of the key energy carriers for the seagoing vessels. Aim of the project is to realize a bunkerstation with a storage capacity of 200 m³ liquid hydrogen. The first users of the bunkerstation will be the shortsea freight vessels and local working boats or dredgers/offshore support ships.

The focus of the LH2 bunkerstation is realizing a bunkerfacility and not the production of LH2.

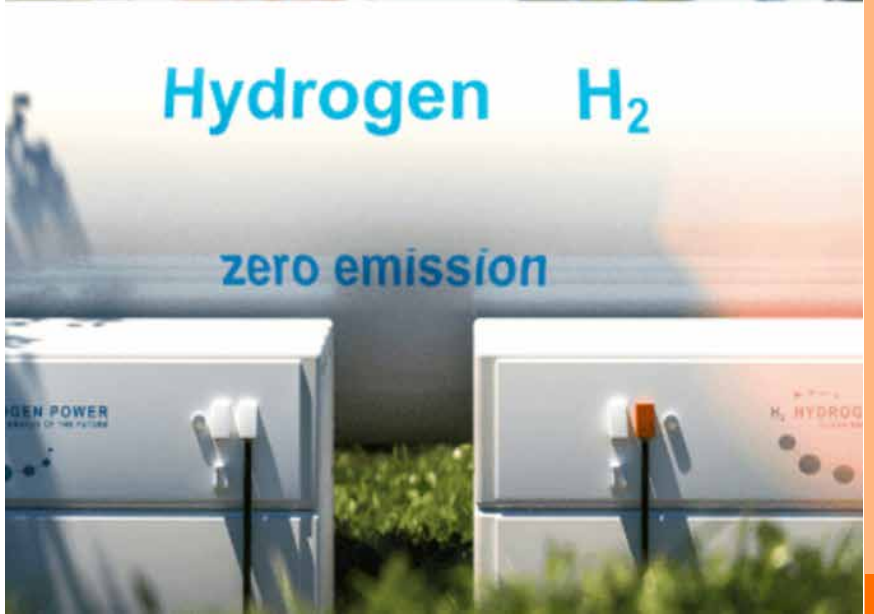
Category:	storage
Capacity:	200 m³
Process phase:	FEED-study / execution
Project period:	2022 - 2023
Project costs:	3.5 M€
Contact:	www.newenergycoalition.org

Partners: PORT OF DEN HELDER, SPAANSEN, TOTAL, TU Delft, New Energy Coalition

DUTCH HYDROGEN INNOVATION STRATEGY

End use industry, mobility and built environment

- On Shore power and emergency power and power generation.
- Energy intensive industrial processes (e.g. glass, food, ceramic and steel production) for graduate transition from natural gas to hydrogen (page 93).
- Infrastructure hydrogen fueling stations initiatives.
- Applications in mobility cars, busses, heavy duty trucks, trains excavators, water taxies, aircrafts.
- Hydrogen hospital Rijnstate first hospital on hydrogen - H2Platform.
- Local DNO Enexis, Alliander, Stedin projects.

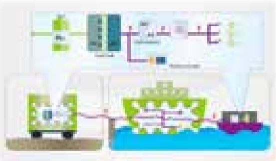


On Shore power and emergency power and power generation

H2 Walstroom

Hydrogen for Green Shorepower in the Three Northern Harbours

The project focuses on the design, development, testing and realization of a mobile fuelcell/genset, which will be deployed to provide clean shorepower to docket vessels in Groningen Seaport, Port of Den Helder and Port of Harlingen.



Category:	end use: energy supply
Capacity:	335kW
Process phase:	FID/execution
Project period:	2020 - 2023
Project costs:	3.9 M€
Contact:	www.eekels.com

Partners: Groningen Seaports, Port of Den Helder, Port of Harlingen, eekels, Nedstack

Hydrogen Emergency Power

Development of a Power Generator on Hydrogen for Datacenters

Data centers usually have several emergency power generators that run on diesel to guarantee the availability of the digital services. The 500 KW hydrogen cell module that will be installed in the new NorthC data center in Groningen will save tens of thousands of liters of diesel on an annual basis. The hydrogen cells in Groningen are expected to be operational Q1-2023 and NorthC is investigating whether this hydrogen technology can also be applied in the company's other data centers.

Category:	end use: energy supply
Capacity:	500 KW
Process phase:	execution
Project period:	2022-2023
Project costs:	unknown
Contact:	https://www.northcdatacenters.com

Partners: NorthC, Nedstack

High Hydrogen Retrofit Partnership

Hydrogen Gas Turbine Retrofit to Eliminate Carbon Emissions

To develop a cost-effective ultralow emissions (sub 9ppm NOx and CO) combustion system retrofit for existing installed gas turbines in the output range of 1 MW to 300 MW. Fuel flexibility and stable operation is required from 100% natural gas to 100% hydrogen.

Category:	end use: energy supply
Capacity:	scalable
Process phase:	FEED-study
Project period:	2e phase 2021 - 2023
Project costs:	unknown
Contact:	www.ansaldoenergia.com/ansaldo-thomassen

Partners: Ansaldo Energia, OPRA, AkzoNobel, GETEC Park Emmen, TU Delft, Vattenfall, Nouryon

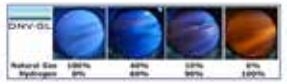
DUTCH HYDROGEN INNOVATION STRATEGY

Energy intensive industrial processes

Hydrogen as a Fuel for Industrial Heating Processes

Development of Fuel Flexible Burner Concept

This projects aims to prepare energy-intensive industrial production processes (e.g. glass, food and ceramic sector) for a gradual transition from natural gas to hydrogen. The fuel flexible burner concept can handle any mix of natural gas and hydrogen.



