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for gas

NORTH WEST GAS REGIONAL INVESTMENT PLAN

2020

NORTH WEST REGION

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FOREWORD

It is our pleasure to welcome you to the fourth edition of the North West Gas Regional Investment Plan (NW GRIP). The NW GRIP is the result of close cooperation between the Transmission System Operators (TSOs) in the ten countries which make up the North West GRIP Region (NW Region). Traditionally the NW Region covers Belgium, Denmark, France, Germany, Ireland, Luxembourg, Sweden, The Netherlands and United Kingdom. Included in this version of the report, the Czech Republic is also part of the NW GRIP.

The 2020 edition of the NW GRIP builds on previous editions and complements the ENTSOG Ten-Year Network Development Plan 2018.

This edition of the NW GRIP focuses on two key challenges for the region:

- The energy transition that is gaining momentum and the role of the gas infrastructure in developing a sustainable society and green Europe.
- The switch from low calorific gas (L-gas) to high calorific gas (H-gas) in the NW Region with associated conversion infrastructure projects.

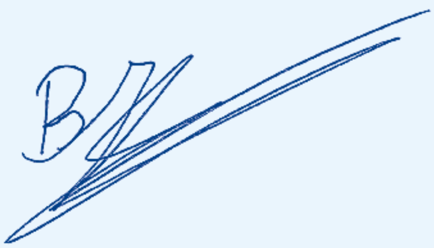
The coordination of this document has been facilitated by Fluxys and Gasunie Transport Services (GTS). The NW GRIP working group welcomes feedback from stakeholders to improve future editions of the report.

We hope that you will enjoy reading the NW Grip and that this report will contribute to the further development of the North West European gas system.

Pascal De Buck
Managing Director &
CEO, Fluxys

Bart Jan Hoevers

CEO of GTS and member of the
Executive Board of Gasunie



EXECUTIVE SUMMARY

The 4th Gas Regional Investment Plan for North West Europe (NW GRIP) contributes to the fulfilment of tasks listed in the European Directive 2009/73/EC Article 7 and Regulation 715/2009 Article 12.

The key focus of this report is on energy transition and the potential future role of gas markets and gas infrastructure in the NW Region. Following the presentation of the European Green Deal in December 2019 by new President of the European Commission Ursula von der Leyen and the commitment to achieve a climate neutral European Union by 2050, it is clear the energy system as a whole faces an ambitious road ahead. However, the use of the existing gas infrastructure allows for intelligent sector coupling and facilitates the envisaged decarbonisation in an economically efficient and technically achievable way.

This report provides an overview of projects and initiatives that gas TSOs are involved in to facilitate the decarbonisation of gas infrastructure across North West Europe. These initiatives demonstrate the commitment of TSOs from the NW Region to actively engage in the decarbonisation of the gas and energy system as a whole. When looking at the different decarbonisation projects, it is evident that the technologies adopted vary from Member State to Member State, which largely reflects the differing focuses, strengths and priorities of national policies.

The second part of this report is focused on the L-gas markets in the NW Region. The anticipated decline of L-gas production is causing a pressing investment requirement for the NW Region. As the only region where L-gas is produced and consumed, the announced phasing out of the Groningen field and the decline of the German L-gas production will require considerable infrastructure investments to allow L-to-H market conversion in large parts of Belgium, France and Germany. A detailed overview is presented on the current status of the L-gas markets and the associated infrastructure adaptations that are required for a successful market conversion and integration into the H-gas system. Reference is made to the first L-gas Market Conversion Review report published in January 2020, under the umbrella of the Task Force Monitoring L-gas Market Conversion.

Some of its key conclusions can be summarised as follows:

- Sufficient supply to cover security of supply (SoS) according to the Task Force Monitoring L-Gas Market Conversion.
- Measures to increase conversion capacity and reduce L-gas demand in the Netherlands are on track.
- Planned L to H infrastructure conversion in France, Belgium, Germany is on track.
- Good international cooperation and alignment between concerned countries.

The impact of COVID-19 in Europe on the L-gas supply and demand projections will be assessed in a second report of the L-gas Market Conversion Monitoring Taskforce, which is scheduled to be finalised in September 2020.

1 ENERGY TRANSITION TOWARDS A SUSTAINABLE FUTURE

This chapter aims to highlight the contribution of its member TSOs towards a sustainable energy transition and decarbonisation in the NW Region.

1.1 THE ROLE OF GAS AND GAS INFRASTRUCTURE IN A LOW-CARBON SOCIETY

The European Union has tasked Member States with ambitious and binding climate and energy targets that aim to reach a 32 % share of renewable energy by 2030 and cut emissions by at least 40 % compared to 1990 levels by 2030. By 2050, Europe is to become carbon neutral with net zero greenhouse gas emissions as outlined in the European Green Deal[1] presented by new President of the European Commission Ursula von der Leyen in December 2019.

There is a growing realisation in Europe that electrification alone cannot achieve the EU's climate and energy targets. The focus is now on the gas network and the role that gas and the gas grid can play in terms of realising the EU's energy and climate targets.

Gas infrastructure in the NW Region has seen decades of investment and development. This infrastructure provides the most efficient solution for transporting and storing large amounts of energy throughout the region.

The gas system is a key player in achieving the European energy and climate ambitions within the NW Region. The gas system offers unique opportunities – in energy storage and transmission – to support the power, heat and mobility infrastructure in enabling the decarbonisation of the energy system in the NW Region in a cost effective, secure and achievable way.

TSOs in the NW Region are committed to achieving the goals of the energy transition and are ready to play a key role in facilitating the decarbonisation of the gas infrastructure. In particular, TSOs in the NW Region are focused on the enabling of renewable and low carbon gaseous energy carriers e. g. biomethane and hydrogen from Power-to-Gas technology.

Renewable and low carbon gases can play a key role in energy transition, enabling a lower cost pathway to decarbonising Europe's energy mix whilst also maintaining and enhancing security of supply.

1 https://www.euractiv.com/section/energy-environment/news/green-deal-branded-as-hallmark-of-new-european-commission/

1.2 DIFFERENT ROADS TOWARDS A LOW-CARBON SOCIETY

Regulation (EU) 2018/1999 on the governance of the energy union and climate action emphasises the importance of meeting the EU's 2030 energy and climate targets and sets out how EU countries and the Commission should work together, and how individual countries should cooperate, to achieve the energy transition.

In accordance with the Regulation, EU Member States, including those in the North West Region are required to submit draft National Energy and Climate Plans (NECP) to the European Commission. Final versions of the NECPs were due for submission by the 31 December 2019.

Assessing different countries' approaches, it is clear that the focus of decarbonisation technologies varies from Member State to Member State, which reflects the different strengths, opportunities and priorities of national policies. This also is true for the approach to decarbonising gas infrastructure within the NW Region. Various developments and initiatives across the NW Region utilise a range of technologies to decarbonise gas networks and the wider energy system, including but not limited to the following:

1.2.1 BIOMETHANE

Renewable biomethane produced from anaerobic digestion and gasification of organic waste streams from agriculture and other industries has the potential to provide a sustainable solution for gas grids in Europe.

Biomethane is a renewable fuel with strong inherent benefits. It can be produced with a nearly constant output and quality. It can be stored, traded, and transported efficiently over long distances at a low cost using existing gas infrastructure, and provides flexibility to intermittent energy resources.

Production of biomethane also provides societal benefits such as production of energy from waste streams. Lastly, by-products of biomethane can be used as fertiliser, thus ensuring a recirculation of phosphor and a reduction of greenhouse gas emissions in the agricultural sector.

Both the production and the subsequent upgrading of biogas to biomethane is a proven technology with widespread utilisation in almost all countries of the NW Region.

1.2.2 NATURAL AND RENEWABLE GAS FOR MOBILITY APPLICATIONS

Compressed natural gas (CNG) is natural gas that is compressed to fit into the fuel tank of a natural gas vehicle (NGV). CNG is a proven, reliable technology with over 27 million vehicles operating worldwide[2]. The Directive on the Deployment of Alternative Fuels Infrastructure[3] sets the regulatory framework for the use of natural gas and biomethane in transport. The Directive requires that refuelling stations should be located, on average, approximately every 150 km long the Trans-European Transport (TEN-T) Core Network.

Liquefied natural gas (LNG) or liquefied biomethane (LBM) offer cost-efficient alternatives to diesel for waterborne activities (transport, offshore services, and fisheries), trucks and rail, with lower pollutant and CO_2 emissions and higher energy efficiency. LNG/LBM is particularly suited for long-distance road freight transport for which alternatives to diesel are extremely limited.

For waterborne transportation more stringent standards came into effect on 1 January 2015, creating sulphur emission control areas (SECAs) for shipping in the Baltic Sea, North Sea and English Channel as set by the International Maritime Organisation (IMO), the regulatory authority for international shipping. Thanks to their low emission values, LNG or LBM are particularly good alternative fuels for ships to meet these standards. In October 2016, the IMO decided to impose a global sulphur cap of 0.5 % on marine emissions from January 2020.

The North Sea, the Channel and the Baltic Sea will also become a nitrogen-oxide emission control area (NECA) area in 2021, resulting in LNG becoming the only fuel which inherently complies with the NECA without after-treatment.

2 https://www.iangv.org/category/stats/

3 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094&from=en

1.2.3 SECTOR COUPLING BETWEEN GAS AND ELECTRICITY GRIDS

The concept of sector coupling *"focuses on the integration of the power and gas sectors, through technologies such as Power-to-Gas."*[4]. Power-to-Gas technology uses electrolysis to convert water to hydrogen by using renewable electricity, which can also potentially be converted into methane or synthetic gas via an additional methanation step. This process can be deployed to produce a decarbonised and renewable gaseous energy carrier, using renewable electricity.

By converting renewable electricity from intermittent renewable sources to hydrogen or syngas, the gas infrastructure can function both as a storage medium as well as an instantly available back-up in case of shortages. Furthermore, valuable synergies can be found when integrated with the chemical industry and mobility sector. When imbalance issues in the power infrastructure are solved by applying Power-to-Gas, the chemical industry and mobility sector can be fed by renewable hydrogen.

1.2.4 HYDROGEN GRID DEVELOPMENT

As outlined in the New Industrial Strategy for Europe, which was published in March 2020, *"modernising and decarbonising energy-intensive industries must [...] be a top priority"*.[5] The Strategy goes on to list the steel, chemical and cement sectors as examples of industries targeted for climate neutral production. According to the EC *"hydrogen is gaining a more prominent role as an enabler of the clean energy transition, in large part due to its capacity to decarbonise sectors that may be difficult to electrify and its ability to capture and store renewable energy sources"*.[6] Hydrogen can be produced from either Power-to-Gas, as described previously, or from natural gas, using a steam methane reforming (SMR) process or similar techniques. The SMR process does produce carbon emissions, however where these emissions are captured using carbon capture usage and storage (CCUS), the resulting hydrogen offtake is effectively decarbonised.

To support the identification of new technology needs, investment opportunities and regulatory barriers to enable the development of clean hydrogen, the New Industrial Strategy for Europe includes a commitment to launch a new 'European Clean Hydrogen Alliance', which will bring together government, institutional and industrial partners. In this way, the European Commission has recognised the important role that hydrogen will have to play in supporting delivery on the EU Green Deal by facilitating the industry to become greener, whilst also maintaining Europe's economic competitiveness.

1.2.5 CARBON CAPTURE, USAGE AND STORAGE

Carbon capture usage and storage (CCUS) is *"a proven technology necessary to achieve climate neutrality in Europe in a cost-efficient manner, and can enable negative emissions"*, according to a European Commission report[7].

1.2.6 ADVANCED END-USE APPLICATIONS

Sector coupling can be realised by the use of hybrid appliances. The term hybrid means that at least two energy carriers are involved. An example of a hybrid application is the hybrid heat pump, which can run on both gas and electricity. It is a combination of a condensing boiler and an air-sourced heat pump. This offers a wide variety of opportunities: the hybrid heat pump can use electricity at times when electricity is cheap and abundantly available, thereby avoiding curtailment and lowering the energy bill for the owner. On the other hand, the hybrid heat pump can use gas instead of electricity at times when electricity is expensive and scarce, thus also contributing to a lower energy bill for the consumer.

1.2.7 ENERGY EFFICIENCY IN GAS TRANSMISSION

NW GRIP members have taken energy efficiency and reduction of emissions as a challenge and have developed operational measures directly related to the transmission systems and gas transport, as well as administrative and organisational measures related to non-transmission activities.

