Green Hydrogen State of the Nation Report

Belgium

A report highlighting the Status and Development of the Green Hydrogen Sector in the clusters of Belgium, the UK, Germany and the Netherlands.

Contents

1. INTRODUCTION 3

ABOUT INN2POWER 3

ABOUT THE AUTHORS 3

2. DEFINING GREEN HYDROGEN 5

THE RAINBOW OF HYDROGEN PRODUCTION 5

DEFINING GREEN HYDROGEN ACROSS THE NORTH SEA REGION 6

3. THE GREEN HYDROGEN POLICY LANDSCAPE 7

NATIONAL POLICY LANDSCAPE 7

REGIONAL / CLUSTER POLICY LANDSCAPE 10

4. THE GREEN HYDROGEN DEVELOPMENT PIPELINE 15

NATIONAL DEVELOPMENT PIPELINE 15

REGIONAL / CLUSTER DEVELOPMENT PIPELINE 17

5. DEVELOPING A HYDROGEN NETWORK 21

FLANDERS 21

CLUSTER TWEED – WALLOON-BRUSSELS HYDROGEN ECOSYSTEM 24

CONSULTING WITH THE INDUSTRY 26

6. CHALLENGES AND OPPORTUNITIES OF THE GREEN HYDROGEN SECTOR 27

OPPORTUNITIES 27

CHALLENGES 27

7. BARRIERS AND OPPORTUNITIES FOR INNOVATION 30

8. CONCLUSIONS 32

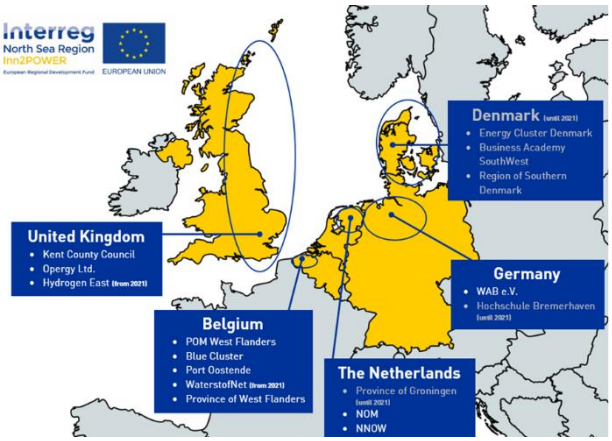
1. Introduction

Belgium has a unique ecosystem in the field of hydrogen with knowledge and expertise about the entire hydrogen value chain. This concerns both the industrial sector and research institutes.

This status report gives a state of affairs of the hydrogen landscape in Belgium, in particular in relation the green hydrogen policy landscape, the status of green hydrogen projects & developments, the existing hydrogen industrial clusters and the challenges and opportunities there are in Belgium in the field of green hydrogen.

About Inn2POWER

This Inn2POWER project brings together the forces of nine partners in four countries in the North Sea region (NSR): the UK, Belgium, the Netherlands, and Germany. The aim is to expand the capacity for innovation and improve access to the offshore wind industry and green hydrogen for SMEs through connecting offshore wind and green hydrogen businesses in the NSR.



The overriding vision of Inn2POWER is to strengthen the North Sea Regions through supporting SMEs to collaborate and enter new markets through Inn2POWER's company directly, focusing on offshore wind and green hydrogen; grant easy access to test and demonstration facilities; and to improve knowledge, skills and availability of qualified staff.

About the Authors

The country report for Belgium was drafted by WaterstofNet, a hydrogen knowledge and collaboration platform that aims to contribute to a carbon-neutral society by supporting and realising hydrogen projects in Flanders and the Netherlands. Together with the industrial sector and the governments, we enable concrete achievements in the field, laying the basis for further collaboration. By doing so, we assist in the further development of Flanders and the Netherlands as frontrunners in the field of green hydrogen. An overview of all achievements and running projects can be found on the WaterstofNet website[1].

WaterstofNet coordinates the Waterstof Industrie Cluster ("Hydrogen Industry Cluster"), an industrial collaborative partnership, uniting companies, knowledge institutions,

[1] www.waterstofnet.eu

governments and authorities that want to collaborate on projects involving green hydrogen as a storage medium for renewable energy and its use for zero-emission mobility, heat or industrial applications. The cluster encourages collaboration, but also initiates and facilitates possible hydrogen projects. It aims to establish itself as a representative spokesperson and point of contact for policy relating to hydrogen. With "hydrogen" we mean only green or low carbon (blue) hydrogen. WaterstofNet does not promote the production or use of grey hydrogen.

The cluster was initially (2016) formed by a group of approximately 20 companies. At present, there are over 100 companies in the cluster, with new members regularly joining. The members can be situated along the entire hydrogen value chain. They include organisations involved in the production of green energy, the production of hydrogen, the transport and storage of hydrogen, companies active in hydrogen technology and applications development and potential end-users of hydrogen. Members are located in or have hydrogen related activities in the Benelux region.

Regarding contacts with policy makers, WaterstofNet has its focus mostly on the Flemish and Belgian federal level. For the Walloon part of Belgium, WaterstofNet collaborates with cluster Tweed that has a strong link with the Walloon authorities and has also a workforce on hydrogen[2]. In the Netherlands there are several direct links with policy makers and partnership with the H2Platform.

Besides the drafting work by WaterstofNet, the report was also verified and completed by the Blauwe Cluster. At the end of 2017, Colruyt, DEME, Econopolis, INVE, Jan De Nul, Sioen Industries, Tractebel Engineering, Vanbreda Risk & Benefits, Vyncke and ZERI set up the non-profit association Blauwe Cluster. The goal was to set up improved, cross-sector partnerships and closer collaboration between knowledge centres and government institutions in order to encourage new investments and realise innovative projects in the Belgian part of the North Sea and beyond[3].

The Blauwe Cluster ("Blue Cluster") today is a network of companies active in the sustainable blue economy and is recognised as a Flemish "spearhead cluster" since 2018. It has around 200 members, of which about 140 are active in the field of offshore renewable energy. In their role they are of course in the ideal position to make the link between offshore wind energy and green hydrogen production, exactly the objective of the Inn2Power project.

[2] https://clusters.wallonie.be/tweed/fr/ecosystemes

[3] Geschiedenis | De Blauwe Cluster.

2. Defining Green Hydrogen

National Hydrogen strategy: long term focus: green, blue as transition technology
Hydrogen is not an independent energy vector; it is always paired with or dependant on another technology to produce the power for hydrogen production. For this report, and the Inn2POWER project, we will focus on the developing 'Green Hydrogen' Sector across the North Sea Region (NSR). This chapter defines what is meant by this definition.

The Rainbow of Hydrogen Production

The source of power used to drive the process of Hydrogen Production is commonly referred to as colours. The term 'Green Hydrogen' has become commonly used to describe Hydrogen Production powered by low-carbon and renewable sources of power. The following table summarises the general definitions of Green Hydrogen as compared to other types of Hydrogen Production.

Colour	Process	Impact
Green Hydrogen	Electrolysis, using renewable energy (wind, solar etc.) to split water into its component parts (H2 + O2).	No carbon emissions, ability to "store" surplus electricity from renewable sources.
Yellow Hydrogen	As above, using nuclear power instead of renewable energy.	Low carbon emissions, ability to "store" surplus electricity.
Brown Hydrogen	Gasification, using coal/biomass/waste to heat water and break it down. Also known as "town gas".	Along with the component parts of water, other harmful elements are produced: carbon dioxide (CO2), carbon monoxide (CO), methane (CH4), and ethylene (C2H4).
Grey Hydrogen	Steam Methane Reforming (SMR), using methane to heat water and break it down.	As above, produces other harmful elements: CH4 and CO2.
Blue Hydrogen	SMR and carbon capture, use and storage (CCUS).	Grey hydrogen but with carbon capture so it is seen as a lower carbon option.
Turquoise Hydrogen	Using Molten Metal Pyrolysis, natural gas is passed through a molten metal that releases hydrogen and solid carbon.	Solid carbon can be used for industrial applications, so it is seen as a lower carbon option.

Defining Green Hydrogen Across the North Sea Region

More specifically, Green Hydrogen has been defined at the European level in the EU's Hydrogen Strategy; A case for urgent action towards implementation published in July 2020. This defines green hydrogen as follows:

"*hydrogen produced through the electrolysis of water (in an electrolyser, powered by electricity), and with the electricity stemming from renewable sources. The full life-cycle greenhouse gas emissions of the production of renewable hydrogen are close to zero. Renewable hydrogen may also be produced through the reforming of biogas (instead of natural gas) or biochemical conversion of biomass, if in compliance with sustainability requirements".*

Across the other countries in Europe, definitions are outlined across strategy and policy documents published by each nation.