Category:	end use: industry
Capacity:	100 kW – 200 MW
Process phase:	execution
Project period:	2020 – 2022
Project costs:	TSE 670 k€
Contact:	Sander.Gersen@dnv.com

Partners: Industry consortium of 35 partners

DNV

NEDMAG on Hydrogen

Demonstration of H_2 Heating a 2 MW Oil Furnace

In this demonstration project the furnace of the industrial magnesium salt mining site of NEDMAG in Veendam will be fueled by varying natural gas/ hydrogen blends. To assure safe and reliable furnace operation, a Fuel Adaptive Control System is installed

Category:	end use: industry
Capacity:	2 MW
Process phase:	execution/commissioning
Project period:	2020 - 2022
Project costs:	unknown
Contact:	H.Hamstra@Nedmag.nl

Partners: NEDMAG DNV tempco LAMTEC

Brightsite Hydrogen

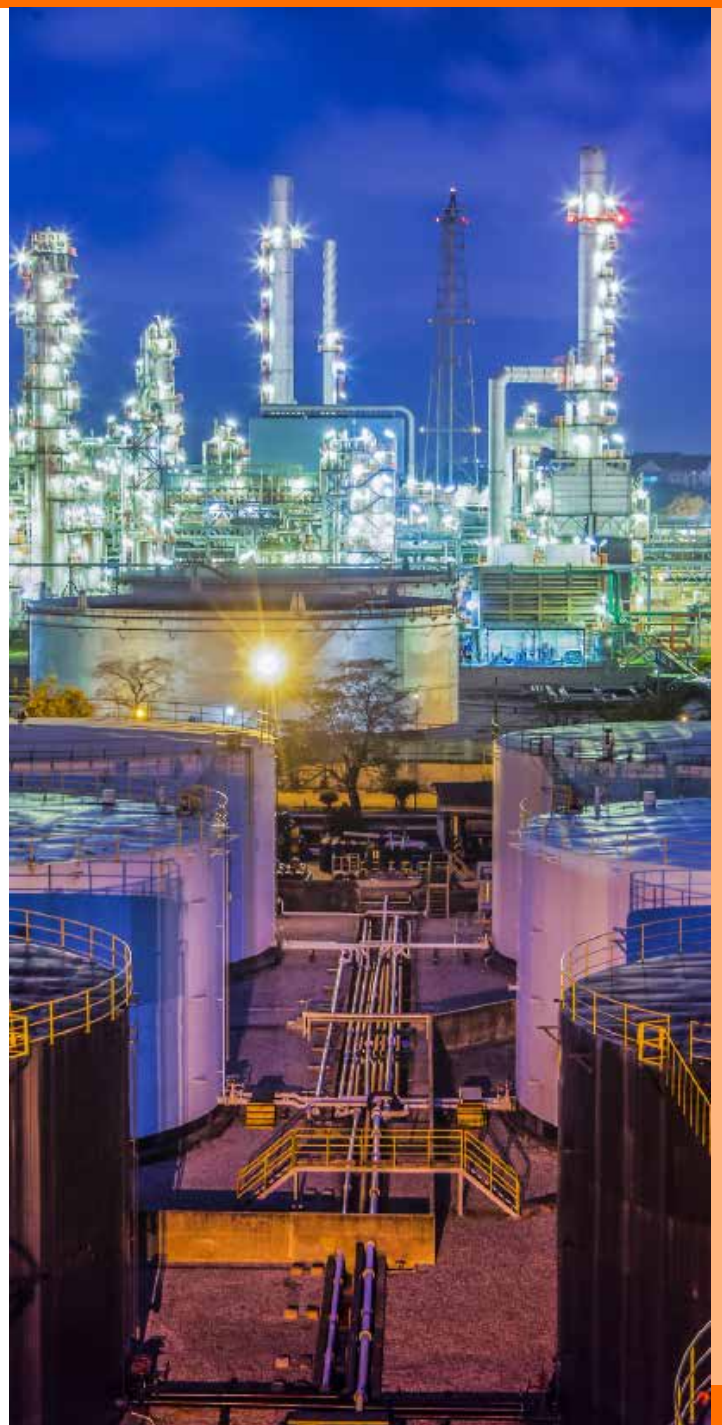
Development of a Plasma Process for the CO_2-free Production of Hydrogen and Ethylene

Using electricity as energy source a plasma process is being developed for the CO_2-free production of hydrogen, acetylene and ethylene using methane from the electrified naphtha crackers as feedstock. The products are the building blocks for the production of fertilizers and plastics. The aim is to construct a demo plant in 2025-2027 producing 10 kt / yr hydrogen and a production plant in 2030-2040 producing 0.2 Mt / yr hydrogen. This work is performed in collaboration with the chemical industry.

Brightsite
Transforming industry

Category:	end use: industry
Capacity:	10 – 200 kt H_2 / yr
Process phase:	concept – pilot
Project period:	2021 – 2030
Contact:	hans.linden@tno.nl

Partners: sitech TNO innovation for life Maastricht University Brightlands Chemelot Campus



DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen fueling stations initiatives

Hysolar

The Production and Supply of Green Hydrogen in Nieuwegein

Hysolar / Greenpoint operates a public hydrogen refueling station since the summer of 2021. The main hydrogen demand is generated by heavy duty machines (e.g., tractors, holders, cranes), trucks, buses, and by passenger cars. Further, in Q2 2023 a 2,5 MW electrolyser will be installed that is supplied with green electricity. To increase the efficiency of the electrolyser, the waste heat will be utilized by a nearby industrial customer.

Category:	end use: energy supply
Capacity:	2,5 MW / 250 ton H_2 / year
Process phase:	execution
Project period:	2021 - 2036
Project costs:	DKTI/ EU LIFE subsidy
Contact:	www.hysolar.nl

Partners:

H2Milk Run

Mobile Hydrogen Refuelling Station

Daily delivery of hydrogen via a small truck with a full functional HRS at multiple sites a day (a "Milk Run"). This initiative enables to start with fuel cell forklift trucks without the need to invest in infrastructure, in order to accelerate the use of hydrogen in logistics in a region. In spring 2022 the new GINAF truck will start to distribute hydrogen in the region of Ede.