4 http://www.europarl.europa.eu/RegData/etudes/STUD/2018/626091/IPOL_STU(2018)626091_EN.pdf

5 https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en

6 https://ec.europa.eu/energy/en/topics/technology-and-innovation/energy-storage/hydrogen

7 https://ec.europa.eu/info/sites/info/files/iogp_-_report_-_ccs_ccu.pdf

1.3 NW REGION ENERGY TRANSITION PROJECTS

TSOs in the NW Region are proactively engaging with industry stakeholders to help ensure that gas and gas infrastructure play a key role in decarbonising the EU energy mix. TSOs in the NW Region are also focused on putting consumers at the heart of the transition by providing choice and a cost-efficient pathway towards the energy transition, by leveraging gas infrastructure and gaseous energy carriers. The following section provides an overview of some of the many innovation projects which are ongoing/planned in the region. Some of these and other initiatives in Europe can also be found on the Innovative Projects Platform on the ENTSOG website[8].

1.3.1 BELGIUM

Seven leading players sign a cooperation agreement for the transport of hydrogen

Hydrogen has an important role to play in the mix of solutions to achieve CO_2 emissions reduction in Belgium. This is why Deme, Engie, Exmar, Fluxys, Port of Antwerp, Port of Zeebrugge and WaterstofNet have launched a joint study, which will serve as a basis to coordinate the delivery of concrete projects that shape the production, transport and storage of hydrogen.

Crucial to the viability of a hydrogen economy is the generation of sufficient renewable electricity for the production of hydrogen. Wind and solar energy will likely not cover the entire energy demand in Belgium, and so part of the necessary renewable energy must be imported. Efficient and economic solutions for the import, transport and storage of hydrogen require specific expertise. This is why the abovementioned seven industrial players and public stakeholders have signed a cooperation agreement to bring their expertise together in a coordinated way to assess the hydrogen supply chain of the future.

In phase one, the partners will undertake a joint analysis of the entire hydrogen import and transport chain. The aim is to map the financial, technical and regulatory aspects of the logistics chain: production, loading and unloading and transport by sea and via pipelines. The outcome of the analysis will be a roadmap that indicates the best way to transport hydrogen for the various applications in the energy and chemical sectors before commencing concrete projects.

8 https://www.entsog.eu/ipp

Picture courtesy of Fluxys Belgium

HyOffWind: Colruyt Group (Eoly), Parkwind and Fluxys join forces in Power-to-Gas

Eoly, part of Colruyt Group, Fluxys and Parkwind have set up a collaboration to boost the hydrogen economy in Belgium. The ambition is to build an industrial-scale Power-to-Gas installation that converts green electricity into green hydrogen. The produced green hydrogen can be used as carbon-free energy or feedstock in transport, logistics and industrial processes, for example in the chemical industry. In addition, this green hydrogen can be transported in the existing natural gas infrastructure and in this way reduce the carbon output from heating or industrial activities, for example.

With this particular project, Eoly, Parkwind and Fluxys are taking a new step towards solutions for a low-carbon future. Unlike demonstration projects elsewhere in Europe, Eoly, Parkwind and Fluxys plan to install one of the first industrial-scale Power-to-Gas facilities. The aim is to build a Power-to-Gas installation that can convert 25 MW of renewable electricity into green hydrogen, which can be marketed as carbon-free fuel or feedstock.

In addition, renewable energies like solar and wind trigger variability in electricity production. As the renewable power generation park expands in the future, increasing variability will become a major challenge. This project aims to offer a solution for this problem. The partners will explore the possibility of offsetting the variability of power generation from (offshore) wind energy and providing support services to the power grid using the Power-to-Gas installation. In this way, the installation will constitute a link optimising how the gas and power systems complement and reinforce each other.

Creating a backbone of green hydrogen

The Fluxys network has the benefit of being highly meshed, with most of its backbone infrastructure doubled. This means that an alternative hydrogen backbone infrastructure may be developed mostly from existing pipelines, and become an integral part of a future European hydrogen network thanks to its multiple interconnections with neighbouring countries. The transport of (decarbonised) natural gas remains possible in this configuration.

At European level, a hydrogen network would enable the replacement of fossil fuels by green hydrogen, and help increase renewables production, by linking production and consumption sites. In North West Europe, the European Commission has recognised *Green Octopus* as an interesting candidate to apply for an Important Project of Common European Interest (IPCEI) status. *Green Octopus* has the intention of creating a cross-border open access pipeline infrastructure of green hydrogen between France, Belgium, the Netherlands and Germany, which can serve hydrogen supply and demand between port regions and industrial clusters. Specifically for Belgium, Fluxys is looking at connecting the main port regions, those being Port of Zeebrugge, North Sea Port and Port of Antwerp which also function as the main industrial hubs.


Picture courtesy of Port of Antwerp

Antwerp@C: Feasibility study for CO_2 capture, utilisation and storage infrastructure in the Port of Antwerp

Eight leading players in the Antwerp Port area – Air Liquide, BASF, Borealis, INEOS, ExxonMobil, Fluxys, Port of Antwerp and Total – have signed a collaboration agreement as a first move towards the possible development of carbon capture, utilisation and storage (CCUS) infrastructure. The consortium will carry out a joint study into the economic and technical feasibility of such facilities. CCUS applications can make an important contribution towards achieving climate goals. With this initiative, the Port of Antwerp is taking yet another important step in the transition to a sustainable, lower emissions port. As the home of the largest energy and chemicals cluster in Europe, the Port of Antwerp can be seen as the ideal location to foster collaboration between companies and take innovative steps towards CO_2 reduction.

Carbon capture and storage (CCS) and the use of CO_2 as a raw material for various industrial applications (carbon capture and utilisation, or CCU) are seen as important avenues in the transition to a lower emissions port. The partners in the project believe that both applications will have a significant impact in the long term and will make a noticeable contribution to achieving the energy and climate objectives at Flemish, Belgian and European level. If the proposals turn out to be technically and economically feasible, then development of CCUS facilities can lead to reductions in CO_2 emissions in the run-up to 2030. These facilities would be of the 'open access' type, thus available to the entire industrial community in the port.

In phase one, the partners will carry out detailed studies of the technical and economic feasibility of CO_2 facilities to support CCUS. The feasibility study will also investigate the possibilities for CO_2 storage. Belgium does not have suitable geological formations for storing CO_2 underground, so international collaboration will be necessary. To stimulate collaboration between potential capture, transport and storage sites, Fluxys and a number of other partners have submitted two applications to the European Commission for recognition as 'Projects of Common Interest', both of which have received the PCI label. These two projects offer possibilities for investigating the development of cross-border CO_2 transport infrastructure, linking up with Rotterdam (CO_2TransPorts project) and Norway (Northern Lights project), respectively. In the context of the feasibility study the results of these applications will be taken into account and contacts with other CO_2 storage initiatives will be sought so that robust concepts can be developed for the CO_2-intensive companies in the region.

Registration of Green Gas and Guarantees of Origin

The Green Gas Register is a voluntary scheme set-up by the Belgian grid operators in 2018 that facilitates trading of green gas certificates (ERGaR based – European Renewable Gas Registry) in Belgium. The register monitors how much green gas is produced and used and by whom. The green gas certificates create an additional commercial value for green gas irrespective of the physical gas flow.

The Green Gas Register supports trading and consumption of green gas. Today this is biomethane, but the register can also issue green hydrogen or syngas certificates if necessary.

The Green Gas Register was established to promote and simplify the trade of green gas in Belgium. The origin of the gas is guaranteed by auditors before being recognised as green gas certificates. These certificates include a proof of origin and optionally a proof of sustainability where the CO_2 equivalent emission is declared by a competent auditor. This allows traders and consumers to demonstrate that green gas traded and used meets international sustainability criteria.

Fluxys greenhouse gas emission reduction program

Fluxys has developed a plan of actions to halve its greenhouse gas emissions by 2025 (compared to 2017). Some of the actions are listed below.

- Pneumatic emissions are reduced by replacing or modifying certain pneumatic equipment, which will be piloted electronically or via compressed air. Where possible new regulating equipment will be chosen to be auto-piloted, thereby avoiding any natural gas emissions.
- Fugitive emissions are reduced through the use of a laser-based system to spot and measure natural gas escaping in the air. The detection equipment is installed on a helicopter flying over the pipeline system to produce very accurate results. Teams in the field perform regular leak detection and repair campaigns for the stations on the network.
- In the course of certain types of work on the grid, Fluxys must isolate a given pipe section and remove the residual gas from the pipe section to be able to work safely. To avoid the release of gas into the atmosphere, the teams in the field are increasingly using mobile recompression units. The recompression units remove the residual gas from the pipe section undergoing maintenance and re-inject it at another location of the grid.
- Fluxys is also looking into the possibility to install a second open rack vaporizer at the Zeebrugge LNG terminal to valorise the warmth of the sea water for the regasification of the LNG, which would have a positive impact on energy consumption as well as emissions of CO_2 and NO_X.

Picture courtesy of Fluxys Belgium

1.3.2 DENMARK

Digital certificates for biomethane

Energinet issues digital certificates for injected biomethane which represent the "green" value of energy produced from biogas, a renewable energy source. The green value of the upgraded biogas may be traded commercially[9].

Energinet expects domestic biomethane production to double by 2020 and we work closely with our European counterparts to establish a trading platform for biomethane certificates. Energinet is involved in ERGaR, which is a cooperation between European registries of biomethane certificates that enables cross border trade of biomethane certificates among the member registries. ERGaR is the Europe-wide recognised organisation for administering and mass balancing volumes of renewable gases virtually distributed along the European natural gas network.

Biomethane injection into the high-pressure grid

Energinet has several projects necessary for bringing biomethane to the high-pressure grid. The technical solutions chosen are individually designed for all projects minimising total expenditure (TOTEX) and ensure high security for the grid to absorb biomethane production. In periods of low demand, the quantity of injected biomethane in some distribution networks will exceed local gas consumption. The technical solutions require the implementations of new types of technologies (e. g. small compressors in combination with deodorisation plants). Currently, one injection plant is in operation and two more are under construction.

In early 2020 13 % of Danish gas consumption was covered by biomethane. The biogas share will increase to above 25 % within three years, which will increase the need for biogas injection from the low-pressure grid into the high-pressure grid significantly.

9 https://en.energinet.dk/Gas/Biomethane/Biomethane-Certificates

Figure 1: Biogas plants in Denmark (Source: Energinet)

M/R-Helle: Hydrogen blending

M/R Helle is a demonstration project to test and evaluate the consequences of hydrogen/natural gas mixtures in the gas infrastructure[10]. Mixtures of hydrogen and natural gas will be circulated for two years. The purpose of the project is to find the constraints and to prepare for a possible future handling hydrogen/natural gas in the gas grid. The initial results show that 10 vol-% blending of hydrogen into the grid is possible without modifications to the existing equipment. Currently, tests are underway to determine whether the system can handle a 15 vol-% hydrogen blend.

North Sea Wind Power Hub

TenneT Netherlands, TenneT Germany, Energinet, Gasunie and Port of Rotterdam joined forces to build an artificial island in the North Sea to host synergy technologies such as Power-to-Gas[11]. The hub provides a basis for a joint European approach up to 2050 and focuses specifically on developing the North Sea as a source and a distribution centre for Europe's energy transition.

10 https://www.entsog.eu/sites/default/files/2018-11/Energinet-MR-station-hydrogen.pdf

11 https://northseawindpowerhub.eu/project/

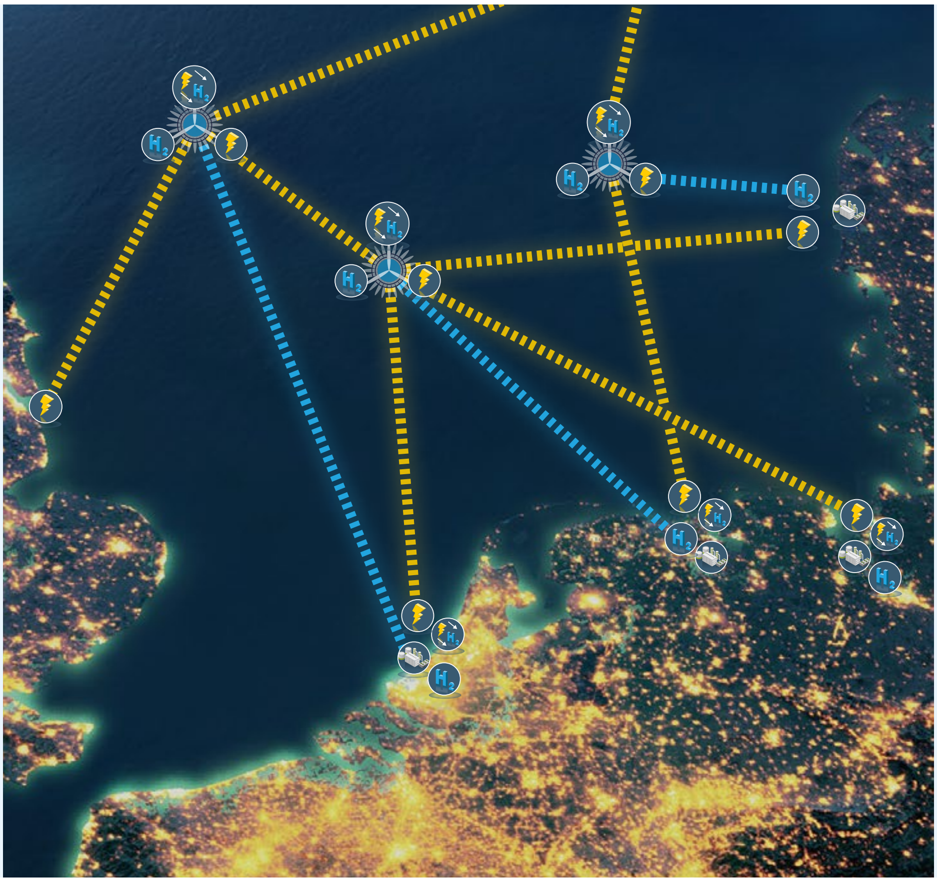


Figure 2: Modular Hub-and-Spoke concept (Source: North Sea Wind Power Hub Consortium)

1.3.3 FRANCE

Biomethane development in France

In France, hundreds of upcoming biomethane plant projects are registered to inject into the distribution and transmission gas system. However, in many cases, the injection capacity of the local distribution system is not sufficient to integrate such production. Furthermore, decentralised production has a significant impact on the gas infrastructure operation (for example monitoring, maintenance, and coordination with the stakeholders).