The Belgian Federal Hydrogen strategy indicates that "*the application of a hydrogen technology in the long term only makes sense if the hydrogen is produced from renewable energy sources*" and that by 2050 "*only renewable hydrogen will get a place in the final energy mix*"[4]. The federal strategy identifies two renewable energy sources to produce this renewable hydrogen: renewable electricity and biogas or biomethane. **This definition is thus in line with the EU definition.** However, the federal hydrogen strategy does recognise that **decarbonised hydrogen** ("low carbon hydrogen"/"blue hydrogen) **will play a role** in reducing CO2 emissions faster and in getting the market going.

As a federal state, Belgium also has regional hydrogen strategies with their own specific focus. For example, the Flemish government presented its Flemish Hydrogen Vision on 13 November 2020. Just like the Federal strategy, the Flemish strategy explains in its introduction the difference between the different types or colours of hydrogen. On green hydrogen it says that it "*is produced from renewable energy (e.g., through electrolysis of water with renewable electricity)*".[5] The Walloon government is still working on its regional hydrogen strategy.

In general it can be stated that **Belgium will follow and accept the EU definitions concerning different types of hydrogen, including green hydrogen**.

[4] Belgian Federal Hydrogen Strategy, View-strategy-hydrogen.pdf (fgov.be), p 12.
[5] Flemish Hydrogen Vision, Beslissingen van de Vlaamse Regering | Vlaanderen.be, p. 3.

3. The Green Hydrogen Policy Landscape

As already briefly indicated under section 2, Belgium is a complex federal state composed of various communities and regions. This complex state structure is accompanied by a **complicated division of competences** between the federal and regional governments. This also applies to energy policy and, consequently, to everything related to hydrogen.

Given the fact that (green) hydrogen is a relative new topic on the policy stage, there is **currently still a lot of discussion between the federal and regional levels about who is competent** for which part of the hydrogen value chain. In general terms we can state that the **federal level is competent to develop the infrastructure**, like a hydrogen backbone, that is necessary to develop a hydrogen ecosystem in Belgium. The three regions have their focus on the production, consumption and trade of hydrogen. Nonetheless, below we provide the best possible overview of what the hydrogen policy stage currently looks like using the **Federal and Flemish hydrogen strategies as our two main guiding instruments**.

In addition to the official policy documents, two **industrial cluster visions**[6] were also written in Flanders and Wallonia by the respective industrial clusters in those regions: the Waterstof Industrie Cluster (WIC) in Flanders and the Cluster TWEED in Wallonia.

National Policy Landscape

The Belgian federal hydrogen strategy[7] aims to prepare Belgium for the climate challenges, alongside the technological and economic challenges of the coming decades. The federal strategy is based on **4 pillars**:

Pillar 1: Positioning Belgium as an import and transit hub of renewable molecules in Europe

Due to its limited surface area and the high demand for energy and materials, Belgium will have to count on a large-scale import of renewable molecules from other European countries and especially also third countries. **The import of renewable molecules for Belgium will amount to between 3 and 6 TWh in 2030 and between 100 and 165 TWh in 2050, in order to satisfy domestic demand**. In addition, Belgium is ideally situated to supply Western Europe with renewable molecules and to position itself as an **import and transit hub**, as is currently the case for natural gas and electricity. **As a result, our demand for import may even double.**

[6] Hydrogen Strategy for Wallonia, Roadmap hydrogène pour la Wallonie - cluster TWEED (slideshare.net) & WIC Hydrogen Strategy, A Flemish Hydrogen Strategy (waterstofnet.eu).
[7] Belgian Federal Hydrogen Strategy, View-strategy-hydrogen.pdf (fgov.be).

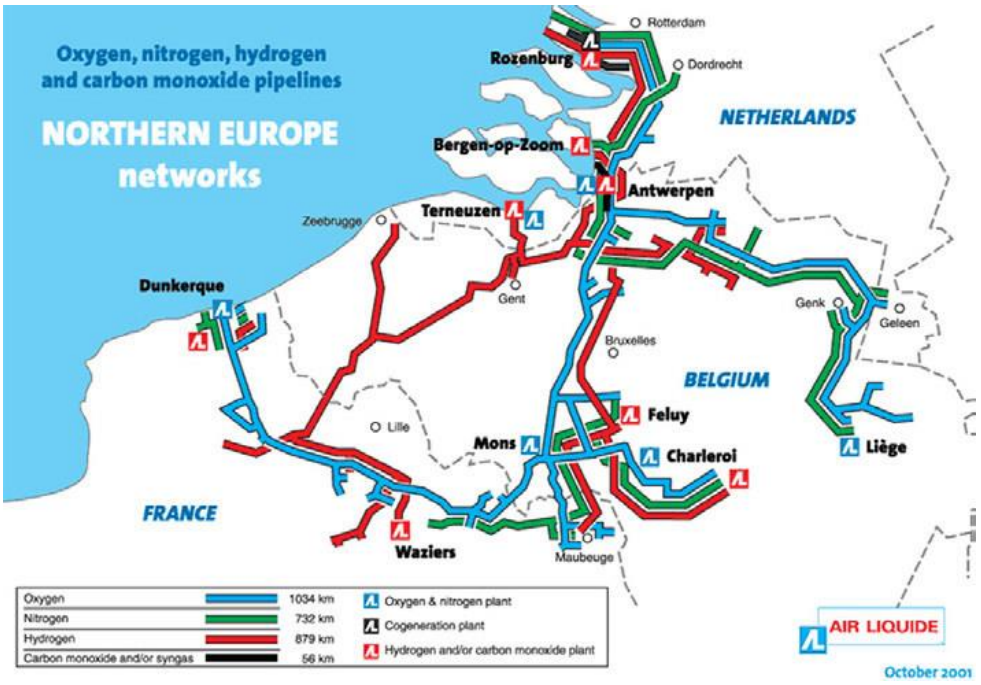
Pillar 2: Consolidating Belgian leadership in hydrogen technologies

Belgian companies and research institutes already have a leading position in this hydrogen market and notwithstanding the fact that the domestic production of hydrogen will remain limited, the **federal government wants to strengthen this pioneer role in hydrogen technology even further**. Together with the regions, the federal government supports industrial companies in their future-oriented innovations

Various studies on and visions of the electrolysis capacity that is needed in Belgium exist. Given the focus on import, this local production capacity will always remain limited and the emphasis will mainly be put on innovation and technological development. Developing this electrolysis technology is nonetheless necessary, both to gain expertise in the working of these units and to support the technological development of the Belgian companies. **This is why Belgium has set itself the target within the national Recovery and Resilience plan of having at least 150 MW of electrolysis capacity into operation by 2026[8].**

Pillar 3: Organising a robust hydrogen market

A hydrogen transport network by pipeline of 613 kilometres **is already present on the Belgian territory**. It has been developed by a private player to supply various industrial customers spread across Belgium, France and the Netherlands. In Belgium, it connects the regions of Zeebrugge, Ghent, Antwerp and Charleroi as illustrated in light blue on Figure 1b.



[8] Belgian Recovery and Resilience plan, NL - Nationaal plan voor herstel een veerkracht_1.pdf (belgium.be), p. 95.