Category:	end use: energy supply
Capacity:	1 truck
Process phase:	execution, demonstration
Project period:	2021 - 2024
Project costs:	1.25 ME
Contact:	l.w.gosseling@mobihy.com

Partners:

H2GPU

Development of a Hydrogen Ground Power Unit at Schiphol

A GPU is used to provide electric power to an aircraft when it is stationary on the ground. In the HGPU that will be developed by zepp.solutions, the conventional diesel engine in the GPU is replaced by a hydrogen powertrain. The first unit will be demonstrated at Schiphol airport by KLM equipment services in 2023.

Category:	end use: mobility & transport
Capacity:	1 H_2 Ground Power Unit (GPU)
Process phase:	FEED-study / execution
Project period:	2022 – 2025 (demo in 2023)
Project costs:	Horizon 2020 subsidy
Contact:	https://tulips-greenairports.eu/ https://zepp.solutions/tulips-gpu/

Partners:

Energy Points

Refueling Stations with Hydrogen From and For the Future

Energy Points are modern hydrogen fueling stations with groundbreaking design. The hydrogen fillingstation in Groningen is 24/7 open and the station in Amsterdam is under construction. Holthausen Energy Points is also helping other hydrogen filling stations with hydrogen supply.

Category:	end use: mobility & transport
Capacity:	2 refilling stations
Process phase:	execution
Project period:	2020-2023
Project costs:	DKTI-subsidy + 500 k€/dam
Contact:	www.energypoints.nl

Partners:

DUTCH HYDROGEN INNOVATION STRATEGY

Applications in mobility (1)

Zephyros

Development of a Maritime Hydrogen Hub in Den Helder

The aim is to demonstrate and stimulate green hydrogen as a maritime fuel on and around the Wadden Sea. The project aims to realize a local solar park, an electrolyser, a pipeline from the electrolyser to an inland port and a public refueling facility, and a hydrogen-electric vessel for use by a pool of maritime service providers and knowledge institutions. The electrolyser is used for flexibility services and congestion management to reduce the hydrogen price with revenues. The aim is to have the hub operational by the beginning of 2022.

Category:	end use: energy supply
Capacity:	2 refilling stations/ 400 kg H_2
Process phase:	FID/execution
Project period:	2019 - 2024
Project costs:	6,4 MEDKTI/ Waddenfonds
Contact:	p.cnubben@nnwenergycoalition.org

Partners: PORT OF DEN HELDER, DAMEN, holland, TOTAL, ENGIE, allander, TUDelft, New Energy Coalition

Project Phoenix

AeroDelft

Building the World's First Liquid Hydrogen-Powered Aircraft

The 1:3 scale prototype is powered by a 1500 W fuel cell coupled with a battery pack for take-off power and safety. Hydrogen is kept in a cryogenic tank at -253°C and warmed to 0°C using a complex tubing system. Phoenix is able to fly for 7h with just 1kg of liquid hydrogen, covering a distance of more than 500 km. These endurance and range values are unmatched by batteries and conventional fuels. Our work can be used to have the first hydrogen-powered passenger aircraft flying by 2030, potentially by a spin-off start-up.

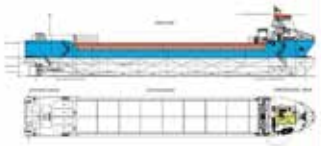
Category:	end use: mobility & transport
Capacity:	prototype
Process phase:	demonstration
Project period:	2021 – 2023
Project costs:	unknown
Contact:	www.aerodelft.nl

Partners: o.a. TUDelft, Fryslan Air, cryoworld, ADSE, Vliz, LUH, TNO, AkzoNobel, AIRTECH, cadence

LH2 Vessel

Construction of a New Build Shortsea Vessel on Hydrogen

Tata Steel Ijmuiden and van Dam Shipping has entered into an agreement to realize a new-build shortsea vessel based on 100% Liquid Hydrogen propulsion. The shipping industry is at the start of a large energy transition process. The newbuild LH2 vessel will be the first "commercial" vessel based on 100% zero emission. The project is supported by the partners in the SH2IPDRIVE R&D program of which van Dam Shipping is one of the lead partners.



Category:	end use: mobility & transport
Capacity:	1 newbuild shortsea vessel
Process phase:	FEED and realization
Project period:	2022 - 2023
Project costs:	15 M€
Contact:	www.vandamshipping.com

Partners: CONOSHIP, TNO, TATA, MARINE SERVICE NOORD, TUDelft, New Energy Coalition

Hydrogen fuel cell sweeper

Sweeping of Inner Cities Without Emissions

The fuel cell uses hydrogen and oxygen to generate energy to drive and sweep the roads, after which only a small amount of water vapor comes out of the exhaust. With the new sweeper we immediately introduce a hydrogen exchange bottle system (H2 pod). This saves us the purchase of an expensive refueling system, because the H2 pod is flexible and offers the possibility to quickly and safely exchange the empty hydrogen exchange bottle for a full one, wherever and whenever we want.

Category:	end use: mobility & transport
Capacity:	500H2 sweeper
Process phase:	execution, demonstration
Project period:	2019 - 2023
Project costs:	DKTI-subsidy
Contact:	www.greenmachines.com

Partners: GREEN MACHINES, Van Campen, CLEANMAT TRUCKS, HOLTHAUSEN

DUTCH HYDROGEN INNOVATION STRATEGY

Applications in mobility (2)

HYDRA-2

Safe Flying with Liquid Hydrogen

With flight demonstrations using hydrogen powered drone's NLR takes a new and safe step towards climate-neutral aviation contributing to the ambitions of the Sustainable Aviation Agreement and the Hybrid Electric Flying Action Program. In spring 2022, NLR expects to perform drone (HYDRA-2) test flights using compressed hydrogen as an energy carrier in a fully composite tank. Additionally, fuel cell technology will be demonstrated producing electric power for the propellers. In autumn 2022, NLR aims to perform a maiden test flight with a drone powered by liquid hydrogen stored in a metal tank.