In the framework of the scenario of the Energy Transition law for which renewable gas injections would reach 22 TWh by 2028, with an estimated impact on transmission and distribution grid amounting to nearly € 1.5 billion. The impact on the gas network would be backhaul installations and mutualised compressors, and meshing the distribution grid. The regular framework established in 2019 ensures producers the right to inject biomethane into the grid, considering reasonable mutualised investments for the network. It can be estimated that around 375 backhaul installations and mutualised compressors will be required, i. e. a financial envelope of € 435 million by 2030. These network adaptations will maximise the volume of biomethane injected into the gas system to reach France's national target for renewable gas (10 % of gas consumption in 2030).

Along with the abovementioned infrastructure deployment, the French biomethane program includes the implementation of technical and organisational optimisation of the global gas system, which involves cross-stakeholder collaboration (distribution system operators, producers, and consumers). West Grid Synergy is an operational demonstrator located in the West of France, in an area with significant biomethane production projects and very high targets for green gas (from 35 to 120 %). The objective is to design technical and organisational solutions based on a comprehensive analysis of the gas system in order to test and value them before industrial implementation of these solutions. Various technical solutions (reverse flow unit, dynamic and remote control of the gas pressure, communicating units, production and consumption forecast) will be designed, tested and operated, including the first two French pilots of reverse flow units between distribution and transmission grids, which were commissioned in Pouzeauge and Pontivy in 2019.

Jupiter 1000, first industrial demonstrator of Power-to-Gas in France

Jupiter 1000 is the first project to recycle CO_2 from stack effluent in France, by integrating a CO_2 capture unit in the chimneys of a local business, Asco Industries. The project is carried out in close cooperation with industries, which will consume the gas produced by the Power-to-Gas demonstration plant.

Coordinated by GRTgaz in collaboration with the Marseille Port Authority, *Jupiter 1000* engages various French partners with complementary skills: McPhy Energy for two electrolysers; Atmostat and the CEA for a methanation reactor; Leroux and Lotz Technologies for CO_2 capture; the CEA for R&D, CNR providing the renewable electricity and piloting future remote management of the facility; RTE, the French electricity TSO, for studying the synergies between gas and electricity systems; and GRTgaz and Teréga managing injection in the gas networks. GRTgaz also oversees the engineering and integration as a whole, and in the mid-term will be managing site operation.

The project was partially commissioned at end of 2019, and the first hydrogen molecules were successfully injected into the transmission system in February 2020.

Jupiter 1000 will produce up to 5,000 MWh over three years. All the industrial partners will be able to test the operation of the installation, assess the impact of hydrogen on the networks and its use in an industrial process, consolidate the economic study on the basis of the performances observed, and thus contribute to the emergence of the Power-to-Gas sector in France.

Jupiter 1000 is a project supported by the South Region, the ADEME (Investments for the Future Program) and the European Union (FEDER).[12]

12 More information on https://www.jupiter1000.eu/english

FenHYx, a research platform for hydrogen

FenHYx is a research, innovation and European cooperation platform on new gases including hydrogen. Its purpose is to define the technical, economic and regulatory conditions for injecting hydrogen and decarbonised gases into the gas infrastructure.

The *FenHYx* platform aims to reproduce the features of gas networks and especially those of the gas transmission networks: compression, expansion, measurement, analysis, injection loop, etc. Trials at different pressures and concentrations of hydrogen and methane will be used to test, assess and certify innovative processes for producing new gases, including hydrogen as well as innovations in equipment. A first cluster will be constructed in the Paris area in 2020 in order to perform tests on the integrity of steels and the tightness of equipment and meters in the presence of hydrogen.

Through this platform, GRTgaz wishes to encourage the collaboration with other operators such as European gas network operators but also equipment suppliers. Several partners have already joined GRTgaz with a view to exploring harmonisation of standards and providing transparency of R&D results.

1.3.4 FRANCE – GERMANY

mosaHYc – Mosel Saar Hydrogen Conversion

GRTgaz in France and CREOS in Germany are working together towards a cross-border 100 % hydrogen transportation network via the reuse of existing gas infrastructure, connecting Saarland (Germany) and Lorraine (France) and arriving at the border of Luxembourg.

The aim of the *mosaHYc* project is to provide a 70 km regional-size hydrogen infrastructure which various hydrogen producers and consumers in Saarland, Lorraine and Luxembourg can access on a non-discriminatory basis and interact freely to develop hydrogen applications in the industry, and especially in the mobility sector. Indeed, the project aims at supplying future hydrogen filling stations, in line with the green cross-border mobility ambitions of Saar federal state in Germany, Grand Est Region in France, and Luxembourg. Thus, the project could contribute to decarbonising mobility uses and address major environmental and societal challenges including improved air quality in the Saar-Lor-Lux region. This hydrogen infrastructure is ideally situated to later support and interlink hydrogen development planned in the industrial areas in Saarland and Lorraine, which historically have been strongly integrated.

As a first step, the project will focus on converting two existing pipelines to hydrogen transport:

- A 15 km long pipeline connecting the power plant site Fenne-Völklingen (Germany) to the industrial platform in Carling (France);
- A 5 km long pipeline from Carling to Perl (Germany).

In the long term, the project could convert existing gas pipelines that are no longer in use to pure hydrogen in order to accelerate the development of a connected inter-regional hydrogen market as a part of the "Get H2" movement and the global development of European interconnected hydrogen transportation networks.

The mosaHyc project will enable the development of a technical and regulatory framework that will allow gas system operators to convert gas pipelines to hydrogen pipelines and operate them in a secure way. In this way, it is a fundamental milestone along the way to develop European hydrogen transportation infrastructure that could interconnect hydrogen hubs of consumption.

1.3.5 GERMANY

Visionary hydrogen network of the German TSOs[13]

Against the background of the increasing interest in hydrogen in a variety of sectors, especially in industry, the transmission system operators developed a possible future vision for a trans-regional hydrogen network and published this in January this year. The pipelines of the visionary network connect regions where hydrogen is produced and regions where hydrogen is consumed by using natural gas infrastructure that is largely (over 90 %) already in place. It comprises a total length of around 5,900 km. The transmission system operators will continue to develop this visionary hydrogen network on the basis of new findings. The basis for the visionary hydrogen network was provided by a study on the regionalisation of hydrogen production and consumption by the Forschungsstelle für Energiewirtschaft mbH (FfE – Research Institute for the Energy Economy) that the transmission system operators commissioned [FfE 2019]. According to this study, the potential domestic focal points for the production of hydrogen from renewable energy sources can be expected to be found predominantly in the regions

13 https://www.fnb-gas.de/media/2020_05_03_fnb_gas_2020_nep_konsultation_en.pdf

VISION FOR A HYDROGEN NETWORK

Disclaimer: This map is a schematic representation and thus has no claim to completeness regarding storage facilities and consumers.

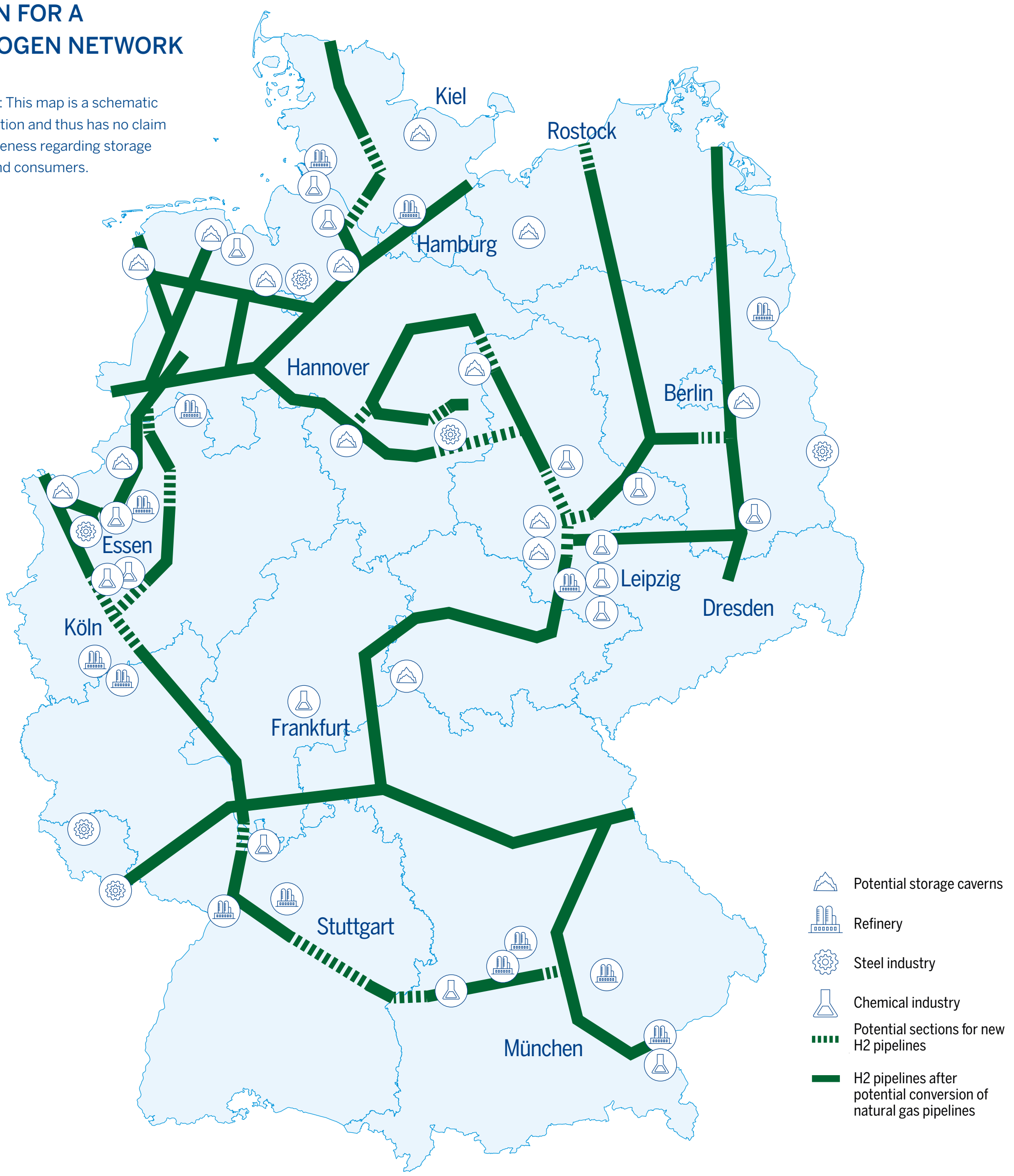


Figure 3: Vision for a hydrogen network (Source: FNB Gas e.V.)

of Mecklenburg West Pomerania, Brandenburg, Schleswig-Holstein, Lower Saxony and North Rhine-Westphalia in the future. The transmission system operators additionally conducted a market partner survey on green gas projects currently in development. In the final analysis, 31 projects, predominantly hydrogen projects in industrial centres of consumption, were reported.

The scope of the hydrogen network includes:

- Cavern storage locations for potential use as hydrogen storage facilities to balance hydrogen consumption and hydrogen production and imports
- Industrial consumers such as steel producers, the chemicals industry, refineries and regions affected by the phase-out of coal as well as the local hydrogen networks that are already in place
- Major metropolitan areas, which can realise reductions in CO_2 emissions in the heating sector by blending hydrogen in the regional distribution systems there
- Approximately 80 % of the German vehicle fleet and part of the non-electrified rail network in order to enable a contribution to the transport transition in this way
- Regions with large supplies of renewable energy sources for producing hydrogen as possible hydrogen import locations

The implementation of the first hydrogen projects (e. g. field labs as hotbeds of a hydrogen economy) is already planned by 2025. These projects can be linked with the first implementation steps for the hydrogen network.