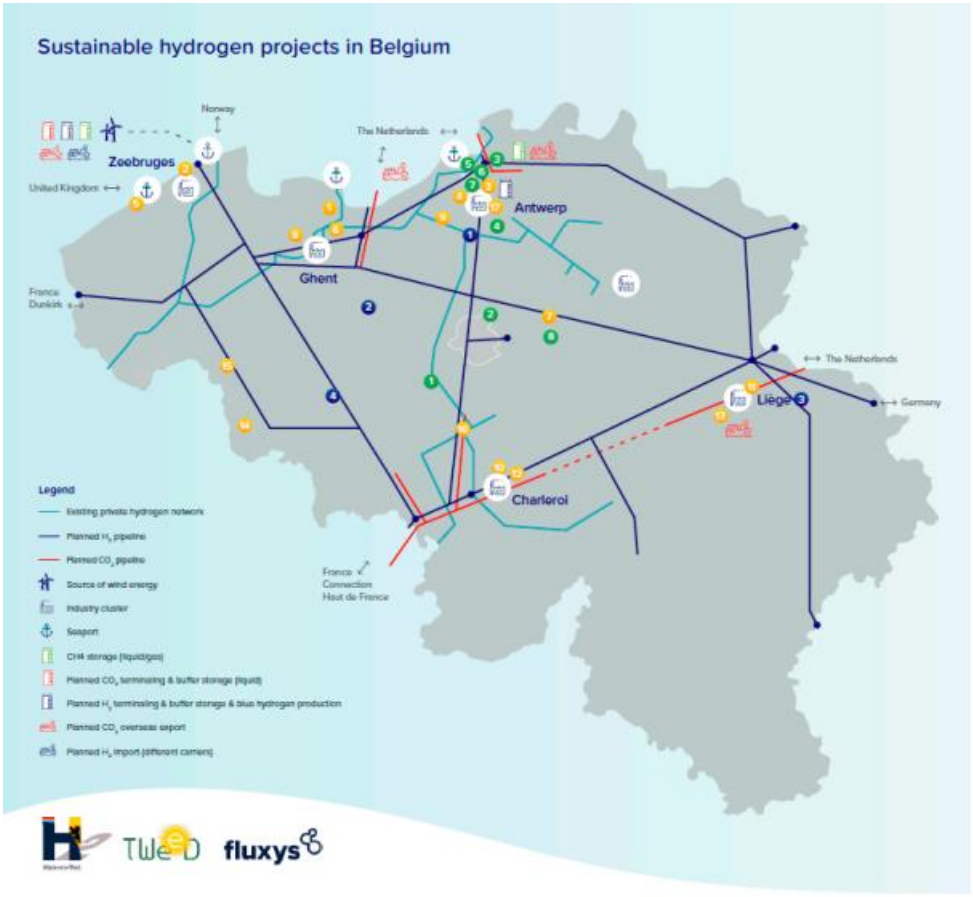


Figure 1a and 1b: existing and future hydrogen pipelines in Belgium

However, many industrial clusters are further away from this infrastructure, although they could also benefit from the development of this molecule to make their activities more sustainable. This is why the federal hydrogen strategy envisages **by 2026 the commissioning of 100 to 160 km of the first open-access hydrogen transport pipelines to complete the existing network**, co-funded by Belgium's national recovery and resilience plan. By 2030, Belgium has the ambition to connect the import hub to neighbouring countries via the open-access hydrogen network in order to realise its international positioning as an import and transit hub for renewable energy in Europe. The development of this hydrogen backbone is discussed in more detail under section 4.

Pillar 4: Investing in cooperation

The first three pillars presented hereabove have highlighted the hydrogen ambitions as well as the provided means and the envisaged measures to achieve them. **The federal government will not be able to achieve these goals alone: sufficient and effective collaboration at all levels will have to be implemented to ensure the success of this strategy.** Therefore structural consultation will be implemented non only at the Belgian level (with the regions), but European cooperation is also required.

Regional / Cluster Policy Landscape

Under this section we make the distinction between the Flemish (1) and the Walloon (2) hydrogen policy landscapes. In each sub section we distinguish between governmental hydrogen strategies (A) and the respective industrial cluster strategies (B).

1. **Flanders**
   A. Flemish Hydrogen Vision

In the Flemish coalition agreement 2019-2024, the Flemish government has included a strong Flemish ambition for hydrogen:

"We continue to invest in research and development into sustainable energy and climate solutions. Our ambition in this respect is to become a European leader in, among other things, hydrogen.[9]"

It therefore reinforced this ambition in November 2020 by publishing a Flemish Hydrogen Vision.[10] This note describes the vision and strategy of the Flemish Government to become a leader in the field of hydrogen. The Flemish Hydrogen vision **does not contain any concrete targets or numbers**.

The Flemish hydrogen vision is **twofold**. First and foremost, Flanders wants to realize the **necessary technological breakthroughs** in the broad field of hydrogen technology with the help of research and innovation. In this way it wants to further develop and strengthen the Flemish industrial hydrogen ecosystem in order to position itself optimally in the European and worldwide growing value chain of hydrogen technology. Secondly, the Flemish government wants to **propagate this ambition across the Flemish policy domains** (energy, industrial policy, mobility) and start the conversation with relevant public and private stakeholders to see whether other legislative initiatives would be useful to further strengthen and roll out the Flemish hydrogen ecosystem.

To achieve this vision, the document identifies **five Strategic Objectives (SOs)** :

SO 1: Strengthening the Flemish research base in the field of hydrogen

A strong research base is important because it can provide longer-term solutions to technological challenges in the hydrogen domain. Work will therefore be done in Flanders to draw up a **research agenda** in the field of hydrogen technology. In addition to the **generic Flemish research channels**, they plan to make extra resources available for a **specific impulse program** to realise the research agenda of hydrogen.

[9] Flemish Coalition Agreement, Vlaamse regering 2019-2024, regeerakkoord (vlaanderen.be), p. 145.
[10] Flemish Hydrogen Vision, Beslissingen van de Vlaamse Regering | Vlaanderen.be.

In addition, as part of the Flemish industrial transition, there is also the **Moonshot program** (launched in 2019), a future-oriented industrial innovation program that aims to achieve a CO2-neutral industry by 2050. A Flemish study[11] identified a whole range of future research challenges in the field of hydrogen as a means of making that industry CO2-neutral. Besides the Flemish resources for research, **European funding opportunities** will also be used to the fullest to support the research and development in Flanders of new technology

SO 2: Strengthening the Flemish industrial ecosystem

The Flemish industrial ecosystem in hydrogen technology includes in the first place the **technology companies that can offer technology for the production, transport, storage, applications and end-use of hydrogen** in their own country, but which can also be strengthened with a view to gaining more market share in a growing worldwide market, resulting in sustainable jobs and a lasting recovery of the Flemish economy. Flanders is also thinking of the strategic production of the technologies themselves, which it prefers to keep on her own territory.

The goal is to **strengthen the technological supply side** through the use of existing instruments, improvement of these instruments, use of the new opportunities offered by European initiatives, and the optimal combination of Flemish and European funding channels. Concerning this last point, Flanders is participating in the **IPCEI hydrogen**, via refundable advances or via participation in risk capital with the Flemish venture capital company.

Furthermore, the Flemish government supports WaterstofNet to take on a **facilitating role in order to give maximum support to Flemish companies with project applications and consortium formation in European funding programmes** (such as the Clean Hydrogen Partnership in Horizon Europe)

SO 3: Stimulating the use of hydrogen (H2) and the application of H2 technologies

In addition to the technology providers, there is the group of Flemish production companies that use hydrogen, especially in production of steel and chemicals, but also to use hydrogen in transport applications and the built environment. Although all phases of innovation can be supported by the Flanders' government**, the emphasis will lie on pilot and demonstration projects, as well as first industrial realisations.**

[11] Towards a carbon-circular and low-carbon Flemish industry Context analysis and roadmap study: Publication for the general public, Samenvatting_roadmapstudie-contextanalyse.pdf (moonshotflanders.be).

In particular, the **hydrogen IPCEI** (Important Project of Common European Interest) **call,** which Europe launched in 2020, allows Member States to fund stages of the journey that go beyond what is usually accepted in the state aid rules. Flanders **selected 10 hydrogen projects for an IPCEI notification**, like projects on production of green hydrogen from renewable energy or the use of hydrogen to convert CO2 to sustainable fuels. The Flemish Government is providing **€ 106.3 million to support the first five projects**. The Flemish hydrogen vision gives a summary of these five projects.[12]

SO 4: Internationalization with a focus on the neighbouring countries

In the hydrogen landscape, Flanders is part of a larger international and European movement. This international movement **must be an integral part of the federal approach**. The aim is to achieve sufficient scale through international cooperation, and in particular with the European neighbours. This will be achieved through various actions like cross-border projects.

Partly through these projects, Flanders wants to enhance **international cooperation with neighbouring countries/regions** (the Netherlands, Germany, etc.) with regard to both policy formulation and investment opportunities. This includes the further development of innovation cooperation with the Netherlands to seize the opportunities of a cross-border ecosystem. Furthermore, Flanders also stimulates economic cooperation across the borders, for instance in the area of the exchange of residual flows and infrastructure (an example is the cooperation between ArcelorMittal and Dow Terneuzen in the Smart Delta region). Just like the federal government, Flanders will **also examine whether it can play a role in the long run in a European hydrogen network**, in which the Flemish network to be established can be integrated in due course. In any case, **studies and initiatives on hydrogen import will be followed up and supported**.

SO 5: Flanking policy to stimulate and support

Besides the focus on innovation and research to support hydrogen technology, Flanders also has the intention to **really roll out hydrogen in our Flemish ecosystem**. After all, hydrogen has a broad field of application, which means that different policy competences have to be addressed. That is why Flanders is looking into whether they can deploy other policy instruments to support this. For example, they are discussing the revenues from the kilometre charge for trucks, **which can be used for ecological investments for heavy transport applications** (trucks, buses, forklifts and waste collection trucks running on hydrogen or methanol). Another important challenge that Flanders wants to tackle is the further implementation and **roll-out of a smart hydrogen (tank) infrastructure**.