Category:	end use: mobility & transport, knowledge
Capacity:	1 drone
Process phase:	FEED-study, demonstration
Project period:	2021 - 2022
Contact:	roel.van.beelhem@nlr.nl

nlr Dedicated to innovation in aerospace

Hydrogen Train

Hydrogen Trains as a Sustainable Alternative for Diesel Trains

The province of Groningen wants to make rail transport in the north of the Netherlands more sustainable, which is currently still largely carried out by diesel trains. A pilot in 2020 with the Coradia iLint-hydrogen train, showed that the hydrogen train can be a fully-fledged alternative to the current diesel trains. The province has the ambition to run new trains on hydrogen from 2025.

Category:	end use: mobility & transport
Capacity:	1,000 km per filling
Process phase:	commissioning
Project period:	2020 - 2025
Contact:	https://www.hivemobility.nl/project/pilot-waterstoftrein/

Partners: ProRail, arriva, ENGIE, ALSTOM, DEKRA

ISHY

Interreg 2 Seas Mers Zeeën ISHY

Implementation of Ship Hybridisation

Part of the project is the development of a hydrogen fuel cell system module suitable for medium scale maritime applications. Zepp solutions will develop and produce this module, which will be ready for implementation in 2023.

Category:	end use: mobility & transport
Capacity:	1 prototype
Process phase:	FEED- engeneering
Project period:	2019 – 2023 (prototype ready)
Project costs:	9 M Interreg 2 Seas grant
Contact:	https://www.interreg2seas.eu/en/ISHY

zepp solutions, Impuls Zeeland, TU Delft, GEO, HybridMarine, YES!, Parkwind, Port Oostende, SOLENT, vfen

H2RenT

H2 RENT

Building 6 Hydrogen-powered Garbage Trucks

The trucks will be operating in different locations, so that municipalities and collection companies can become acquainted with hydrogen technology. A unique aspect is that service companies are also involved in the demonstration project.

Category:	end use: mobility & transport
Capacity:	6 trucks
Process phase:	execution
Project period:	2019 - 2024
Project costs:	unknown
Contact:	stefan.neis@waterstofnet.eu

Partners: ESR, DE BURGH, TB, LOVEN

DUTCH HYDROGEN INNOVATION STRATEGY

Hydrogen hospital

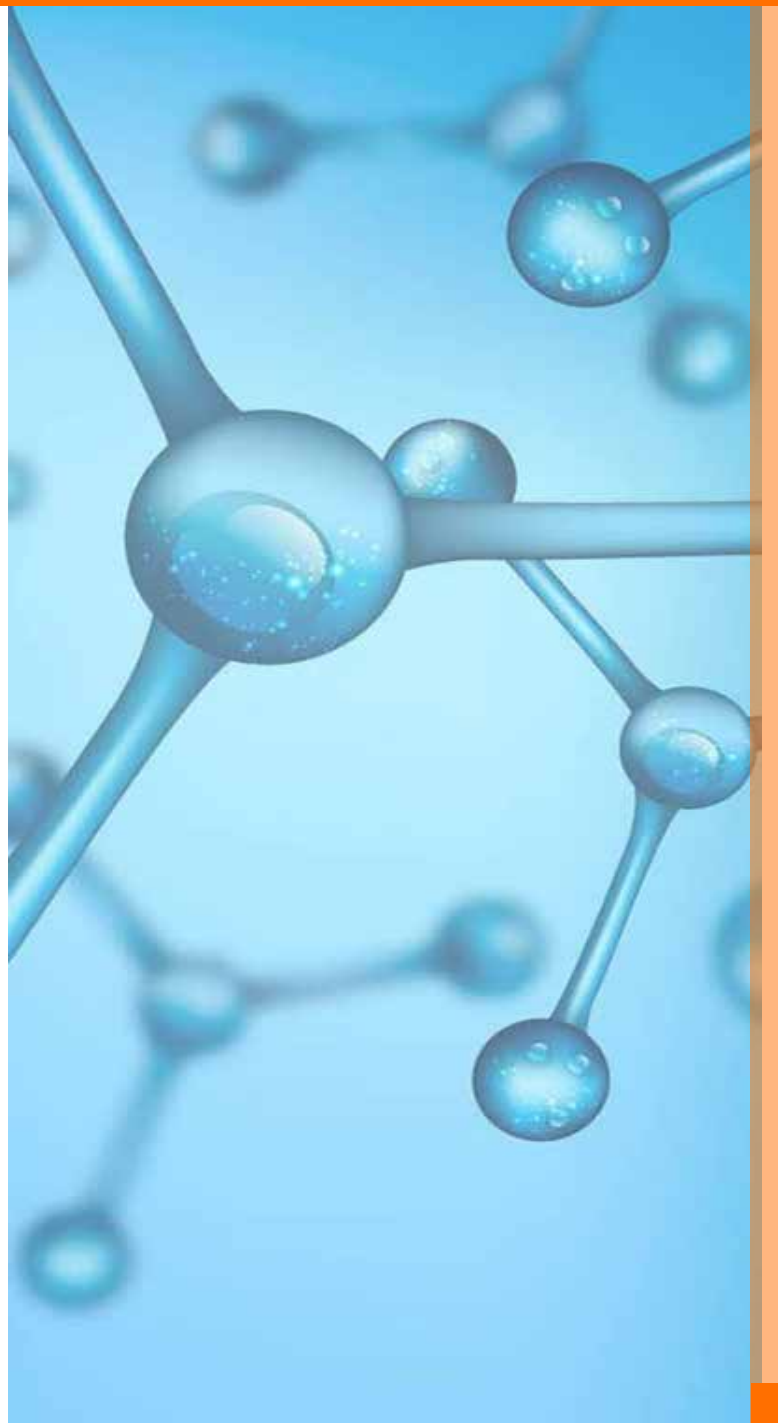
Hydrogen Hospital

Development of a Sustainable Hydrogen Smart Grid in Elst

The hospital's energy needs will be partly met by the electricity generated from the solar panels on the site. The surplus of solar energy produced is converted into green hydrogen. The hydrogen produced is stored at day level, but also across the seasons. A so-called "smart grid" at the location in Elst determines when it is efficient to convert the hydrogen into electricity and heat. In this way, the local electricity grid is not overloaded, and a maximum CO2 reduction is achieved at our own new location.