The hydrogen network is open to different technologies. It can receive hydrogen irrespective of the source. For example, regions with a level of electricity generated from renewable energy sources in northern and eastern Germany or imports that arrive in Germany through pipelines or tankers offer great potential.

The hydrogen network will probably be developed in geographical terms from north to south, as the potential sources and storage locations for hydrogen are predominantly found north of the River Main. The expansion in the direction of the south will develop into the major consumption centres.

By connecting the hydrogen network up to the hydrogen infrastructure to the neighbouring European countries, the Europe-wide exchange of hydrogen will already be possible at an early date.

ELEMENT EINS

In order to promote a successful energy transition, the German gas TSOs Gasunie Deutschland and Thyssengas, together with the transmission system operator for electricity, TenneT, are planning to build a Power-to-Gas pilot plant *ELEMENT EINS*. With a capacity of 100 MW, it will be one of the largest of its kind in Germany.

By way of Power-to-Gas technologies, sustainable electricity can be converted into gas (green hydrogen or synthetic methane). Existing gas infrastructure can thus be used for the transport and storage of renewable energies. Power-to-Gas can make a significant contribution to solving the problem of the weather-dependent and thus volatile availability of renewable energies, as well as the transport of huge amounts of electricity. The ability to store large volumes of renewable electricity will reduce the load on the power grid significantly.

From 2022 to 2028, the project *ELEMENT EINS* will gradually connect electricity and gas grids, offering new storage capacities for renewable energies. The recently finalized technical feasibility study foresees the first step, the construction of 40 MW electrolysis capacity, in the vicinity of the TenneT substations in Diele (Lower Saxony), which primarily collect and distribute offshore wind energy from the North Sea. The *ELEMENT EINS* pilot project provides companies with their first experiences of Power-to-Gas facilities on an industrial scale. The partners ultimately hope to achieve a comprehensive coupling of the energy, transport and industrial sectors. Gas that has been converted from green energy will be transported from the North Sea to the Ruhr region through existing pipelines, but that is not all. This green gas could also be made available to the mobility sector through hydrogen filling stations and to industrial consumers through storage caverns.

The availability of renewable energy is weather-dependent. To date, there are no technically and economically viable solutions for storing large amounts of electricity for a long-term period. Power-to-Gas technologies help solving this problem. By using Power-to-Gas, renewable electricity can be converted into gas (green hydrogen or synthetic methane) which can be transported or stored in the gas grids. Once converted into gas, the renewable energy can be used in other sectors, which ultimately accelerates the energy transition.

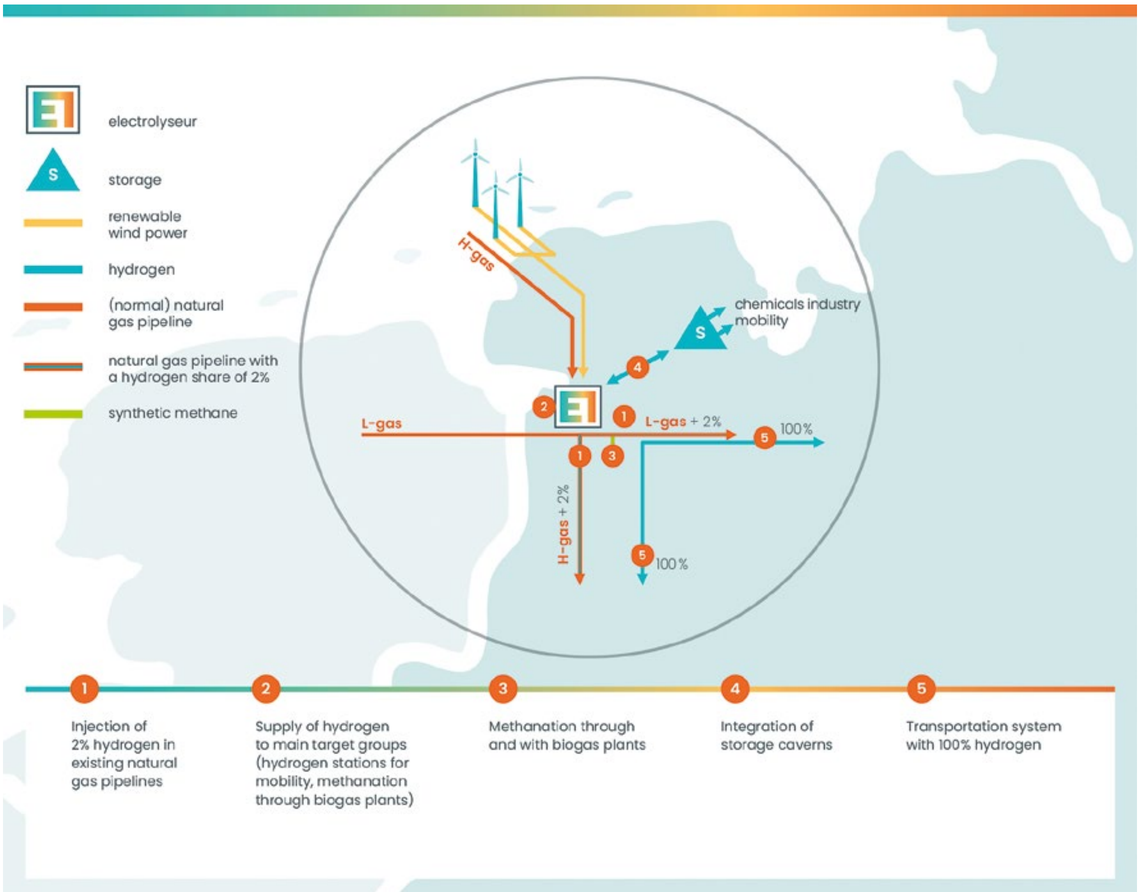


Figure 4: *ELEMENT EINS* (Source: TenneT, Gasunie Deutschland, Thyssengas)

The region of northern Lower Saxony offers, in particular against the background of the high wind energy generation and the decline in L-gas production and the resulting change in gas flows, the possibility in the medium term to completely convert natural gas pipelines to hydrogen and convert wind energy from the North Sea and others into hydrogen to be transported to the Ruhr area.

At the Diele site, TenneT operates a transformer station that currently feeds up to 1.2 GW of electrical power from several offshore wind farms into the extra-high voltage grid. As a result, a large amount of energy from offshore wind farms is permanently available at this location.

A long-distance gas pipeline runs a few kilometres from this substation, which is jointly owned and operated by Gasunie Deutschland and Thyssengas, and which essentially transports H-gas from Norway to the industrial centres of the Ruhr area and the Rhineland. Both cavern and pore storages are also connected. According to current estimates, at least 2 % by volume of hydrogen can be added to this H-gas grid by the *ELEMENT EINS* project. In the future, at least 10 % by volume of hydrogen could be added.

Also a few kilometres from the Diele transformer station is a gas pipeline operated by Gasunie Deutschland, which today transports L-gas from the Netherlands to Bremen. Connected to this long-distance gas pipe, another L-gas pipe runs from Barßel in the direction of the Ruhr area. At least 2 % by volume of hydrogen can be added to these long-distance gas lines in the first phase. These pipes can be successively converted to pure hydrogen lines from 2026 onwards.

In a first phase a Power-to-Gas plant with an electrical output of up to 40 MWel will be built and integrated into the grid. After the first phase, the *ELEMENT EINS* project is to be gradually expanded in a modular manner. An electrolyser input power of approximately 100 MWel is targeted.

According to the graphic above the *ELEMENT EINS* project can be broken down into five use cases:

1. Injection of 2 % hydrogen in existing natural gas pipelines
2. Supply of hydrogen to main target groups
3. Methanation through and with biogas plants
4. Integration of storage caverns
5. Transportation system with 100 % hydrogen

The project partners intend to use the *ELEMENT EINS* project to provide a conversion service for electricity from renewable energy into green gas. The gas network operators offer the conversion service as a special form of transport service that can be requested by network users. Users of the Power-to-Gas system would therefore be market participants themselves (energy traders) who deliver their electricity directly from the electricity market to a virtual trading point in the gas market or to an exit point in the gas network. Such a conversion service would make it possible for market participants, for example, to market electricity on the gas market at times of low electricity market prices or to develop new gas products. The network operators thus neither exercise the functions of extracting nor selling gas. Via the above-mentioned system everyone can get access to the conversion service on a non-discriminatory basis, in compliance with the requirements from Third Energy Package.

Picture courtesy of National Grid

GET H2

GET H2 is the initiative for the implementation of a nationwide hydrogen (H_2) infrastructure for Germany and the starting point for nationwide hydrogen infrastructure.

Germany has set for itself the target of reducing CO_2 emissions by 80–95 % (compared to 1990). In order to achieve this goal with the greatest possible efficiency, more key technologies are needed in addition to the expansion of renewable energy generation and electricity infrastructure. The conversion of electricity generated by renewable energies into H_2 – Power-to-Gas – is, as such, key to a successful energy transition.

The key concept is as follows:

- Electricity from renewables (wind and sun) is converted into H_2
- H_2 is transported using the existing gas transmission network
- In the industrial, transport, energy and heating sectors, green H_2 is used as a CO_2-free energy source
- H_2 that is not used directly is stored in underground caverns, especially for dark doldrums

GET H2 connects regions with a high proportion of renewables from wind and solar power to the industrial-scale production of H_2. Furthermore, *GET H2* aims to develop a nationwide H_2-infrastructure. Such infrastructure will link all sectors and make the best possible use of the existing gas transmission network and storage facilities as well as the electricity grid. This way, the initiative also solves the problem of supplying renewables during dark doldrums and in the winter months.

GET H2 Nukleus: Kick-off from Lingen to Gelsenkirchen

As part of the project *GET H2 Nukleus* the first publicly accessible H_2-infrastructure will be built. The approximately 130-kilometer-long network from Lingen to Gelsenkirchen connects the production of green H_2 to industrial customers in Lower Saxony and North Rhine-Westphalia, thus creating the basis for a hydrogen economy in Germany.

- Electricity from renewables
- Power-to-Gas plants (electrolysis) to produce green H_2
- Existing electricity and gas infrastructures including gas storage facilities
- Supply of H_2 to refineries and chemical parks for use in production processes, including initial applications for the transport sector if necessary

Project partners of *GET H2 Nukleus* are BP, Evonik, Nowega, OGE and RWE.

More than 30 project partners support *GET H2*.[14]

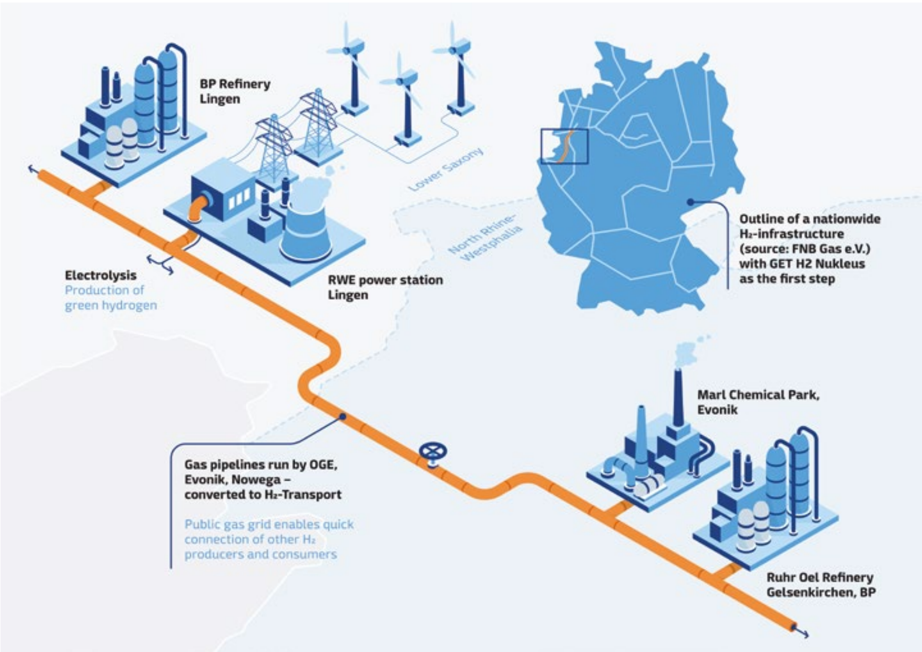


Figure 5: *GET H2 Nukleus* (Source: BP, Evonik, Nowega, OGE, RWE)

14 The full list is accessible via: https://www.get-h2.de/en/partners/

hybridge

hybridge is the name of the largescale Power-to-Gas project by Amprion and OGE. The aim of the pilot plant is to convert up to 100 MW of electrical power into hydrogen by 2023. As part of this project, technology that will play a key role in the transformation of Germany's energy system will be further developed.