In addition, the Flemish government will also take the initiative to start discussions with the **relevant research institutions and public and private stakeholders to identify the**

[12] Flemish Hydrogen Vision, Beslissingen van de Vlaamse Regering | Vlaanderen.be, p. 13-15.

obstacles in the legislative and regulatory framework for the further roll-out of hydrogen technology. This Flemish hydrogen vision should therefore be seen as a starting document on which to build further with the relevant Flemish industrial and research world.

Finally, Flanders intends to keep an eye on the relevant federal and **European legislation** on hydrogen. Cooperation at the Belgian level takes place, for example, in the ENOVER Hydrogen working group with representatives of the federal and regional energy administrations. **The Flemish authorities suggest here to start a specific consultative body with the federal government** in order to be able to harmonise the various legislative optimisations concerning hydrogen.

B. Waterstof Industrie Cluster (WIC) – Flemish WIC Hydrogen Strategy

Besides the governmental hydrogen vision discussed above, a bottom-up strategy from the Flemish industry- coordinated by WaterstofNet within the framework of the Waterstof Industrie Cluster (WIC) has been submitted to the government[13].

The WIC Hydrogen Strategy **formulates objectives for all parts of the hydrogen chain,** from production and import of hydrogen, via transport and distribution, to concrete end-use applications. The WIC prioritises use in a number of industrial sectors and in heavy transport, and to a more limited extent in the built environment. Later, hydrogen will also be used for power generation and grid flexibility. You can find a **schematic overview** of all targets that the industry cluster identified for 2030 below:

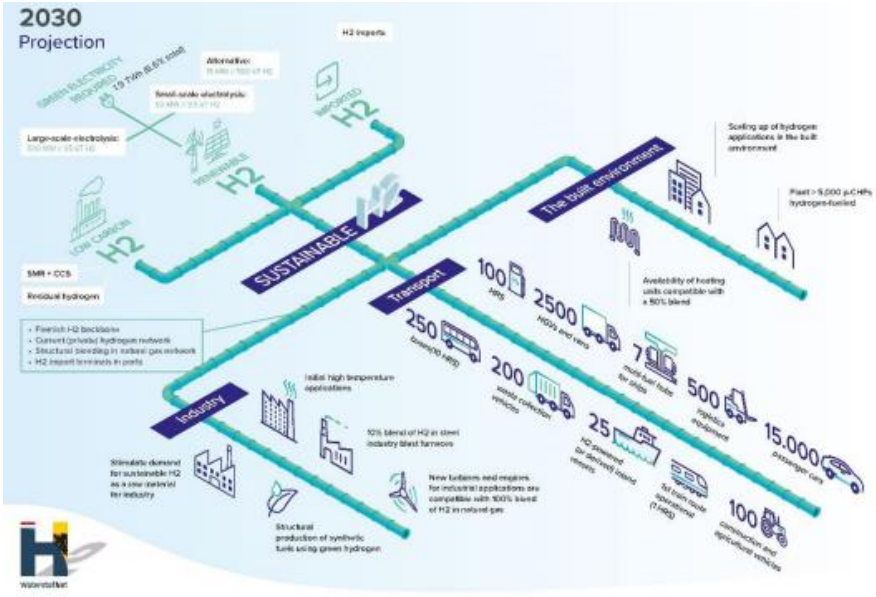


Figure 2: Targets for 2030 identified by the Waterstof Industrie Cluster

[13] WIC Hydrogen Strategy, A Flemish Hydrogen Strategy (waterstofnet.eu).

2. Wallonia

A. Walloon Hydrogen Strategy

As already was indicated above, the Walloon government is **still working on its regional hydrogen strategy**. The Walloon strategy is expected to come out at the earliest by the end of 2022. As a result, there are **no official targets for 2030 or 2050 yet for Wallonia**.

B. Cluster Tweed- Hydrogen Roadmap

However, just like in Flanders, also Wallonia has an **industrial cluster** who has developed a vision document on hydrogen. The mission of the Cluster TWEED is to pave the way for the setting up of high quality and industrial-size projects in the fields of production and exploitation of sustainable energy. The Cluster animates six different ecosystems, of which a club dedicated to hydrogen called the "**H2Hub Wallonia**".

Cluster Tweed has drafted a Walloon Hydrogen Roadmap ("H2 Roadmap pour la Wallonie") in 2018.[14] This study, validated by the Walloon industry, analyses in particular the role of hydrogen in the region by 2030 and 2050. You can find a **schematic overview** of Cluster Tweed's findings below:

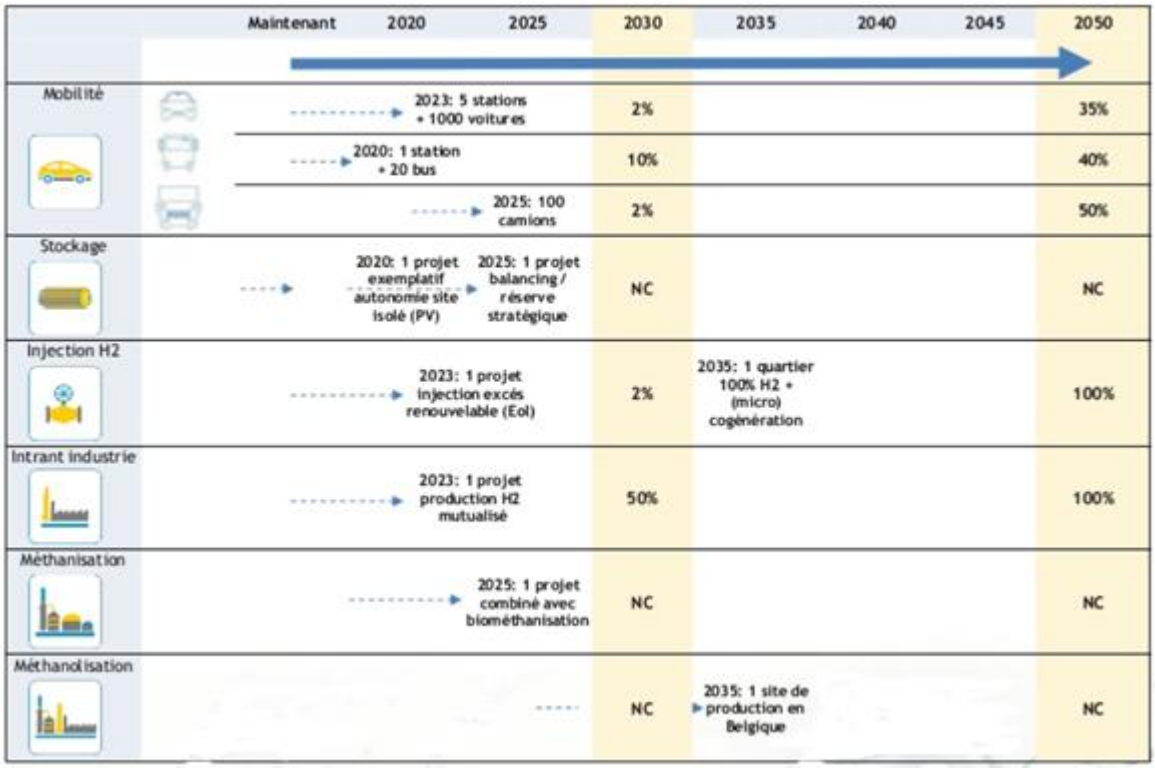


Figure 3: Targets for 2030 and 2050 identified by Cluster TWEED

[14] Hydrogen Strategy for Wallonia, Roadmap hydrogène pour la Wallonie - cluster TWEED (slideshare.net).

4. The Green Hydrogen Development Pipeline

As already discussed under section 3, Belgium is a complex country with often an unclear distribution of competences. In general we can say that the development of a **Belgian hydrogen backbone is a federal matter**, as is everything that is related to offshore wind. Projects related to other hydrogen topics (like production and use of hydrogen) will be discussed under the regional subtopic of this section.

National Development Pipeline

In order to develop a structural hydrogen economy, Belgium needs an open-access infrastructure that connects to future sustainable green production facilities and import scenarios. **Two (complementary) avenues** are being explored: the **conversion of existing natural gas pipelines and the construction of a new infrastructure**.