Category:	end use: built environment
Capacity:	scalable
Process phase:	FEED-study
Project period:	2021 – 2023
Project costs:	unknown
Contact:	www.hymatters.com

Partners: HyMatters Rijnstate



DUTCH HYDROGEN INNOVATION STRATEGY

Local DNO Enexis, Alliander, Stedin projects

Hydrogen District Wagenborgen

Connecting 33 Homes to the Local Hydrogen Network

The hydrogen is used to heat the houses. The homes will receive a hybrid heat pump that runs on sustainably generated electricity as much as possible. At cold moments, a boiler running on hydrogen switches on. The houses will be insulated and will receive solar panels and gas stoves will be replaced by induction hobs. The hydrogen that is needed is made by a farmer in Siddeburen. The gas is partly transported to the homes via existing gas pipes, and partly via a new network to be built.

Category:	end use: built environment
Capacity:	33 homes
Process phase:	execution
Project period:	2021 – 2023
Project costs:	unknown
Contact:	www.enexisgroep.nl

Partners: Eelshuis Energie, Energiewacht, INTERGAS, cleanenergy, ENEXIS GROEP

Hydrogen Neighbourhood Hoogeveen

100 Newly Built Houses and 430 Existing Houses Connected to Hydrogen

The newly built Nijstad-Oost residential area has been designated as a demonstration project for the application of hydrogen in newly-built houses. The destination plan will soon be brought into execution. Construction is expected to start in 2023. Other houses will be connected later.

Category:	end use: built environment
Capacity:	530 houses
Process phase:	execution, final call in 2022
Project period:	2020 - 2030
Project costs:	TSE 400 k€
Contact:	www.waterstofhoogeveen.nl

Partners:

Hydrogen Neighbourhood

Pilot Heating with Hydrogen in Neighbourhood Berkeloord, Lochem

At Berkeloord there are relatively old, sometimes even monumental buildings. The project consist of two subjects; reduction of energy consumption and heating with hydrogen. Since cooking cannot yet be done with hydrogen; induction would be the most obvious option. Before winter 2022/2023 the first house will use hydrogen.

Category:	end use: built environment
Capacity:	9 - 15 residential houses
Process phase:	execution, construction
Project period:	2020 - 2025
Project costs:	unknown
Contact:	info@lochemenergie.net

Partners: LOCHEMENERGIE, alliander, remeha

H2@Home

Research of In-house Installations with Hydrogen

A consortium of companies, lead by Flamco and gAvilar, are doing research on in-house installations with hydrogen. They research a new reducer, gasmeter and behavior of in-house piping systems for gas (including house connection). Target is also to find out which measurements/safety systems are needed when using hydrogen instead of natural gas to heat residential houses and how to change over existing systems used for natural gas.

Category:	end use: built environment, knowledge
Process phase:	commissioning
Project period:	2020 - 2022
Project costs:	350k TSE subsidy
Contact:	Lianne Mostert, gAvilar Ben Mureau, Aalberts hydronic flow control

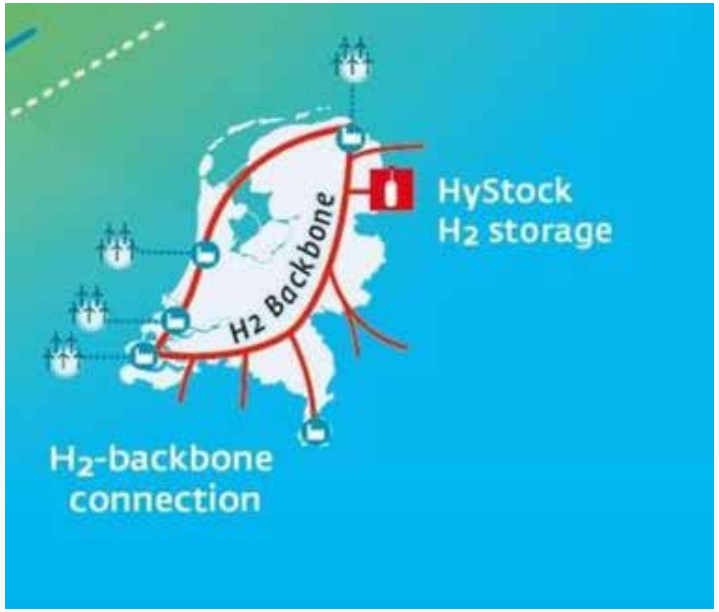
Partners: gAvilar, PIA, Beutech, Flamco, COMAP, hsf, VSH, remeha, THE GREEN VILLAGE

Hydrogen networks and partnerships

HYDROGEN NETWORKS AND PARTNERSHIPS

HyDelta Research

HyDelta Research, a Dutch national research program, aims to removing barriers towards a large-scale implementation of hydrogen in the Netherlands and in particular the safe integration of hydrogen into the existing gas transport and distribution infrastructure.



HyDelta 2

Research on Obstacles on Hydrogen Deployment

HyDelta 2 is a continuation of HyDelta 1, which is a Dutch national research programme aimed at removing barriers towards a large-scale implementation of hydrogen in the Netherlands and in particular the safe integration of hydrogen into the existing gas transport and distribution infrastructure. After completion, the aim is to start HyDelta 3, a similar program.