One major question needs to be answered in order to initiate the next stage of the energy transition: What happens with the ever-increasing quantities of electricity from wind and solar that do not always find takers? To effectively solve this issue electricity must be diverted to other sectors where large amounts of energy are also required. This is technically possible by coupling the existing infrastructure of the German electricity and gas systems with each other. Power-to-Gas systems act as a bridge between the individual systems. They enable electricity to be transformed into hydrogen; an important raw material and environmentally friendly energy source that can be used in all sectors. The same applies to synthetic methane, which in turn can be obtained from hydrogen.

The energy transported via the gas and electricity lines is never owned by the "forwarders", the network operators. They make their infrastructure available to all market participants on a non-discriminatory basis and are remunerated for their transport services via a regulated network charge. Sector coupling at system level involves transformation between two regulated areas: the electricity transmission network and the gas transmission network. It is intended that the transmission system operators will be responsible for the planning, construction and operation of the sector transformer, i. e. the Power-to-Gas plant. This will be financed through network charges which means that no state support system, allocation system or similar will be needed for these new network elements. As the "bridging capacity" between the systems is limited, the network operators plan to auction it off to traders or direct customers. The revenues from the auctions are offset against the costs by the network operators and reduce the network charges.

Amprion and OGE are planning the first large-scale Power-to-Gas plant in Germany to convert electricity from renewable energy sources into hydrogen. A suitable location for the hybridge pilot project is in Southern Emsland: On the border between Lower Saxony and North Rhine-Westphalia, there is an ideal intersection between electricity and gas grids. The following is planned: An electrolyser with electrical input of 100 MW will be installed near one of Amprion's substations and connected to Amprion's electricity grid. Based on this, all future ways of integrating hydrogen will be tested. The hourly

— COUPLING POWER AND GAS SYSTEMS – AN OVERVIEW

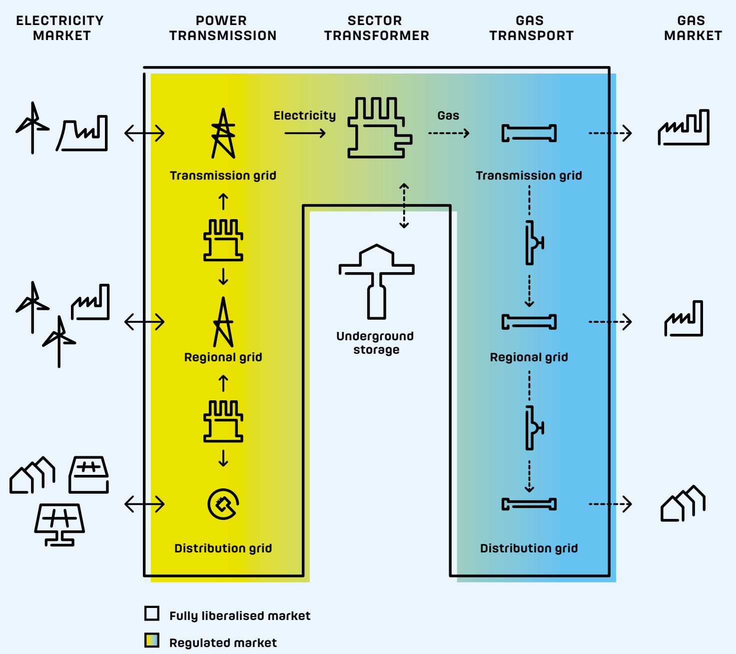


Figure 6: Coupling power and gas systems – an overview (Source: www.hybridge.net)

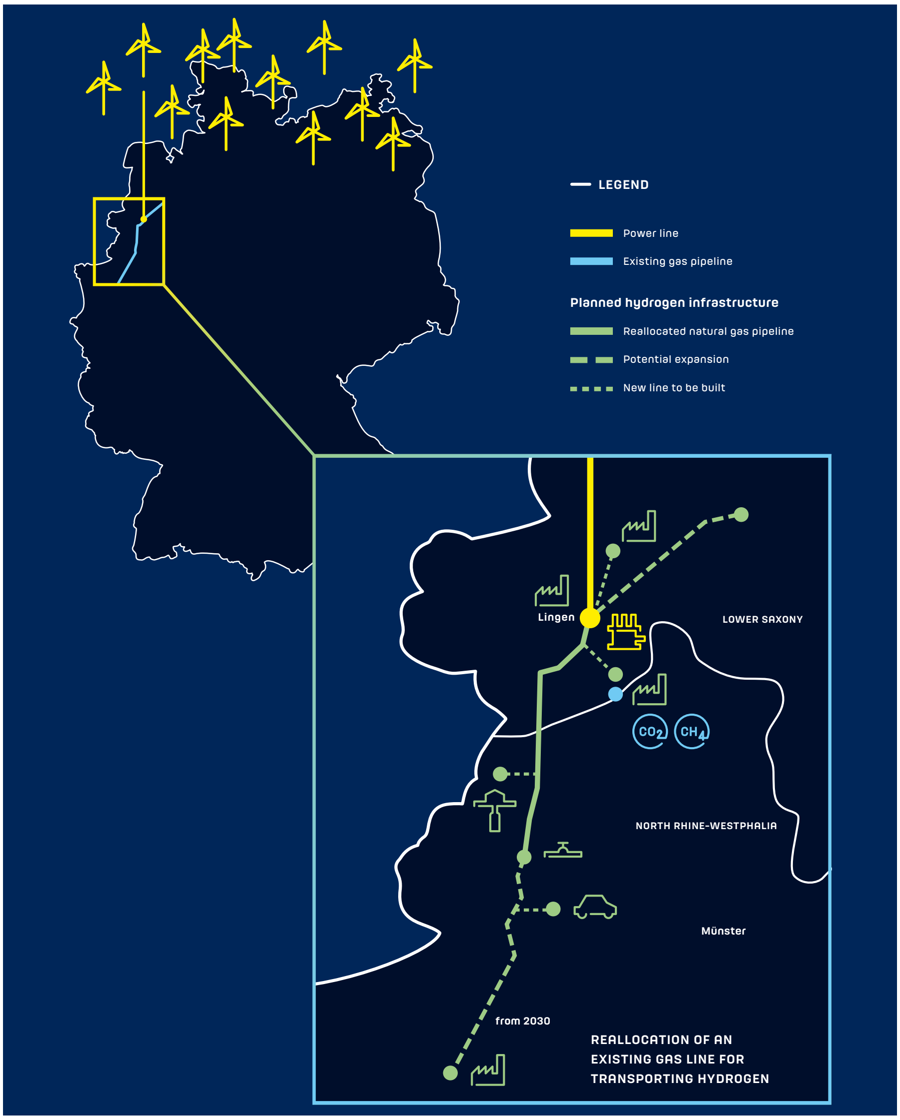


Figure 7: Reallocation of an existing gas line for transporting hydrogen (Source: www.hybridge.net)

output of the electrolyser will be approximately 20,000 m³ into the energy system in the hybridge project. OGE plans to convert part of its existing gas network for the exclusive transport of pure hydrogen.

Companies located near the new hydrogen pipeline can use the green hydrogen. In the further course of the project, the provision of hydrogen filling stations in the mobility sector, for example in motor vehicles or trains, is also possible. In addition, gas storage facilities will be converted in order to temporally decouple the supply of renewable energy sources from the demand for hydrogen. The storage facilities can then take in hydrogen instead of natural gas and feed it back into the hydrogen network. In this way, a reliable supply of hydrogen based on renewable energy can be efficiently realised.

Adding hydrogen to natural gas networks is another option that will be tested as part of the project. The green gas can then also be used for other purposes such as heating. As part of the OGE network, the hydrogen network will be connected to both the transmission network and to regional, local natural gas networks. OGE ensures that a limited amount of hydrogen can be added to the natural gas in compliance with current regulations. When these options have been exhausted, hydrogen can also be methanised with CO_2 and fed into the natural gas grid too.

The technological prerequisites for the construction of the plant are already in place. If the legal and regulatory authorities consent to the project, Amprion and OGE can begin the approval process and construction in the near future. The plant would then be ready for operation in 2023.[15]

15 More information is available at www.hybridge.net.

1.3.6 IRELAND

Biomethane Development in Ireland

Gas Networks Ireland has a strategic plan to achieve 20 % renewable gas on the gas network within a decade, which is equal to circa 11.0 TWh of renewable gas (Gas Network Ireland's high national renewable gas production forecast). This figure is supported by independent reports by the EU Commission and the SEAI. To achieve this level of renewable gas, Gas Networks Ireland is focusing on supporting anaerobic digestion (AD) with separate initiatives for the agriculture sector and the commercial waste industry sector.

It is forecasted that up to 10.1 TWh per annum of renewable gas can be delivered from the agriculture sector by 2030. Agri-based AD will be supported on the basis that biogas is purified to natural gas standard at the AD site, ready for collection. Gas Networks Ireland, in conjunction with other industry stakeholders, intends to invest in the renewable gas collection logistics and Central Grid Injection (CGI) facilities located on the gas transmission network where renewable gas quality will be verified and the grid injection process will be managed and metered. The CGI facilities are designed to operate as gas entry points on the network where gas shippers can register capacity and transact gas into the system for delivery to their gas customers in the heat, power and transport sectors.

The first transmission connected CGI facility is being developed in Mitchelstown, Co. Cork as part of the *GRAZE* (Green Renewable Agricultural & Zero Emissions) gas project. This project has been shortlisted for grant funding support from the Irish Government's Climate Action Fund. In addition to the *GRAZE* gas project, Gas Networks Ireland is planning on developing a further five CGI facilities in a project collectively called *The Renewable Gas Central Grid Injection Project*. These facilities will be geographically spread along the gas network and provide centralised locations for renewable gas producers from local AD plants (within a 50 km radius) to inject into GNI's transmission system. This will help enable the rollout of renewable gas on a national basis.

Ervia CCUS project

Gas Networks Ireland and its parent company Ervia are investigating the potential for a large-scale CCS project in Ireland to capture the CO_2 from a number of gas-fired CCGT power plants so that they provide low-carbon electricity. Initial findings suggest that CCS may be technically and economically viable for Ireland and over the next few years, Ervia will progress feasibility studies into the technology for Ireland. The significance of CCS has been recognised by the Irish Government which has recently established a Steering Group to examine its feasibility in Ireland.

Gas Networks Ireland and Ervia have developed a long-term vision for how to help decarbonising Ireland and in particular the electricity, heating and transport sectors. This vision is to utilise natural gas as a 'Bridging Fuel' out to 2030 and then decarbonised gas as a 'Destination Fuel' out to and beyond 2050 through the utilisation of renewable gases and CCUS technology.

In September 2019 Ervia signed a Memorandum of Understanding (MOU) with Equinor. The MOU describes how Ervia will work with Equinor and the Norwegian Government's wider 'Northern Lights' project, which aims to drive CCS development across Europe. If successful, the project would see carbon emissions from Ireland's electricity production and large industry captured and exported via ship to be permanently stored in Norway's vast geological reserves in the North Sea.

In addition to exploring carbon emissions export and storage in Norway, Ervia is also assessing the feasibility of a permanent carbon store closer to home, in the now depleted Kinsale gas field. This low-pressure field on first look appears to be a suitable reservoir for CO_2 storage. Further analysis will take place over the coming years to ensure that it is a suitable, secure storage site. Existing local infrastructure could potentially be repurposed for a CCS project. The two combined cycle gas turbines in the area are relatively modern and may be suitable for post-combustion carbon capture. The offshore pipeline, that first carried natural gas to Ireland, could potentially be reutilised to carry CO_2 back to where the natural gas came from, offshore and deep beneath the seabed.

1.3.7 SWEDEN

Development of biogas trade

The Gas Barometer measures how much biogas is consumed by customers connected to the transmission network. During the gas year 2018/2019 the transmission system had 19 % biogas. Across the entire network, if the DSO networks are included, the amount was 22 %. The aim is to have at least 30 % biogas in the transmission system by 2030, an achievable goal if the current trend is sustained.

LNG/LBG infrastructure

In Sweden, there are two LNG terminals in operation. The Nynäshamn LNG terminal, south of Stockholm, has a storage volume of 9,300 tons and is in operation since 2011. In this area only the local refineries are connected to the terminal. Other customers (industries, ferries and the city of Stockholm) are supplied with gas by truck. The Lysekil LNG terminal on the Swedish west coast is in operation since 2014. Similar to the Nynäshamn LNG terminal, a small local distribution grid connects to refineries while the other customers are supplied by truck.