In 2021, Fluxys (national TSO for natural gas) developed a roll-out scenario for hydrogen and CO2 infrastructure[15]. In doing so, Fluxys distinguishes **two phases**:

Phase 1: Short-term options towards first minimum decarbonisation infrastructure

This phase focuses on:

- Development starting from industrial clusters
- Mix of reused natural gas pipelines and new infrastructure
- Progressive development of connections between clusters: enabling transfers, increasing security of supply and flexibility
- Development of interconnections with neighbouring grids
- Further development of Zeebrugge's role as an energy entry gateway

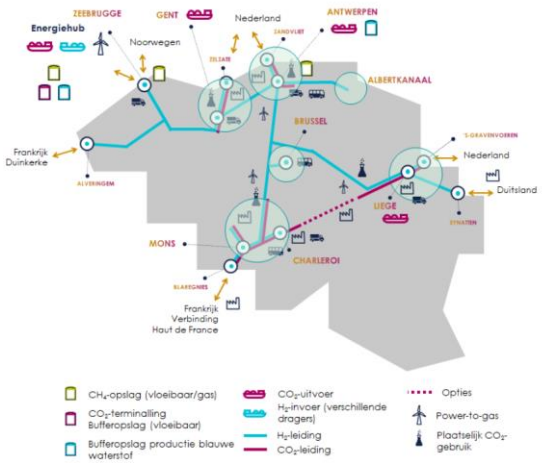


Figure 4: Short-term options towards first minimum decarbonisation infrastructure

[15] Shaping the hydrogen and carbon infrastructure for Belgium, Shaping the hydrogen and carbon infrastructure for Belgium (fluxys.com).

The investment costs for this phase are estimated at around 1.1 billion euros.[16]

A first minimum infrastructure for decarbonisation is being created from the **industrial clusters** of Antwerp, Ghent, the Albert Canal, Zeebrugge, Brussels, Charleroi/Bergen and Liège. For the port of Antwerp, a local backbone is estimated at 30 km. In North Sea Port, it was considered that a number of chemical companies could be connected via a 65 km hydrogen pipeline network (partly in the Netherlands). In the port of Zeebrugge, a local network of 15 - 25 km would be constructed.

These local pipelines would then be interconnected, using a mix of repurposed natural gas pipelines and new infrastructure. A connection between Zeebrugge, North Sea Port and the port of Antwerp is estimated to be around 100 km.

Phase 2: Long-term step-by-step development towards a fully carbon-neutral grid

This phase focuses on :

- Additional interconnections between clusters for more flexibility
- Additional interconnections with neighbouring grids for security of supply and access to a large market
- Import of remotely produced green hydrogen through the Zeebrugge terminal as an energy hub

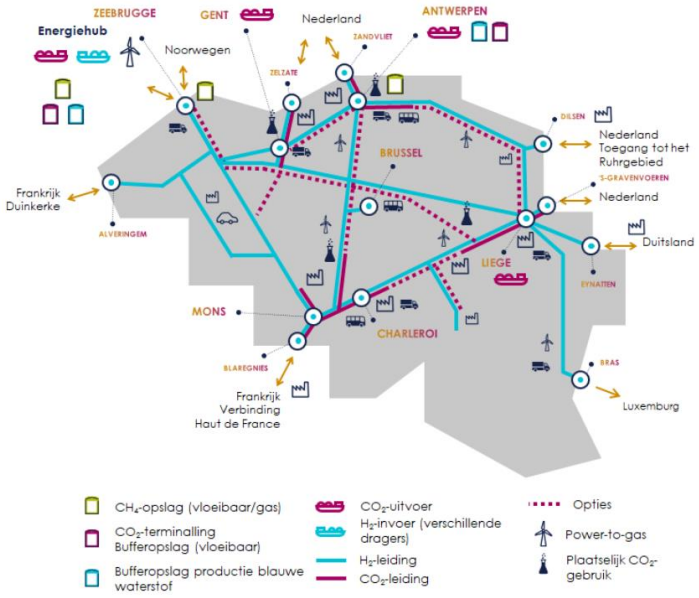


Figure 5: Long-term step-by-step development towards a fully carbon-neutral grid

[16] Our infrastructure (fluxys.com).

These plans for a hydrogen infrastructure must of course fit into a larger European plan. A **European hydrogen backbone** was drawn up by 19 European natural gas operators in 2021.

The European plan also assumes the start of the network around 2025 towards a connection of the most important European **'hydrogen valleys'** in 2030 via a network of approximately 11,600 km. This network will be further extended to a network of 40,000 km by 2040, with an estimated 69% of the hydrogen pipeline network consisting of converted natural gas pipelines. The investment cost of this European hydrogen backbone is estimated between 54 - 81 billion euros. The transport cost of hydrogen is estimated between 0.1 - 0.2 euros per kg hydrogen per 1000 km, which is cost-efficient transport.

Figure 6: Hydrogen backbone in Europe by 2040

Regional / Cluster Development Pipeline

As of 2021, WaterstofNet will write a yearly "**status report**" for the Flemish government, describing the current state of play of the hydrogen landscape in Flanders and the major developments that have occurred in the previous year[17]. This report also gives a **comprehensive overview of the industrial developments** (and projects) that have been realised in the hydrogen sector in the preceding year. The report is every year **validated** by the members of the Waterstof Industrie Cluster. This report is thus an ideal source for Flanders for this sub-section. For Wallonia, there is no equivalent report describing the state of play for hydrogen in Wallonia. The information on the Walloon pipeline for green hydrogen projects was collected via Cluster TWEED.

[17] Status report 2021: Hydrogen in Flanders, WaterstofNet-Statusrapport-2021_F.pdf.

1. Flanders – Status report 2021

The status report is very detailed and provides an overview of all developments in 2021 related to the local production, import, distribution & storage of hydrogen, just as everything related to the use of hydrogen in industry, transport and the built environment. **For a deep dive** into all the projects that are in the pipeline in Flanders you can **consult the Status Report**. Below we will just give **a small selection of projects** that already exist or are in the pipeline in Flanders:

- The installation and operation of **multiple hydrogen filling stations** in Antwerp (x3), Zaventem, Halle, Wilrijk, Haasrode, Herve, Olignies and Erpe-Mere.

- **Terranova hydrogen project**. Onsite hydrogen production from solar and wind on the Terranova site. This green hydrogen will be used for transport and industry.

- **Hyoffwind**. Virya Energy, Parkwind, Eoly Energy and Fluxys announced a partnership in 2018 to boost the sustainability of the energy landscape in Belgium. With the green energy project Hyoffwind, the partners want to build a power-to-gas installation to convert renewable electricity into green hydrogen through electrolysis. On 15th July 2022 the Flemish government dedicated 22,95 million euros out of the Flemish Recovery Plan to Hyoffwind.

- **Power-to-methanol Antwerp**. This project in Antwerp will produce methanol from captured CO2 combined with hydrogen that has been sustainably generated from renewable electricity. The consortium comprises leading industrial and business partners: ENGIE, Fluxys, Indaver, INOVYN, Oiltanking, Participate maatschappij Vlaanderen (PMV) and Port of Antwerp-Bruges.

- **Hydrotug**. A world first from CMB: the first tug in the world to be powered by internal combustion engines burning hydrogen in combination with diesel.

- **Hyport**. Port of Oostende, DEME Concessions and PMV concluded an exclusive partnership to have a plant operational in the port area of Ostend by 2025 that produces green hydrogen.

- **North-C-Methanol** is the first large scale demonstrator project of North-CCU-Hub. It consists of an electrolyser plant with a power of 63 MW, splitting water in green hydrogen and oxygen, using renewable energy from off-shore wind. On 15th July 2022 the Flemish government dedicated 22,95 million euros out of the Flemish Recovery Plan to this project under its new name **North-C-Hydrogen**.

- In oud-Heverlee, the latest prototype of the **solar hydrogen panels** is being tested in day-to-day living conditions.

- **Antwerp@C,** an initiative by Air Liquide, BASF, Borealis, ExxonMobil, INEOS, TotalEnergies, Fluxys and Port of Antwerp-Bruges aims to capture CO2 at reasonable cost and export it to be stored in offshore facilities or to make it available for possible future reuse.

- Air Liquide, DATS 24 and Port of Antwerp are joining forces in the **HyTrucks** consortium to run 300 hydrogen-powered trucks in Belgium as part of the HyTrucks initiative. This project aims to have a total of 1,000 hydrogen-powered trucks on the road by 2025 and to build the appropriate infrastructure linking Belgium, the Netherlands and West Germany.

- **H2Mhytic**: This project develops innovative electrodes and membranes to build large-scale electrolysis cells with high efficiency at low cost.