Category:	knowledge, research
Process phase:	execution
Project period:	01/05/ 2022 – 30/04/ 2023
Project costs:	2.3 M€
Contact:	j.garcia@newenergycoalition.org

Partners: gasunie, DNV·GL, TNO, TKI Nieuw Gas, kiwa, New Energy Coalition

HYDROGEN NETWORKS AND PARTNERSHIPS

Hydrogen Network Netherlands

- **Gasunie**; building a national network – including underground hydrogen storage - that will link up hydrogen supply and demand.
- **Hydrogen network Netherlands;** five industrial clusters will be linked to each other, to foreign countries and to hydrogen storage facilities. 85% of the hydrogen network will consist of recycled natural gas pipelines. Current plans call for the first parts of the national network to be available in 2025. These are located in the northern part of the Netherlands, and a link with northern Germany will already have been established by then. In addition, several industry clusters (in the IJmond and Rijnmond regions) are working together with local industrial players on regional hydrogen networks. Around 2025, a start will be made on connecting the regional pipelines with each other, with foreign countries and with hydrogen storage facilities, so that they become part of the national and the future European hydrogen network.

HYDROGEN NETWORKS AND PARTNERSHIPS

Hyready database

- Database on Consequences of Adding H_2 to NG Networks
- This HyReady project aims to encourage the industry to “Be ready for Hydrogen”. Practical and uniform engineering guidelines are being developed to support the introduction of hydrogen to the gas grid (from transmission systems to end-users). Results are easily available from a Wiki site.

HYDROGEN NETWORKS AND PARTNERSHIPS

Boosting Hydrogen Economy in the Euregio Meuse-Rhine

- A consortium of nine partners is joining forces to boost the development of clean hydrogen innovation, demonstration and knowledge sharing in the Euregio Meuse-Rhine, as a first step towards the large-scale roll-out of a clean hydrogen economy. The intention is to develop new hydrogen applications where it makes sense, for example in the field of transport or industrial processes. The parties involved draw up plans and visions, but also organize inspiration and demonstration sessions.

Waterstof Coalitie Limburg

IHK

parkstad limburg

pom Limburg economisch versnellen

TWEED

stadt aachen

LIOF

SPI EU

HYDROGEN NETWORKS AND PARTNERSHIPS

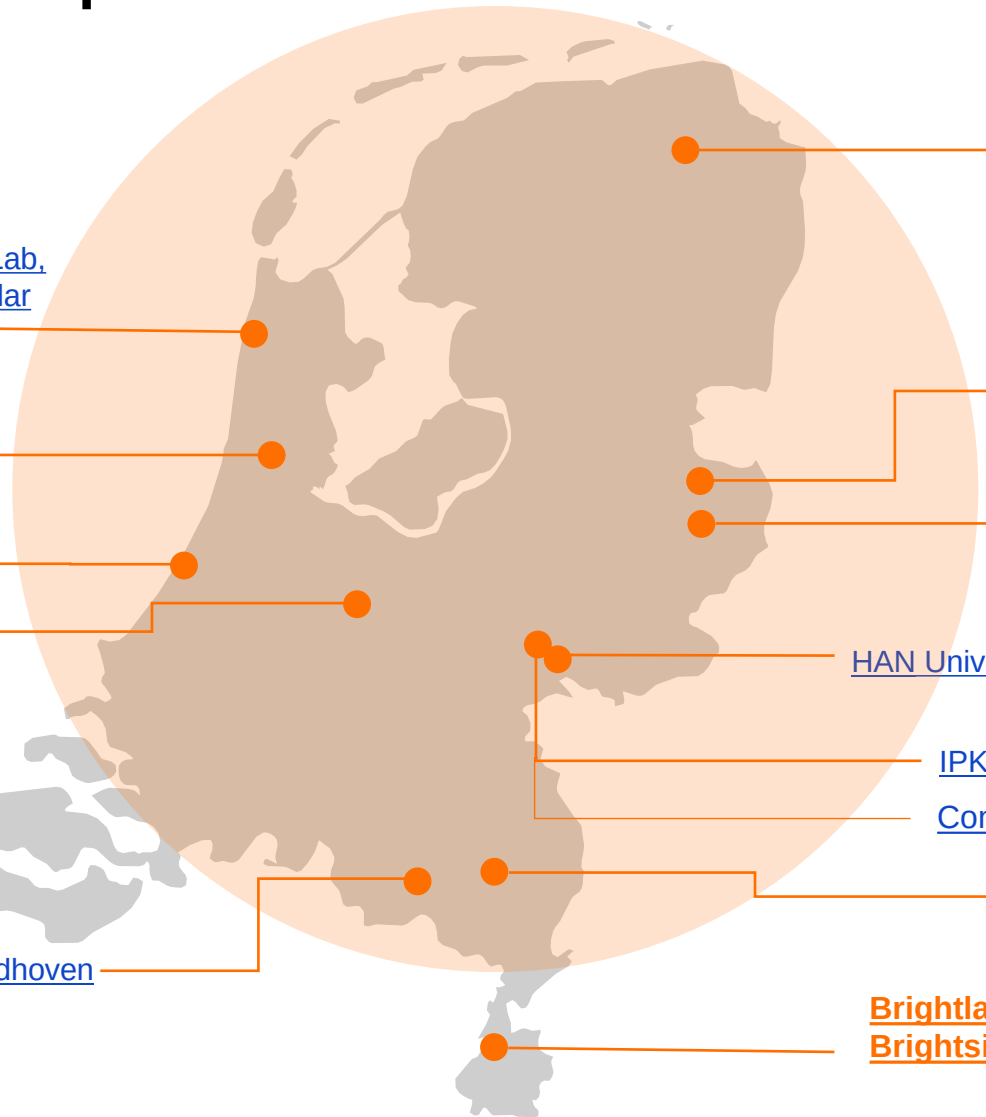
HyNorth Connecting Initiatives

HyNorth is the result of the Hydrogen North Netherlands Investment Plan from 2020. “We want to look at the dependencies between projects and identify where projects are missing that are necessary for the hydrogen ecosystem. At HyNorth, we want to join forces in the North by bringing governments, businesses and knowledge centers together. We want to connect supply and demand by seeking out collaboration. The challenge is to grow this to gigawatt scale.”