There are plans for a LNG terminal in Gothenburg. This project has PCI status and an environmental permit has been granted. The terminal will support railcar loading, truck loading, storage and bunkering. As a first stage of the terminal a bunker facility has been built which began operation in Autumn 2018. The bunker facility includes a discharge station, a cryogenic pipeline and bunkering hoses. The LNG is brought to the facility using trailers or containers and is unloaded at the discharge station. The new facility is flexible and may be used for the storage and transport of renewable gas (LBG, Liquid Biogas).

The LNG project is operated in collaboration with the Port of Gothenburg. A modern LNG/LBG infrastructure is entirely in line with the port's ambition to reduce the environmental impact of shipping and establish a sustainable Scandinavian freight hub.

Figure 8: The cryogenic pipeline at the LNG/LBG bunkering facility in Gothenburg (Source: Swedegas)

1.3.8 THE CZECH REPUBLIC

***Greening of Gas* project**

NET4GAS, s.r.o. (TSO) together with GasNet, s.r.o. (DSO) are cooperating on a project which aims to build and connect a facility to demonstrate the operational and industrial feasibility of energy transition projects within the Czech gas system. In this way, the joint project aims to prove the future potential of existing gas infrastructure.

The joint project *Greening of Gas* is prepared as a pilot project which aims to produce renewable gases using the unique Power-to-Gas technology. The project consists of a combination of two technologies. One is the production of hydrogen by water electrolysis from renewable electricity and the second one is biogas purification technology (bio methanation) with a subsequent production of a synthetic methane. The project also aims to test injection of methane and possibly hydrogen into the transmission and/or distribution gas systems in the Czech Republic.

The project is currently in the feasibility study phase. The current schedule expects its commissioning in 2023. The operator of the facility has not yet been decided due to legislative requirements, including the requirements for unbundling of the transmission system operator. It is the first project of its type to be developed in the Czech Republic. Therefore, it faces potential difficulties related to its innovative nature, the fact that the technology is untested in the current environment, and the lack of an applicable legal framework.

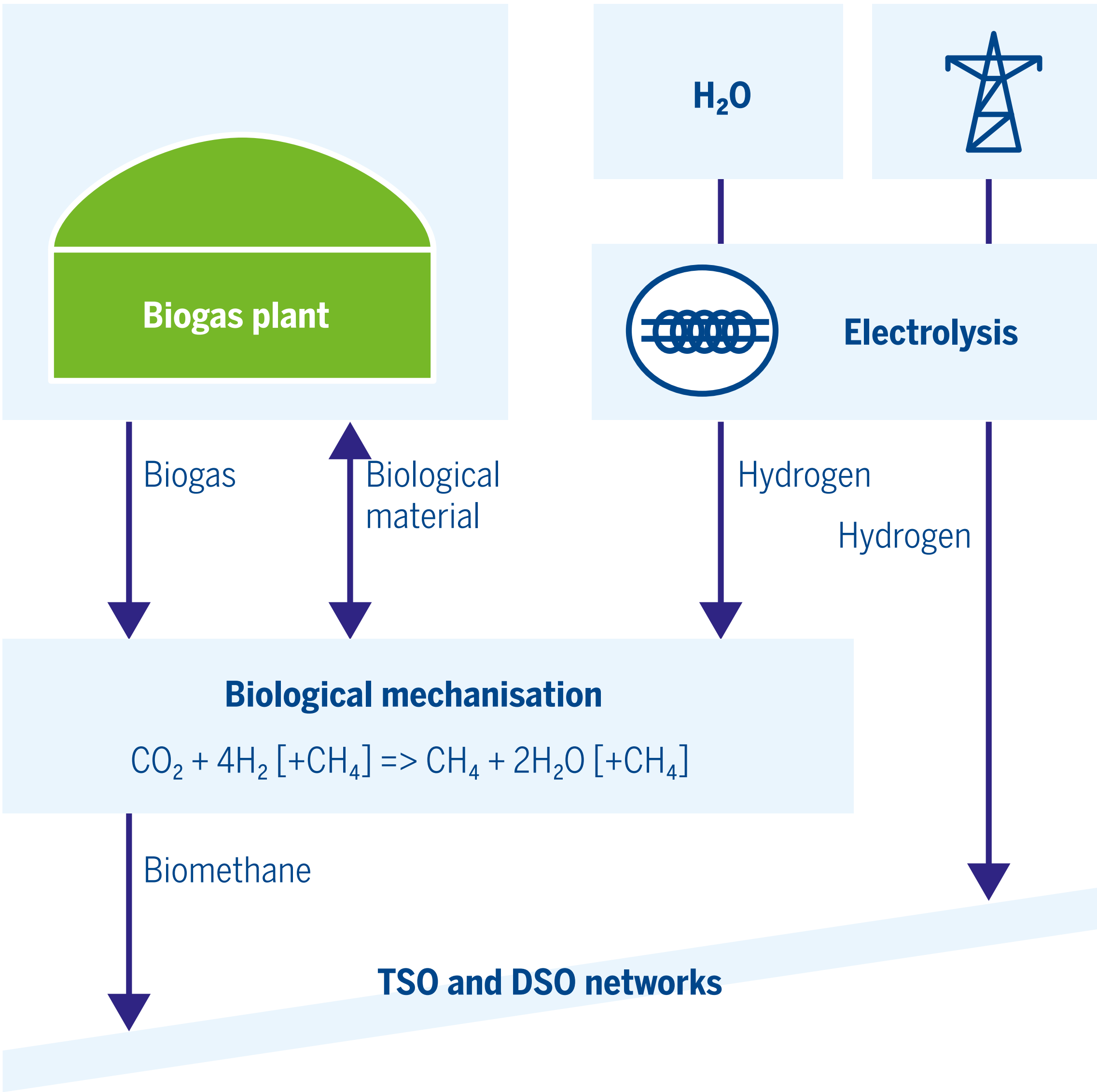


Figure 9: Schematic description of the prepared Power-to-Gas facility (Source: NET4GAS)

1.3.9 THE NETHERLANDS

Supercritical water gasification (SCWG)

Supercritical water gasification (SCWG)[16] is an innovative technology that produces carbon neutral gasses from wet biomass like manure, green waste and sewage sludge. Gasunie New Energy and SCW Systems are working together to build a demonstration installation near Alkmaar in the Netherlands. The first reactor is planned to become operational in 2020. The objective of the project is to increase production in steps to 20 PJ.

SCWG differs from existing gasification technologies because it is not necessary to remove water from the raw biomass material. Instead, SCWG uses the water in the conversion process. Because of this a higher production efficiency is obtained.

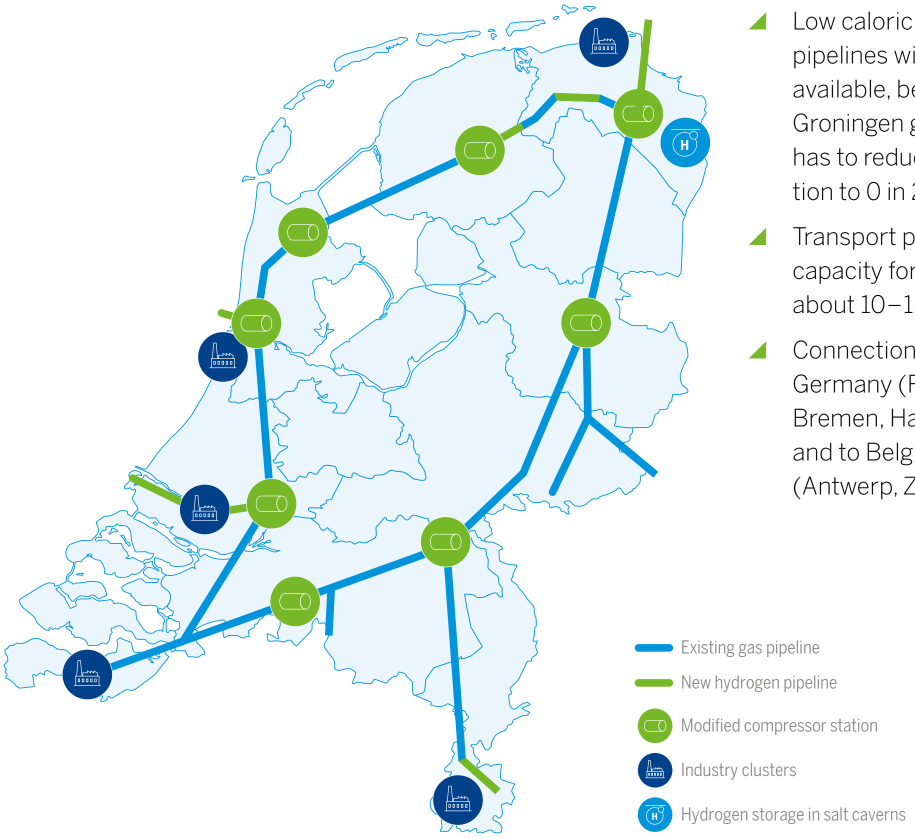
SCWG is a so called thermo-chemical conversion technology. A mixture of water and biomass is brought to a supercritical phase by increasing temperature and pressure. In this supercritical phase the organic molecules in the biomass material are cracked. It is within this process that biogas (methane, hydrogen, CO_2 and CO) is formed.

Besides the higher conversion efficiency of SCWG, the technology has several other advantages. Firstly, SCWG is a multi-feedstock technology. This means that the technology can produce bio-syngas from a great variety of available sources. Secondly, SCWG delivers biomethane at high pressure. Because of this, the gas can be injected into the nearby high-pressure gas transmission grid without further compression.

This has a further advantage because there are no supply limitations due to low gas demand, which normally occur in the low-pressure distribution grids. Consequently, SCWG makes it possible to directly supply green gas to large industrial customers and gas storage facilities.

16 https://www.gasunienewenergy.nl/projecten/scw

Picture courtesy of Fluxys Belgium



- Low caloric gas pipelines will become available, because the Groningen gas field has to reduce production to 0 in 2022
- Transport pipeline capacity for hydrogen about 10–15 GW
- Connections to Germany (Ruhr area, Bremen, Hamburg) and to Belgium (Antwerp, Zeebrugge)

Figure 10: Hydrogen backbone in the Netherlands (Source: Gasunie)

Hydrogen backbone

The hydrogen backbone in the Netherlands[17] is a nationwide network that will connect hydrogen demand with production and storage locations of hydrogen. A first part is already operational (since October 2018): a pipeline connecting the industrial facilities of Dow and Yara in Zeeuws Vlaanderen. This pipeline has been converted from carrying natural gas to hydrogen.

In follow up phases a gradual expansion of the hydrogen network can be realised to a scheme as shown in the map above. Part of the network currently carrying natural gas will become available for other purposes. This is due to the decline of the Groningen field, decreasing market demand, and decreasing export contracts. Already in 2023 some pipelines can be converted to hydrogen, developing further in 2030 to a nationwide network, including connections with neighbouring countries. Transmission capacity is expected to be at least 10 GW (240 GWh/d) in 2030 for all x-border interconnection points.

Among the projects that could profit from the backbone are:

- The North Sea Wind Power Hub
  An opportunity for internationally coordinated, large scale, far offshore wind energy from the North Sea. An opportunity which would deliver energy at competitive prices by approximately 2030 and thus facilitate Europe meeting the targets of the Paris Agreement. The Netherlands is committed to exploring and developing regional socio-economic beneficial and reliable offshore infrastructure, including possible conversion into Power-to-Gas that supports wind farm operations and interconnections between markets.
- Djewels
  The project is a significant step towards scaling up the electrolysis technology, (co-) develop, own and operate a large-scale electrolyser, offering conversion services (electricity to hydrogen) to market parties, contribution to the development of a hydrogen economy in (North-) Netherlands, particularly in the chemical industry and mobility sector.

17 https://www.dewereldvanwaterstof.nl/longread-hydrogen/infrastructure/

Figure 11: *Porthos* (Source: Gasunie)

Carbon capture

Carbon Capture, utilisation and storage is a technology that offers significant reductions of carbon emissions. In the Netherlands two projects are under development, the *Porthos* project in the Rotterdam area and the *Athos* project in the Amsterdam area.

Porthos

The initiators of the *Porthos* (Port of Rotterdam CO_2 Transport Hub and Offshore Storage)[18] project are the Port of Rotterdam Authority, Energie Beheer Nederland B.V. (EBN) and N.V. Nederlandse Gasunie. These companies are working on the construction of a CO_2 transport and storage infrastructure between the Port of Rotterdam and depleted gas fields beneath the North Sea. Some of the CO_2 can be used in the South Holland greenhouses to ensure faster plant growth. The total length of the CO_2 infrastructure is around 55 km. The storage will take place in the P18 fields, 21 km off the Dutch coast.

Port of Rotterdam Authority, EBN and Gasunie are three organisations that play an important role in the Dutch energy landscape. In this project, each external organisation offers specific experience and expertise. Port of Rotterdam Authority with its knowledge of the local situation and market, EBN

18 https://www.rotterdamccus.nl/en/

with its expertise of the deep subsurface and Gasunie as gas infrastructure and transport expert.