- **Intensse-H2**: investigates the feasibility of a concept of integrated water supply and electrolysis. Instead of pre-treating the seawater with a desalination process such as reverse osmosis, the electrolyte can be used as a draw solution to draw the seawater via a semi-permeable membrane directly into the electrolysis cell (due to the difference in osmolarity).

- **CHyPS:** this project will develop a modelling tool for marine engines running on hydrogen and methanol, and for the storage system of these fuels, with a focus on liquid hydrogen.

- With regard to offshore hydrogen production, DEME Offshore is involved in the **PosHYdon project** to realise a first in the field of offshore hydrogen production via a 1 MW electrolyser on a gas platform.

In the figure below you will an overview that comes out of the Federal Hydrogen Strategy that contains both Flemish as well as Walloon hydrogen projects:

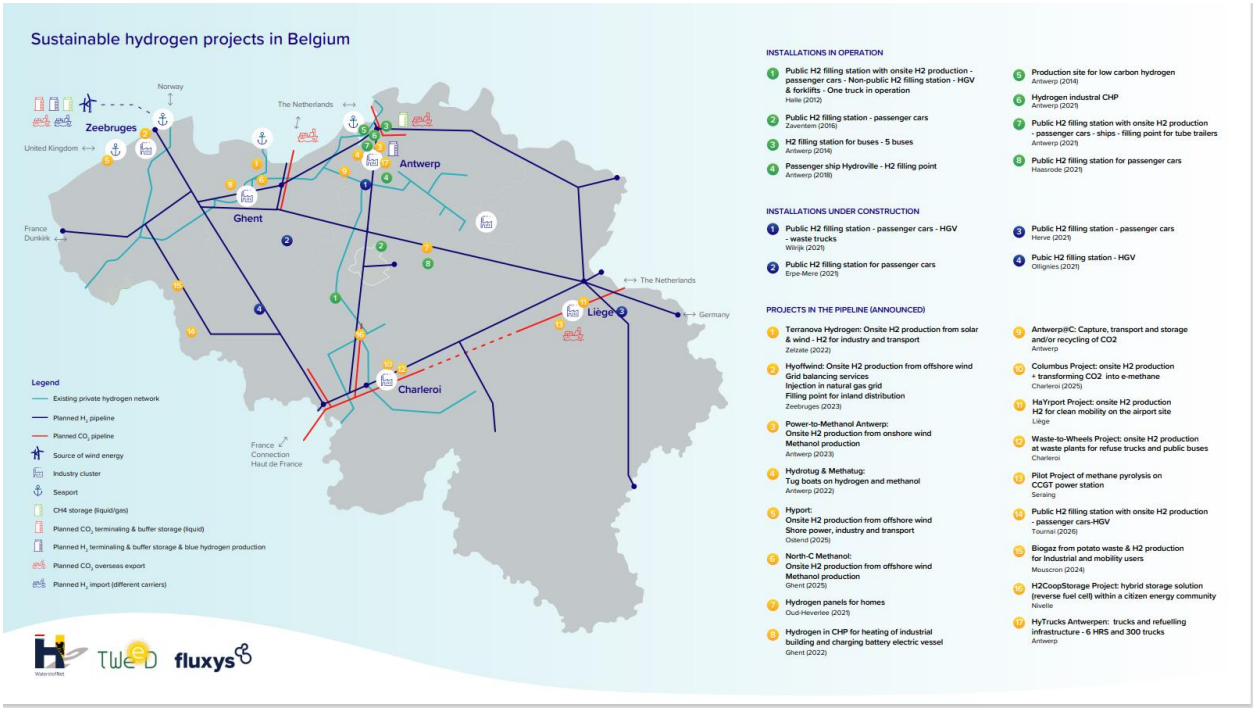


Figure 7: Hydrogen projects in Flanders and Wallonia

2. Wallonia – Information from Cluster TWEED

As was already indicated above, the projects in Wallonia are not documented in similar structural way like is done in the Flemish Status Report. However, in figure 7 (above) you can also find Walloon projects. Below we will just give **a small selection of projects** that are in the pipeline in Wallonia:

- **Columbus Project** : transforming CO2 generated during the lime production process (through innovative process which concentrates the CO2 stream) into e-methane (green hydrogen produced by a 75 MW electrolyzer stack).[18]

- **HaYrport Project** : equipping the airport with installations for production (electrolysis), distribution, and the use of green hydrogen for clean mobility on the Liège airport site (airport's own vehicle fleet and also vehicles from the exterior).[19]

- **Waste-to-Wheels Project**: generation of hydrogen (electrolysis) at waste plants for refuse trucks and public buses.[20]

[18] ENGIE, Carmeuse, and John Cockerill join forces to reduce industrial CO2 emissions in Wallonia - ENGIE Laborelec %

[19] HaYrport: Liege Airport and CMI working on a hydrogen solution for green mobility - John Cockerill

[20] Belgium: Green Light For A Hydrogen Production And Distribution Station In Charleroi - FuelCellsWorks

- Pilot Project of Luminus of **methane pyrolysis** on the CCGT power station in Seraign.

- **Public H2 filling station** with electrolysis for passenger cars and HGVs in Tournai built by Luminus ans IDETA.

- **H2CoopStorage Project** : hybrid storage solution (reverse fuel cell) within a citizen energy community (e.g. citizens, tertiary actors, hotels) in Nivelle.[21]

- **LOOP-FC**: will focus on home fuel cells by optimizing their thermal management and assessing their cogeneration potential.[22]

- **HYLIFE**: seeks to develop new fuel cells at a low cost.[23]

  WALLONHY: focuses on the deployment of more on electrolyser, as a key element in energy storage.[24]

5. Developing a Hydrogen Network

As was already shortly discussed under section 3, Belgium already two hydrogen industry networks with the Waterstof Industrie Cluster in Flanders and the Cluster TWEED in Wallonia. In this section we will go into more detail about the constellation and members of these two ecosystems. In Flanders we will also describe the membership and the role of the Blauwe Cluster (Blue Cluster).

Flanders

a) Waterstof Industrie Cluster (WIC) – Flemish-dutch hydrogen ecosystem

The Waterstof Industrie Cluster was already briefly presented at page 4 of this report. The industrial cluster was established as part of the 'power-to-gas' roadmap study for Flanders (2014–2015). WaterstofNet vzw has been coordinating the cluster since 1 September 2016, when the cluster began as an Innovatief Bedrijfs Netwerk (or 'innovative company network' in English) with the support of VLAIO (Flanders Innovation and Entrepreneurship). Since September 2019, following the conclusion of the subsidy programme, the cluster has continued on its own.

The cluster was initially formed by a group of approximately 20 companies. At present, there are **over 120 companies** from Belgium and The Netherlands in the cluster, with new

[21] h2coopstorage
[22] Projets - ReWallonia.
[23] Projets - ReWallonia.
[24] Projets - ReWallonia.

members regularly joining. The members come from **every part of the hydrogen value chain**. They include organisations involved in the production of green energy, the production of hydrogen, the transport and storage of hydrogen, and companies active in hydrogen technology and applications that involve potential end-users. The figures below show the members of the Waterstof Industrie Cluster on a map (figure 8) and along the entire hydrogen value chain (figure 9).

Figure 8: Map of the members of WaterstofNet's Hydrogen Industry Cluster

Figure 9: WaterstofNet's Hydrogen Industry Cluster members throughout the hydrogen value chain

b) <u>Blauwe Cluster – Flemish offshore renewable energy cluster</u>

The Blauwe cluster ("Blue Cluster") was already introduced under section 1 and can be described as a network of companies active in the sustainable blue economy and is recognised as a Flemish "spearhead cluster" since 2018. It has around 200 members, of which about 140 are active in the field of offshore renewable energy. In their role they are of course in the ideal position to make the link between offshore wind energy and green hydrogen production, exactly the objective of the Inn2Power project. Due to the multitude of companies, not all of them have been included in the graphical representation of the value chain below:

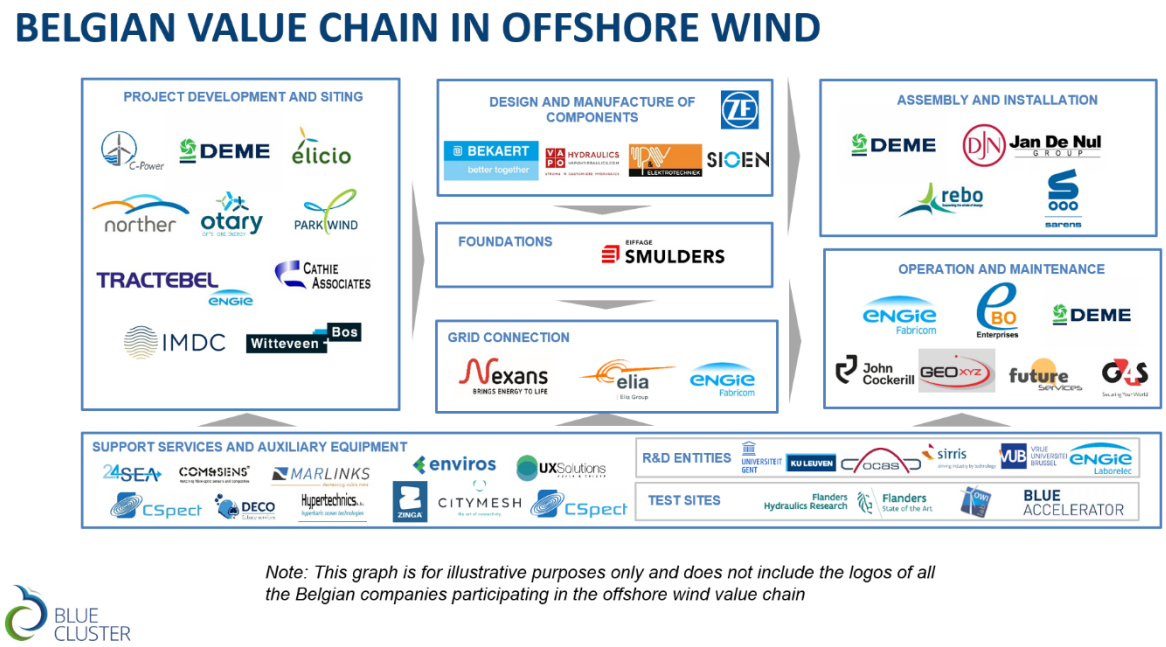


Figure 10: overview of part of the members of the Blauwe Cluster

Cluster TWEED – Walloon-Brussels hydrogen ecosystem

Gathering **hundreds Walloon & Brussels actors of the Renewable Energy sector**, the first mission of the Cluster TWEED (Technology of Wallonia Energy Environment and sustainable Development) is to pave the way for the setting up of high quality and industrial-size projects in the fields of production and exploitation of sustainable energy. The cluster is organized along six ecosystems, one of which is the **H2Hub Wallonia, a club within the Cluster specifically dedicated to hydrogen.** [25] The Hub positions itself as a partner of other Belgian initiatives (Waterstofnet – Waterstof Industrie Cluster, Fluxys, Flux50 etc.) in order to offer a global Belgian vision on hydrogen initiatives. **The objective of H2Hub Wallonia** will be to allow a transversal vision on the initiatives under development, to group them together and to give the actors concerned a good visibility on the theme; whether they are academic, public or private. The figures below show the hydrogen members of the Cluster TWEED on a map (figure 11) and along the entire hydrogen value chain (figure 12).

[25] Cluster TWEED, H2 & Plan de relance : vers un H2Hub Wallonia ! | TWEED (wallonie.be).

Figure 11: Map of the members of Cluster TWEED's H2Hub Wallonia *(combined with WIC)*

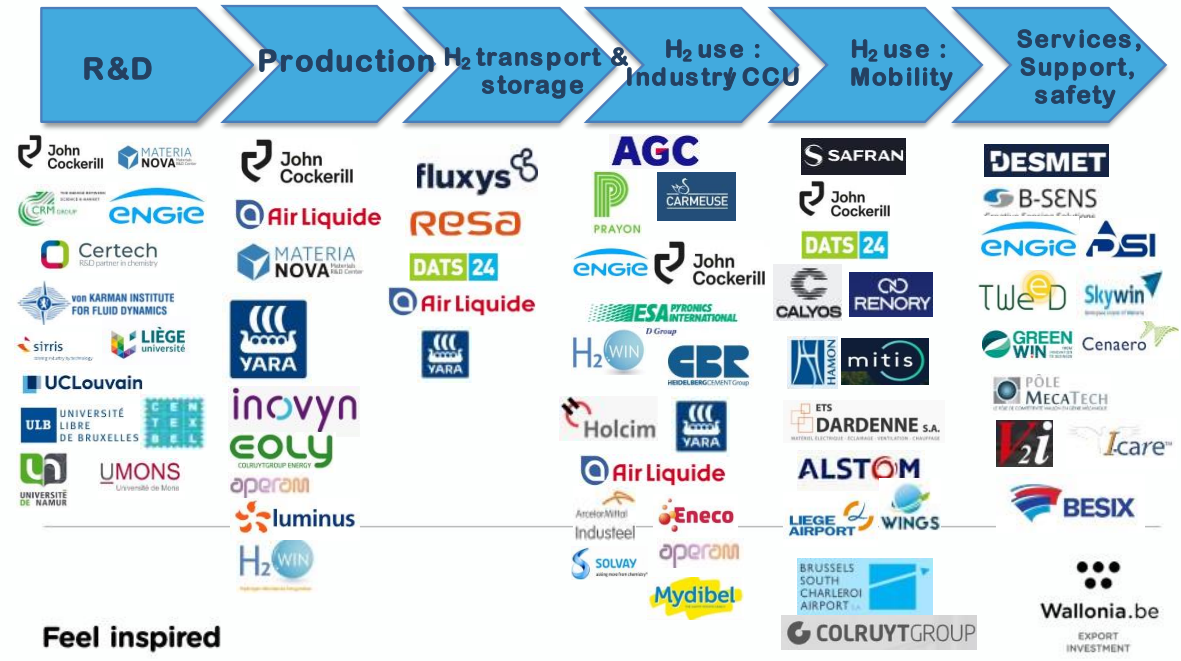


Figure 12: Cluster TWEED's members throughout the hydrogen value chain

Consulting with the Industry

Given the fact that WaterstofNet is coordinating the Waterstof Industrie Cluster in Flanders, the Blauwe Cluster is also helping to write this report and the good relations we have with our Walloon counterparts of the Cluster TWEED, we think these three fora are extremely well suited for a validation process of this report and the classification system. **In fact, the majority of the information that is processed in this report was already validated in advance by the industrial players** in Flanders and Wallonia since they were closely involved in the elaboration of the most important sources used for the drafting of this report (like the WIC Hydrogen Strategy and the Status Report in Flanders and the Cluster TWEED Hydrogen Roadmap in Wallonia). All these sources are the result of close cooperation with the industry players and were finalised by a validation of the content. We therefore believe the content of this report has sufficiently been validated by our Belgian hydrogen ecosystems. Finally, we are confident that the members of our Waterstof Industrie Cluster and the members of the Blauwe Cluster and Cluster TWEED are willing to participate in a facilitated workshop for the Inn2POWER project.

6. Challenges and Opportunities of the Green Hydrogen Sector

Opportunities

Belgium has a great deal of knowledge and expertise in the field of hydrogen in Flanders. Besides important technology players in the field of hydrogen production, transport and storage, we have **companies that are already applying hydrogen technology, developing demonstration activities and/or following developments** with great interest in order to be able to respond quickly to the many future opportunities. And we also have **important logistical assets**. The world's largest hydrogen pipeline network traverses our country. And with our seaports, we can ensure the smooth transport of hydrogen to our industrial clusters and the further transit of hydrogen to our neighbouring countries. [26]

Just as Belgium has over time come to play a role in natural gas supply with its highly interconnected network, LNG terminal and direct pipelines to the UK and Norway**, it wants to position itself as an import and transit hub for renewable molecules in Western Europe**. Apart from the economic opportunities that this new role represents for our territory, the creation and strengthening of the interconnections resulting from these exchanges will also contribute to a common, liquid and competitive market in the field of CWE, which will strengthen the negotiating position vis-à-vis producers and ensure the competitiveness of our industrial players.

Challenges

One of the biggest and most obvious challenges for the green hydrogen sector in Belgium is the fact that Belgium is a small densely populated country with relatively limited possibilities for the local production of green energy. For Belgium, there are various studies and visions about the necessary electrolysis capacity in Belgium. Given the focus on imports, this **local production capacity will always remain limited** and the emphasis will mainly be on innovation and technological development. An own production in Belgium can certainly have advantages, but only to the extent that this can be done more efficiently and cheaper compared to the import of renewable molecules[27].

A second challenge lies in the **complex state structure** and accompanying division of competences between the federal and regional level, also in the field of energy policy. In addition, this term in office is characterised by an **asymmetric composition of governments**: the coalition at the Flemish level differs from the coalition at the federal level, which can sometimes hamper smooth cooperation in various crucial (energy) dossiers.