Knowledge Centers

KNOWLEDGE – HYDROGEN TECHNOLOGY

Knowledge hotspots



EnTranCe | Groningen

Energy & Health Campus (incl. TNO-Faraday Lab, Europe's largest hydrogen research facility, Solar lab, Battery lab) former ECN | Petten

H2Hub | Almelo

Centre for Electrochemistry | Amsterdam

NSCA Hydrogen Hub | Amsterdam

Fraunhofer Project Center | Enschede

Energy Initiative | Delft

KWR Water Research Institute | Nieuwegein

HAN University of Applied Sciences | Arnhem

IPKW Hydrogen Hub | Arnhem

Connectr | Arnhem

Holst Centre, part of TNO | Helmond

Institute for Renewable Energy (EIRES) | Eindhoven

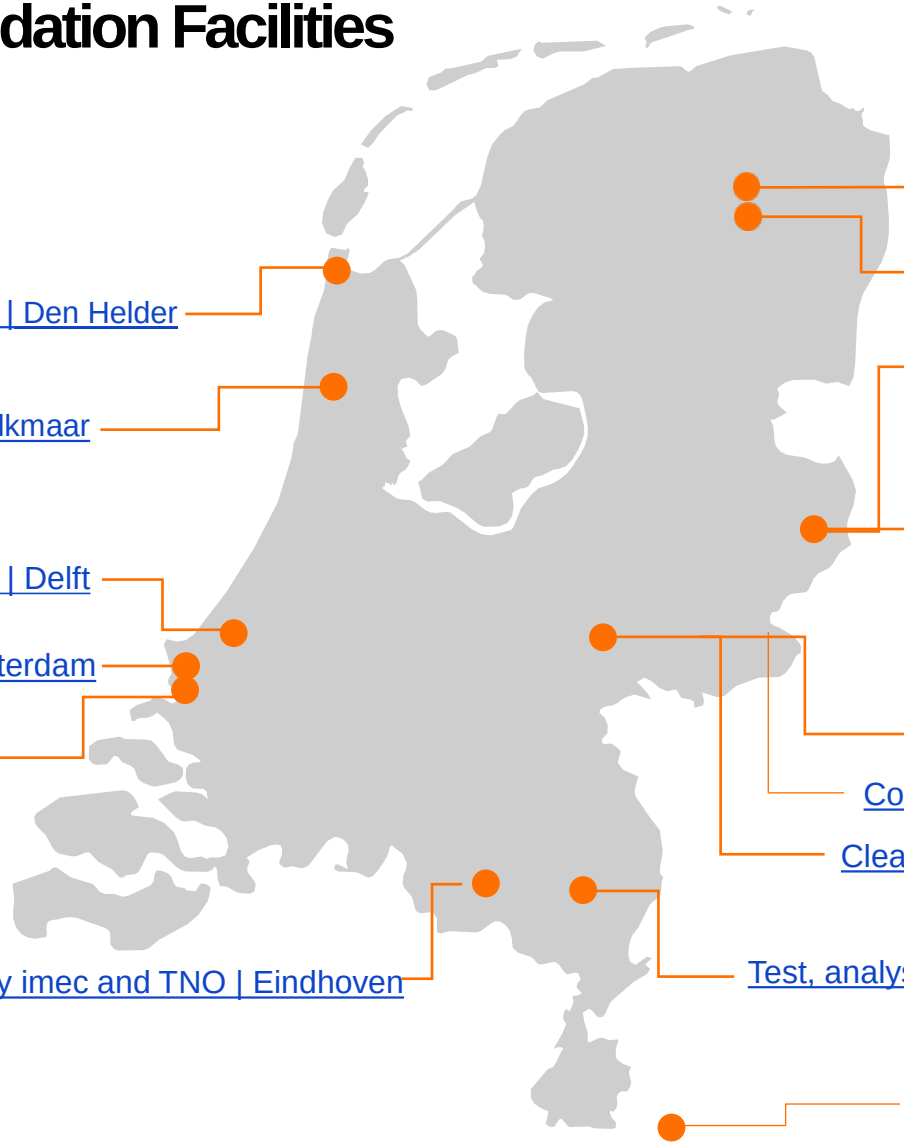
Brightlands Chemelot Campus | Geleen

Brightsite plasma lab

Lab facilities & tech hubs

KNOWLEDGE – HYDROGEN TECHNOLOGY & EV RELATED

Test & Validation Facilities



Hydrohub MegaWatt Test Center | Groningen

Hydrogen Innovation Network Groningen (WING)

Marine Energy Technologies Innovation Park | Den Helder

Advanced battery technology Centre | Enschede

Investa Biomass Gasification + Green Gas | Alkmaar

Battery safety test lab | Enschede

The Green Village | Delft

(D) Meet Munster

H2EnergyLab - RDM Centre of Expertise | Rotterdam

IPKW Living labs Arnhem

Fieldlab Industrial Electrification | Rotterdam

Connectr | Arnhem

Clean Mobility Center | Arnhem

Holst Centre - Open-Innovation by imec and TNO | Eindhoven

Test, analyse, and research – Automotive Campus | Helmond

(D) PEM Motion Aachen

KNOWLEDGE – HYDROGEN TECHNOLOGY

Hydrogen Innovation Center Groningen (NEW)

This ultramodern Center of DNV on the Zernike Campus provides a broad range of services to assure the compliance of fuels (Biogas/ Hydrogen), systems or technologies with applicable standards. This center with 80 experts delivers laboratory services with a unique and comprehensive portfolio of testing and validation capabilities, backed by strong multidisciplinary knowledge and experience in the oil and gas sector.