Porthos has been granted Project of Common Interest (PCI) status by the European Commission. A PCI project is an energy infrastructure project that has obtained preferred status on behalf of the European Commission. This also means that permit applications are more streamlined and the applications are made simultaneously as one total package of permits.

Athos

Initiators of the *Athos* (Port of Amsterdam CO_2 Transport Hub and Offshore Storage)[19] project are the Port of Amsterdam, Energie Beheer Nederland B.V., NV Nederlandse Gasunie and Tata Steel. The companies are working on a project to capture, transport and store CO_2 in the North Holland region.

This project entails the development of a large-scale, open-access interoperable high-volume CO_2 transportation infrastructure from mainland Europe and Ireland to CO_2 storage locations in the Dutch section of the North Sea. The purpose of the project is to enable emission reduction for industrial CO_2 emitters in the Nordseekanal (and potentially from the Irish capture plants located at the Aghada & Whitegate CCGTs and the Irving Oil refinery) and the Ruhr area of Germany. Customers are planned to be large emitters from the Nordseekanal area. The Nordseekanal area is a highly suitable location for a CO_2 transportation and storage gateway for two reasons:

- It has large industrial clusters in close proximity, both in the Netherlands (the IJmuiden-Alkmaar-Amsterdam triangle, the Rotterdam area, and in the hinterland the cluster near Sittard-Geleen) and across the border (the industrial cluster near Antwerp, Belgium and the heavy and chemical industry of the Ruhr area, Germany). Within a radius of 200 km these CO_2 emission sources stemming from the power and industrial sectors of Rotterdam, Antwerp and North Rhine-Westphalia accumulate approximately 260 Mton/y CO_2.
- It has easy access to abundant CO_2 storage capacity in the North Sea, i. e. depleted natural gas fields.

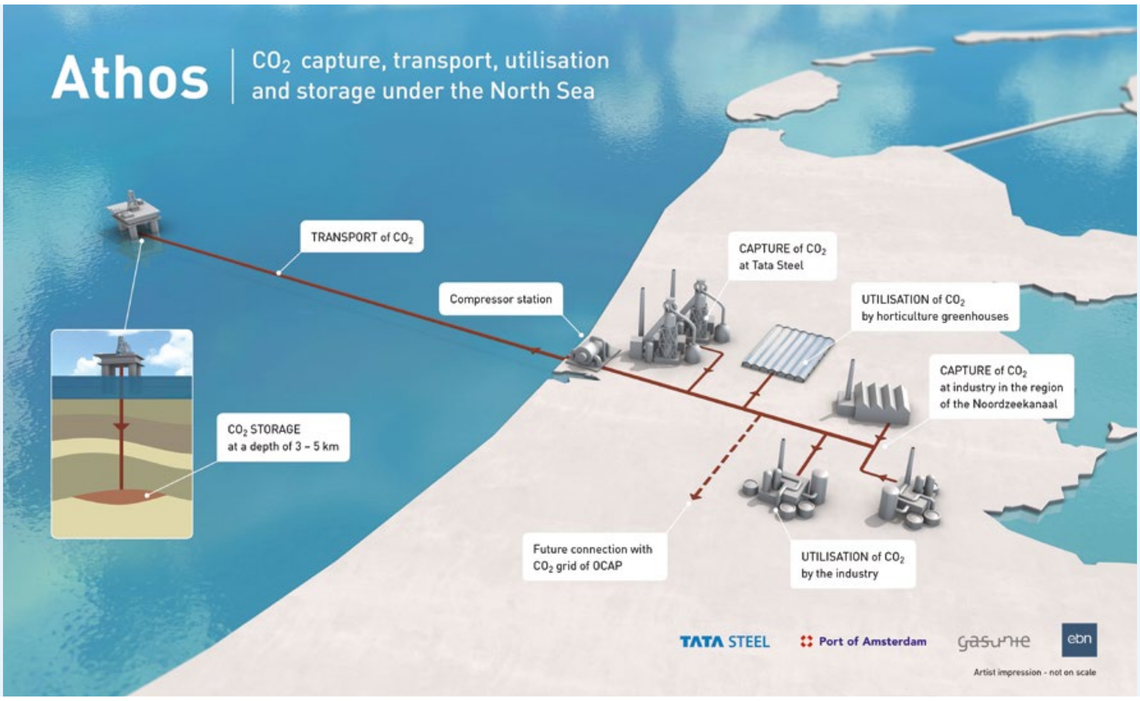


Figure 12: *Athos* (Source: Gasunie)

19 https://ec.europa.eu/info/sites/info/files/detailed_information_regarding_the_candidate_projects_in_co2_network_0.pdf

Heat transport grid South Holland

The Dutch Ministry of Economic Affairs and Climate Policy has appointed Gasunie to develop the first phase of the heat transmission grid in South Holland[20]. The grid will have a capacity of approximately 250 MW and will transport waste heat from the Rotterdam harbour. This heat is to be delivered to greenhouses, businesses and households in the Rotterdam/The Hague region.

The main trunk line will run from Rotterdam to The Hague. The development of this pipeline will be a cooperation between Gasunie and Port of Rotterdam Authority. When completed, the heat transport grid will be operated by Gasunie. The operation of the grid will be regulated, similar to the transmission of natural gas. This also means that it will be an open transport grid which may be used by a variety of heat suppliers.

The Rotterdam harbour can provide enough heat for about 500,000 households and most of the nearby greenhouses. The heat it provides to these consumers will replace existing gas fired heating, thereby reducing carbon emissions up to 2–3 megatons per year. As a consequence, this project will contribute to the national climate goals.

During the first phase of the project the economic feasibility will be investigated. A final investment decision is scheduled for 2020. Start of construction is expected in the beginning of 2021, so that the project can become operational in 2023.

Figure 13: Heat transport grid South Holland (Source: Gasunie)

20 https://www.gasunienewenergy.nl/projecten/warmtenet-zuid-holland

1.3.10 UNITED KINGDOM

Project *CLoCC*

Project *CLoCC* (Customer Low Cost Connections) has simplified the process of connecting to the National Transmission System (NTS) for a new generation of gas customers, opening up the NTS to a wider range of gas sources from smaller and larger connections. The project has successfully delivered against its three objectives:

I. Creating an online connections platform to facilitate the customer experience. The goal of this workstream was to consider what elements of the current connection process could be supported by development of an online gas customer connections portal and what functionality would be most beneficial to potential future customers.

II. Innovative physical connection solutions tailored to the needs of non-traditional NTS gas connections at high pressure. This workstream was tasked with completing a global technology watch, developing conceptual designs and conducting field trials of the proposed engineering connection solution(s).

III. Optimising commercial processes to meet the requirements of non-traditional NTS gas customers. Considering areas such as payment terms, fees and contract optimisation.

As a result of the project, we have demonstrated time and cost savings by considering the new Standard Design connection journey a customer follows and a number of customers have indicated they will be applying to National Grid for a Standard Design connection as the project is implemented.

First Biomethane Connection

To help prove the new concepts from project *CLoCC*, expressions of interest from potential pilot customers were invited in January 2018. From nine interested applicants, Somerset Farm in Cambridgeshire was selected. Somerset Farm is owned by Biocow Ltd, a leading operator of anaerobic digestion plants, and is supported by CNG Services. Since then there has been close cooperation with Biocow and CNG Services to develop the new connection for biomethane to enter the NTS, the first of its kind. This included allowing a more flexible oxygen specification using a new risk assessment. The goal is that the project will be commissioned in 2020. When Somerset Farm begins injecting its biogas into the NTS, it will be the first time a biomethane producer will connect to the high-pressure National Transmission System. This underlines support for the UK's Clean Growth Strategy and is an example of how the gas network can be used on the journey to decarbonise transport, heat and power generation. Continued collaboration with Biocow and CNG Services to learn from the implementation of the project and review policies and procedures in light of this new connection is intended.

Pictures courtesy of National Grid

Picture courtesy of National Grid

Fourdoun – First Compressed Natural Gas (CNG) connection

Work is ongoing on a new connection in Scotland with Air Liquide and CNG Services which will be the first of its kind for the NTS (and for any other 75 bar transmission grid in the EU). This is a Compressed Natural Gas (CNG) Mother Station which will use gas from the NTS to fill trailers to deliver CNG to a whisky distillery. This is Europe's largest "virtual" pipeline, transporting gas to off-grid distilleries to support the transition from oil (used for raising steam in the boilers) to cleaner natural gas with a 30 % reduction in carbon emissions. This is an exciting development as it is using the new concept of Self Build. Under this approach, the customer has been responsible for the design and build of the whole project including the NTS connection assets. In addition, following risk assessment, it was agreed that there was no requirement for a remotely operable valve to be installed which helped to reduce the capital costs. This project has been able to accommodate a number of firsts in the approach to the connection, including reducing costs to the customer wherever possible.

Picture courtesy of National Grid

Hydrogen in the NTS (*HyNTS*)

HyNTS is a programme of work that seeks to identify the opportunities and address the challenges that transporting hydrogen within Great Britain's National Transmission System (NTS) presents. This will unlock the potential of hydrogen to deliver the UK's 2050 net zero targets.

Currently there are three live projects under the HyNTS programme:

- **Project Cavendish**
  A review of the potential of the Isle of Grain region to use existing infrastructure to supply hydrogen to London and the South East including hydrogen generation, storage, transport and CCUS.
- **Hydrogen flow loop**
  Offline test loop to evaluate metallurgy changes on existing NTS steel pipe and new Mobile Automated Spiral Interlocking Pipe (MASIP) when exposed to 30 % hydrogen, identifying next steps to assess the NTS' suitability to transport hydrogen.
- **NTS hydrogen injection**
  To identify the requirements to enable a physical trial of hydrogen injection into the NTS, identifying the gaps in the safety case and indicating the most suitable NTS location for a live small-scale trial.

Two projects are under development:

- **Hydrogen deblending**
  To assess a variety of hydrogen recovery technologies and develop concept designs for selected options including a techno-economic review and identify the requirements for a demonstration project.
- **H21 Network operations Network Innovation Competition (NIC) 2019 bid**
  Supporting Northern Gas Network's 2019 NIC bid alongside the other Gas Distribution Networks to address the impact of 100 % hydrogen distribution from Local Transmission System offtakes to consumers' meters, encompassing the potential impact on current operational and maintenance activities, regulations and procedures.

Two projects are now completed:

- **Feasibility of hydrogen in the NTS**
  A feasibility study with the aim of determining the capability of the NTS to transport hydrogen. Includes a review of relevant assets, pipeline case study and draft scope for offline trials.
- **Aberdeen vision**
  A feasibility study for the generation of hydrogen at St Fergus using the NTS (up to 2 %) to supply the city of Aberdeen. Includes hydrogen generation, injection, separation and transport.

Picture courtesy of GASCADE

HyNTS is a programme of work that seeks to identify the opportunities and address the challenges that transporting hydrogen within the National Transmission System (NTS) presents. This will unlock the potential of hydrogen to deliver the UK`s 2050 net zero targets.