[26] Status report 2021: Hydrogen in Flanders, WaterstofNet-Statusrapport-2021_F.pdf.
[27] Belgian Federal Hydrogen Strategy, View-strategy-hydrogen.pdf (fgov.be), p. 13.

WaterstofNet has identified in 2020 in its WIC Hydrogen Strategy a number of policy recommendations that can make or break a flourishing green hydrogen ecosystem in Belgium[28]:

- Production of hydrogen and hydrogen-based energy derivatives
  - ✓ (Partial) exemption from electricity-related taxes/charges for hydrogen production
  - ✓ Continued implementation of the Guarantees of Origin system in Flanders, expansion to low-carbon hydrogen and e-fuels, and maximum harmonisation of the GO instrument with the other regions and the Member States. A uniform EU system is the end goal
  - ✓ Introduction of differentiated taxation of energy carriers based on greenhouse gas intensity
  - ✓ Access to sufficient, affordable, and reliable energy
- Distribution and storage infrastructure
  - ✓ Development of a legislative framework for blending hydrogen into the existing natural gas network, supported by feed-in tariffs (provided this is a relevant transitional method)
  - ✓ Development of legislation that facilitates the development of an open-access network for hydrogen and CO2. Nevertheless, it must be kept in mind that the current hydrogen infrastructure has been financed and constructed privately and is also run by private entities as part of their business operations.
- Hydrogen in industry
  - ✓ The implementation of low carbon technologies will depend on its competitiveness compared to existing technologies. Cost reduction of low carbon technologies depends, on the one hand, on prioritising and investing in research and innovation, while on the other, it calls for the exploration of new, possibly temporary instruments to assist the transition from demonstration projects to large-scale implementation.
  - ✓ Investigate new instruments (such as Carbon Contracts for Difference) to support new, non-competitive 'low-carbon' technologies for initial large-scale implementation.
  - ✓ Developing a targeted Flemish investment support framework for pilot projects on an industrial scale that takes the initial lower cost efficiency of these installations into account
  - ✓ Incentivising companies by expanding the 'Ecology Premium Plus' to cover non-transport applications by adding new items to the fixed technology list (e.g., electrolysis, fuel cells that recover heat, etc.)

[28] WIC Hydrogen Strategy, A Flemish Hydrogen Strategy (waterstofnet.eu), p. 40-42.

- Hydrogen in transport
  - ✓ Develop a plan in consultation with the sector (filling station operators, transport federations such as Febetra, Febiac, ACEA, etc, vehicle manufacturers, etc.) for the roll-out of a refuelling infrastructure network that provides sufficient coverage for Flanders, at minimum. This must include locations for H2 generation, transport and storage.
  - ✓ Exempt zero-emission heavy-duty transport from taxes and charges, e.g., by lowering or lifting tolls.
  - ✓ Explicitly include hydrogen-powered buses in De Lijn's long-term plans as an alternative to regional transport.
  - ✓ Explicitly include RFNBOs in the Belgian fuel law, as stipulated by the REDII. That could include liquid, gaseous fuels, or pure hydrogen. There should be a level playing field between hydrogen/H2 carriers and other alternatives such as…
  - ✓ Support inland navigation pilot projects and perpetuate an active role in CCR to develop the general legal framework on inland navigation alternative fuels (especially H2 and methanol) and fuel cells/combustion engines.
  - ✓ Exempt hydrogen-powered mobility applications from excise duty until the initially high costs of hydrogen can be bridged.
- Hydrogen in the built environment
  - ✓ Support pilot projects required for testing technical solutions, identify legal barriers and develop safety standards.
  - ✓ Ensure that (future) legislation on built environment heating remains tech-neutral to keep options open for hydrogen (e.g., re-use of the distribution network, fuel flexibility targets for heating devices, etc.).
  - ✓ Incorporate (future) solutions (e.g., domestic hydrogen energy storage) in EPB/EPC schemes, so that they can also be valorised.

7. Barriers and Opportunities for Innovation

Apart from the barrier already mentioned under section 6, the fact that Belgium is a small and densely populated country that will largely have to depend on import of green hydrogen, the **technological challenges related to hydrogen are the same for Belgium as they are for the rest of the world**. The scale up from a MW electrolyser to a GW electrolyser is a global technological challenge and is not limited to the geographical borders of Belgium.

Linked to the small size of Belgium as a country, is the **limited budget of research & development & innovation** that is available in such a small country like Belgium. The budgets that are available are mostly general calls and not specifically aimed at hydrogen projects.[29] For Flanders, additional academic fundamental research is crucial for providing solutions to the many technological and non-technological challenges posed by the role of hydrogen in our energy transition. At the different Flemish universities and knowledge institutions the expertise is highly specialized and outstanding. However, the research is fragmented and collaboration between the institutions (in the domain of hydrogen) is at this time rather limited, which is a missed opportunity. A catalogue giving an overview of the academic hydrogen related research projects that exist in Flanders[30]:

[29] ABOUT | Be Hyfe.

[30] Status report 2021: Hydrogen in Flanders, WaterstofNet-Statusrapport-2021_F.pdf.

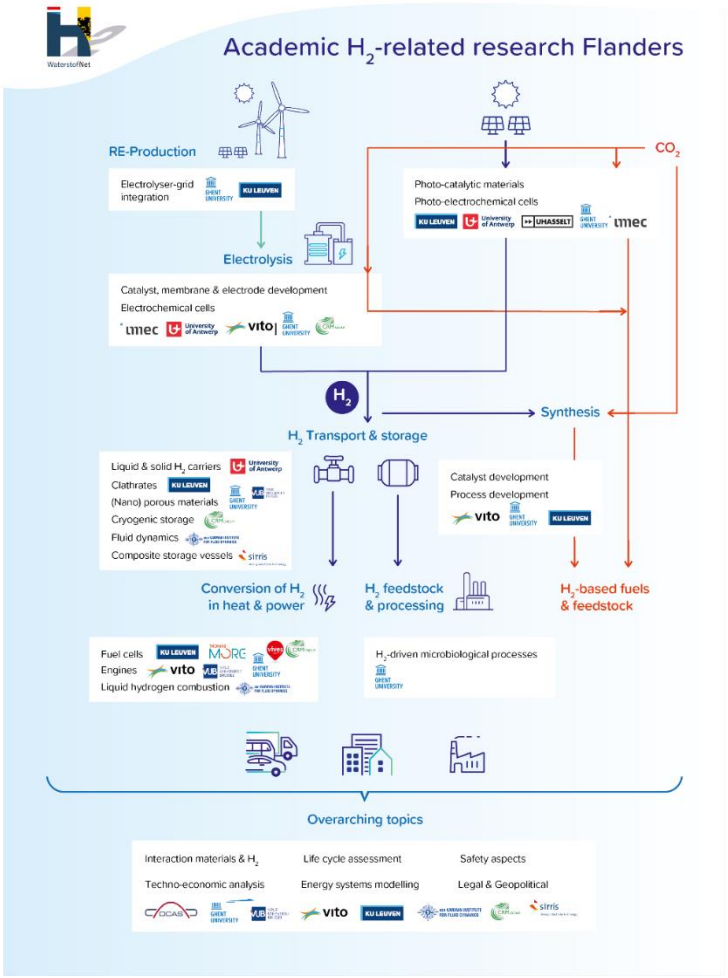


Figure 13: overview of the hydrogen related research projects in Flanders

Last year, also on Belgian/federal level an academic network on hydrogen has been set up with the 'BEHyFE project'. The goal of this project is to achieve a **Belgian hydrogen homebase** of academic knowledge and expertise by establishing a core group of 16 broadly trained and highly networked early-stage researchers (ESRs) to support the Belgian industry in finding both technological and societal solutions, guaranteeing security of supply and meeting our environmental targets.

8. Conclusions

Despite its limited surface area and small budget, Belgium has many assets to play a pioneering role in the green hydrogen revolution that is on our doorstep. Due to its small scale and unfavourable climate, Belgium **will never become a major producer** of green hydrogen. But thanks to its strategic location with three major ports and an already existing hydrogen and natural gas pipeline network, Belgium can become a **gateway into Europe for green hydrogen** produced in countries with lots of sun and wind. Belgium can become a **transit country** for green hydrogen, as it already is today for LNG.

Furthermore, Belgium already has **technological leadership** in the production of (components of) electrolysers. With the right investments and government support, Belgium can maintain and even expand this technological leadership. The new research agenda on hydrogen can also play an important role in maintaining this position.

The **danger** that is mainly around the corner for Belgium is an enormously complex state structure and corresponding division of competences, also with regard to energy policy and therefore everything related to hydrogen.