The technology services include:

- Performance assessment of downstream and renewable energy technologies
- Fuel interchangeability and end-use equipment testing
- Fuel composition monitoring, metering and custody transfer
- Independent innovation support and fuel technology demonstration
- Engine and combustion technology testing
- Impact assessment of new fuels on pipelines and facilities
- Fuel (re)loading and conditioning
- Technology integration support and optimization.

Talent

FINDING YOUR FUTURE EMPLOYEES

Availability of talent

Universities all over the country offer education related to the development of hydrogen technology. Some examples are:

- Almelo: H2 Hub Twente
- Amsterdam: Van 't Hoff Institute for Molecular Sciences
- Arnhem*:* Electrical and Electronic Engineering
- Arnhem: Energy innovation – CONNECTR
- Arnhem: HAN H2Lab
- Delft: Sustainable Hydrogen Electrical Energy
- Eindhoven: Sustainable Energy Technology
- Rotterdam: Erasmus University Rotterdam
- Eindhoven: Electrical and Electronic Engineering
- Enschede: Inorganic Materials Science (IMS)
- Enschede: Faculty of Engineering Technology (ET)
- Groningen: Zernike Institute for Advanced Materials
- Groningen: Centre of Expertise Energie
- Groningen: EnTranCe | Centre of Expertise Energy – Hanze
- Utrecht: Materials Chemistry and Catalysis
- Maastricht Faculty of Science and Engineering Plasma Physics
- Aachen (D) University Aachen: Center for Sustainable Hydrogen Systems
- Munster (D): Ludwig-Maximilians-Universität München

Fiscal Climate & Incentives

VARIETY OF NATIONAL INCENTIVES: TAX BREAKS

Innovation box

Effective tax rate of only 9% for R&D income

- Companies can benefit from an effective tax rate of only 9% for R&D income from patented and unpatented intangible assets which:
  - have been developed by the taxpayer, and;
  - for which an R&D statement (“WBSO verklaring") has been obtained

The main features of the Innovation Box

- The lower tax rate of 9% is claimed in the corporate income tax return filed by the taxpayer. The effective tax rate is achieved by using the following formula: 9/25 (regular corporate income tax rate) of the total amount of net earnings stemming from the intangible asset that has been allocated to the innovation box is recognized as taxable profit which is taxed at the regular corporate income tax rate.
- Losses/expenses incurred in respect of intangible assets to which the innovation box applies are deductible at the normal tax rate of 15%- 25%, i.e., the innovation box will only apply after recovery of those losses and expenses at the regular rate.
- There is a restriction with respect to the level of income that can be allocated to the innovation box (“modified nexus” approach). Relevant is whether R&D will be performed in-house or not, and how R&D costs are divided between related parties. This implies that the more R&D activities are outsourced to related parties, the less profits can be allocated to the intangible assets resulting from such R&D activities.
- To make the innovation box more accessible and appealing to SMEs, a flat-rate regulation is introduced. On request, 25% of the profit will be designated as Innovation Box benefits, whereby the flat rate will be capped at € 25,000. A company may decide on an annual basis whether or not to apply the flat-rate regime.
- The application of the Innovation Box is optional.

VARIETY OF NATIONAL INCENTIVES: TAX BREAKS AND INVESTMENT FUND

Selection of additional national incentives and initiatives

- The **WBSO** is a tax incentive scheme that offers compensation for part of a company's research and development (R&D) wage costs, other costs, and expenditures.

- The **Energy Investment Allowance (EIA)** is a tax incentive intended for companies that invest in energy-saving installations, or that make use of sustainable energy; they can deduct 45.5% of the invested sum from their taxable profits from the year in which the goods are purchased.

- The **MIA scheme** is a tax incentive that allows companies to deduct up to 36% of the cost of an environmentally friendly investment from the fiscal profit on the regular depreciation.

- The **Vamil scheme** is a tax incentive that lets a company decide for itself when to write off the investment costs. This provides an advantage in liquidity and interest.

- The **Offsetting job-related investment reduction (BIK)** is an investment discount introduced because of the Corona crisis. It enables you to, under certain conditions, offset part of your investments against your payroll taxes. *NB: The EC has yet to approve this measure.*

- **InvestNL**: an investment fund with the Dutch government as 100% shareholder, financing companies that make the Netherlands more sustainable and innovative. With an equity capital of €1.7 billion, its initial focus is on energy transition and innovative fast-growing companies (scale-ups).

HYDROGEN IN THE NETHERLANDS

The Netherlands as a partner in Europe

- Dutch initiatives are **closely aligned with European partners and EU-wide innovation programs**.

- Examples include:
  - **Horizon Europe**, an ambitious program and 100 billion Euro investment fund, with which the European Commission and member states seek to boost Europe's global competitiveness. Hydrogen is a prominent topic in this program, which includes the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), a public-private collaboration aimed at boosting research, technological development and demonstration projects.
  - The **largest project to receive funding from the EU's Connecting Europe Facility (EU-CEF) program** is a Dutch initiative: TSO 2020. This project is aimed at developing a cross-border energy network in which surplus renewable energy from Germany and North Sea wind farms is converted into hydrogen in the Netherlands, which is then distributed to Dutch and German consumers.

Business Community & Support

INVEST IN HOLLAND NETWORK

We roll out the orange carpet

Invest in Holland is the national network of the Netherlands Foreign Investment Agency (NFIA), an operational unit of the *Dutch Ministry of Economic Affairs and Climate Policy*, and our regional and local partners. Together we support foreign companies to set up and expand their business in the Netherlands.

We connect you
with local networks, regulators, clusters and consultants.

We inform you
about incentives, business locations, regulations and procedures.

We organize
custom-made fact finding trips for your investment project.

We provide
confidential and free support.

INVEST IN HOLLAND NETWORK

We welcome you!

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