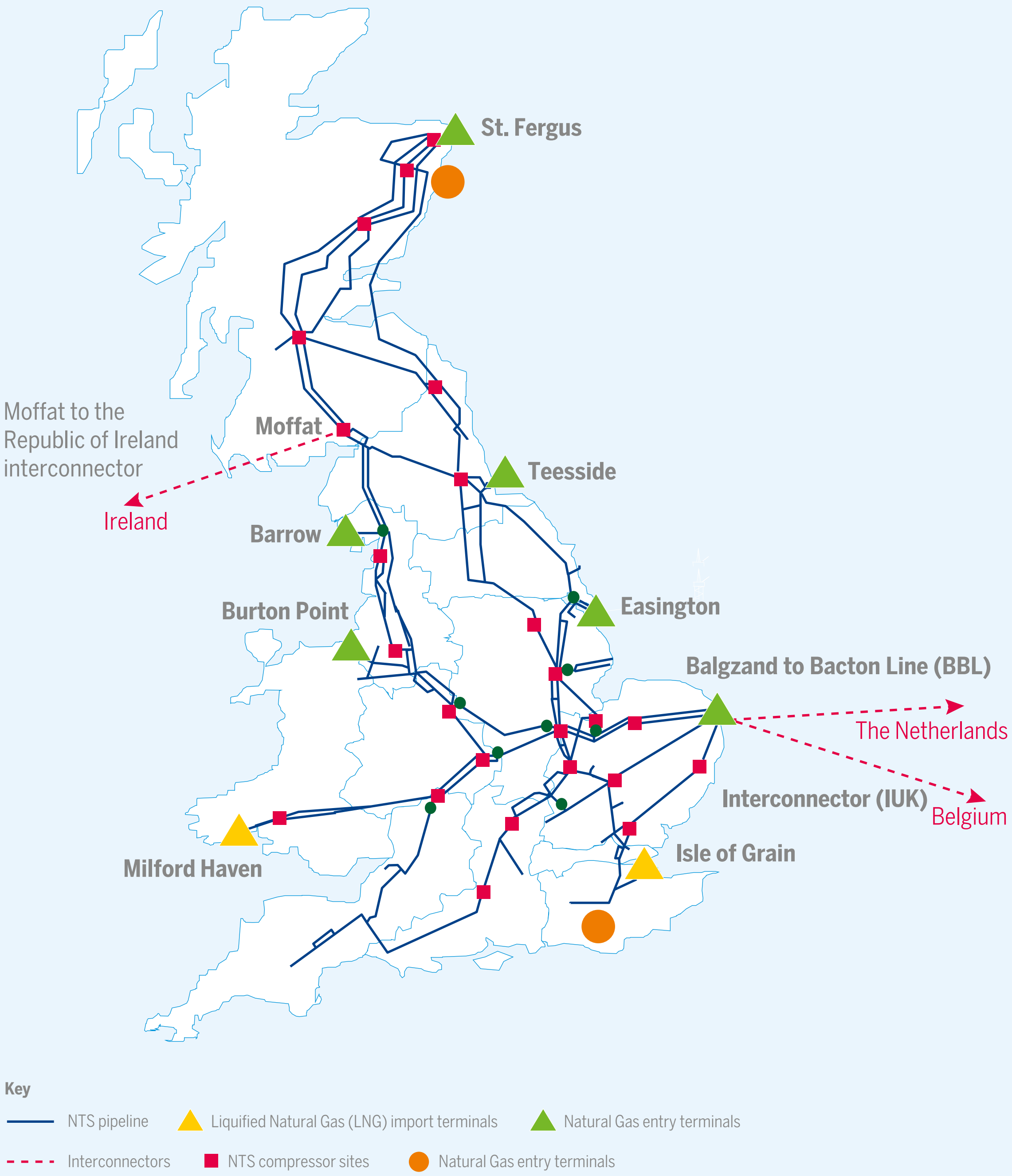


Figure 14: Hydrogen in the NTS (*HyNTS*) (Source: National Grid)

2 LOW CALORIFIC GAS AND CONVERSION PROJECTS

Low calorific gas (L-gas) supply in Germany and the Netherlands is in decline. Due to its different gas composition, L-gas markets will have to be converted and integrated into the existing high calorific gas (H-gas) networks. This conversion process has started in all three L-gas importing countries (Germany, Belgium and France).

As a consequence of its different gas composition, the L-gas markets in Germany, Belgium and France are physically separated from the H-gas markets in Europe. In addition, appliances not suitable for operating on H-gas are suitable for L-gas and vice versa in all countries.

The L-gas market today serves more than 14 million customers and has a considerable share in the gas markets of the Netherlands, Germany, Belgium and France, as indicated in the map below.

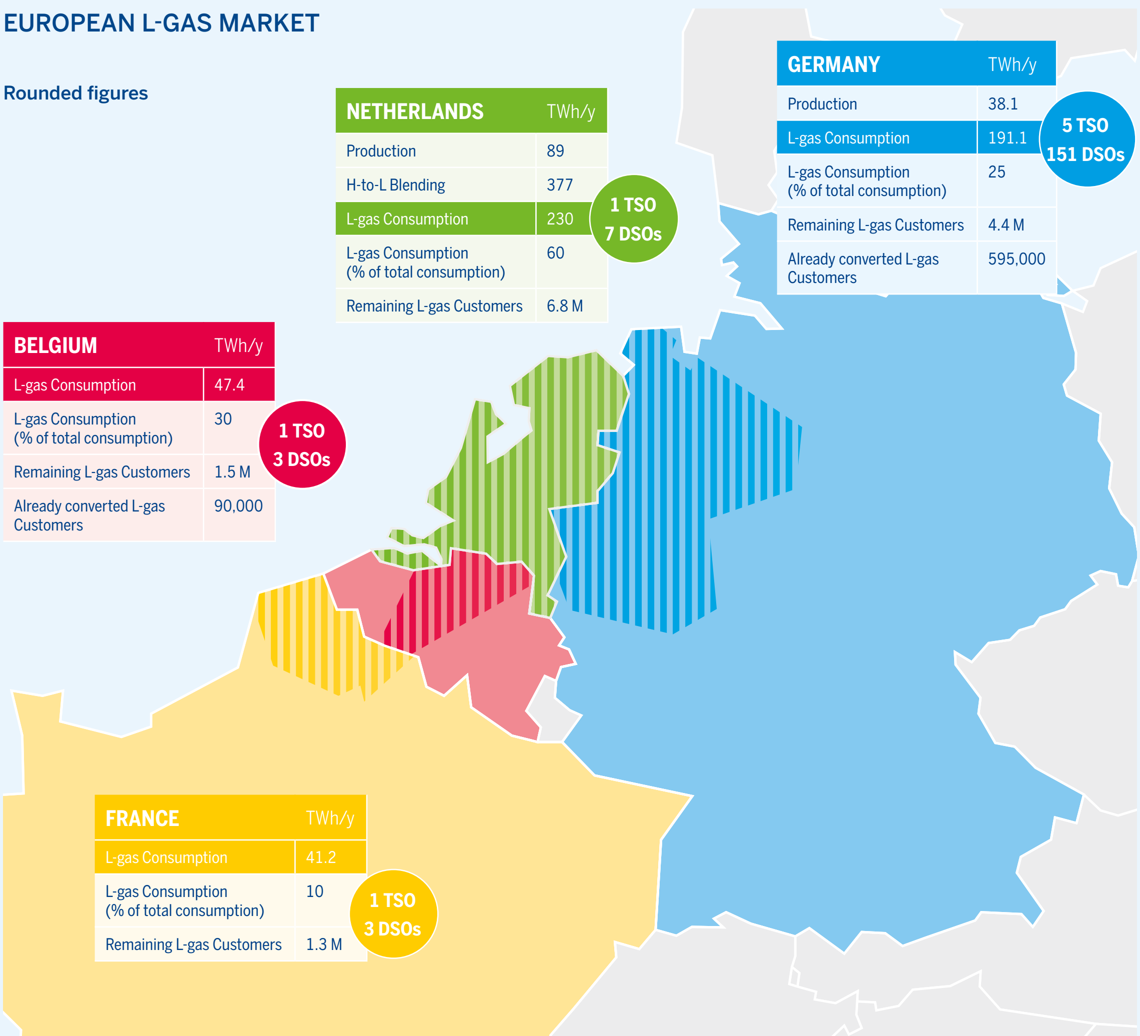


Figure 15: European L-gas market in 2020 (Source: L-gas Market Conversion Review, IEA/ENTSOG, Dutch MEA and NW GRIP TSOs)

2.1 L-GAS SUPPLY FROM THE NETHERLANDS

About 90 % of L-gas demand in NW Europe is supplied from the Netherlands, of which some 30 % was directly produced from the Groningen gas field in gas year 2018/19. The remainder is supplied by a blend from various H-gas sources. These H-gas sources can be domestic production from small fields or from import.

Historically, the main supplier of L-gas in NW Europe was the Groningen gas field in the Netherlands. This can be seen in the graph below which shows the historical gas production from the Groningen gas field.

Since an earthquake in 2012 it has become apparent that gas production from the Groningen field induces earthquakes which could pose unacceptable safety risks for the people living on top of the Groningen gas field. There have been approximately 1,300 gas production induced earthquakes in Groningen, as can be seen in Figure 18.

In May 2019 a gas production induced earthquake occurred with magnitude 3.4 on the Richter Scale. After this earthquake the State Supervision of Mines advised the Dutch Minister of Economic Affairs and Climate Policy to reduce the Groningen production in gas year 2019/2020 to 12 bcm/y (117 TWh) on average. This advice followed their previous advice to reduce the Groningen production to 12 bcm as soon as possible. Following the advice of the Dutch State Supervision of Mines, the Dutch Minister of Economic Affairs and Climate Policy asked the Dutch TSO GTS to investigate the possibility of accelerating the decrease of the national production to a safe level of 12 bcm (117 TWh) in an average gas year, while maintaining security of supply. To reach this goal, GTS advised the Minister responsible to take several measures (see below). With these proposed measures gas production of Groningen will reach a safe level in gas year 2019/2020 and the Netherlands is able to deliver sufficient L-gas to the L-gas customers in the Netherlands, Germany, Belgium and France. The Minister decided to implement all the proposed measures. In accordance with the Dutch Gas act, it was decided that additional production from the Groningen field is permitted in case of a colder than average winter. In March 2020 the Dutch Minister of Economic Affairs and Climate Policy decided to reduce the Groningen production for gas year 2019/2020 with 1.1 bcm to 10.7 bcm (105 TWh) Groningen gas in an average year. The reason for the reduction was due to the high nitrogen utilization in the first quarter of the gas year and the expansion of UGS Norg.

Picture courtesy of Fluxys Belgium

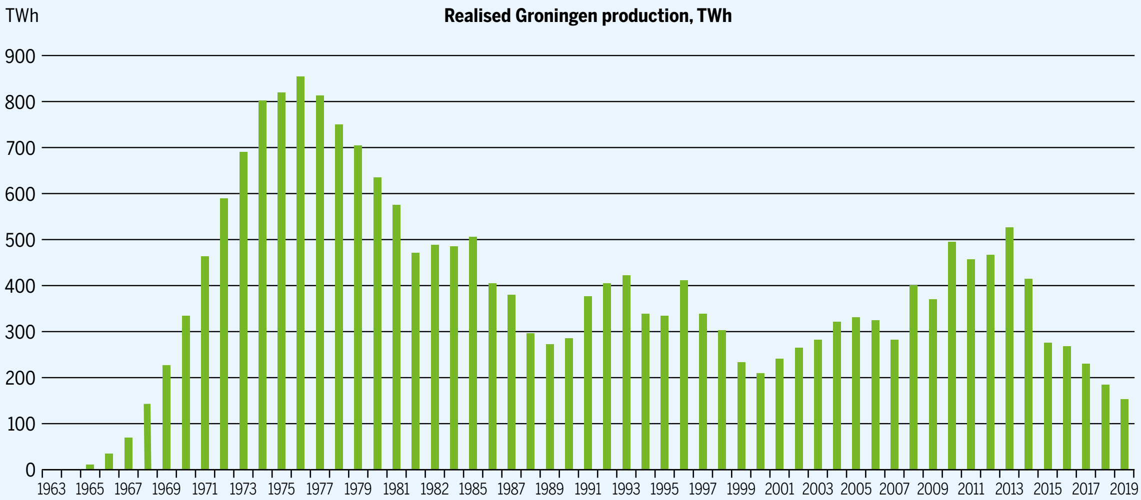


Figure 16: Realised Groningen production (Source: NAM)[21]

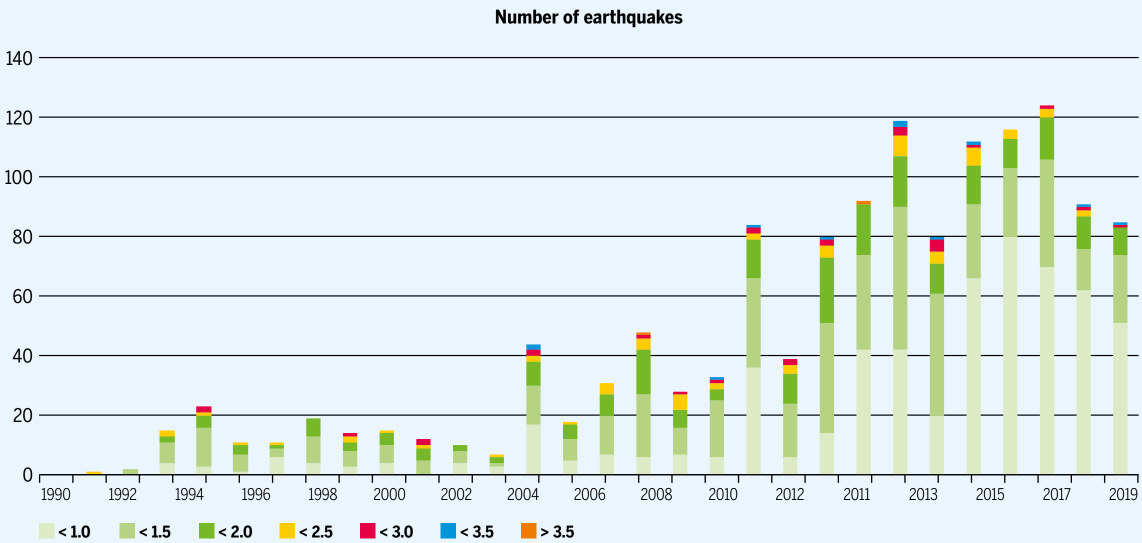


Figure 17: Number of earthquakes and their magnitude in the Groningen gas field – from 1990 to 2019 (Source: NAM)

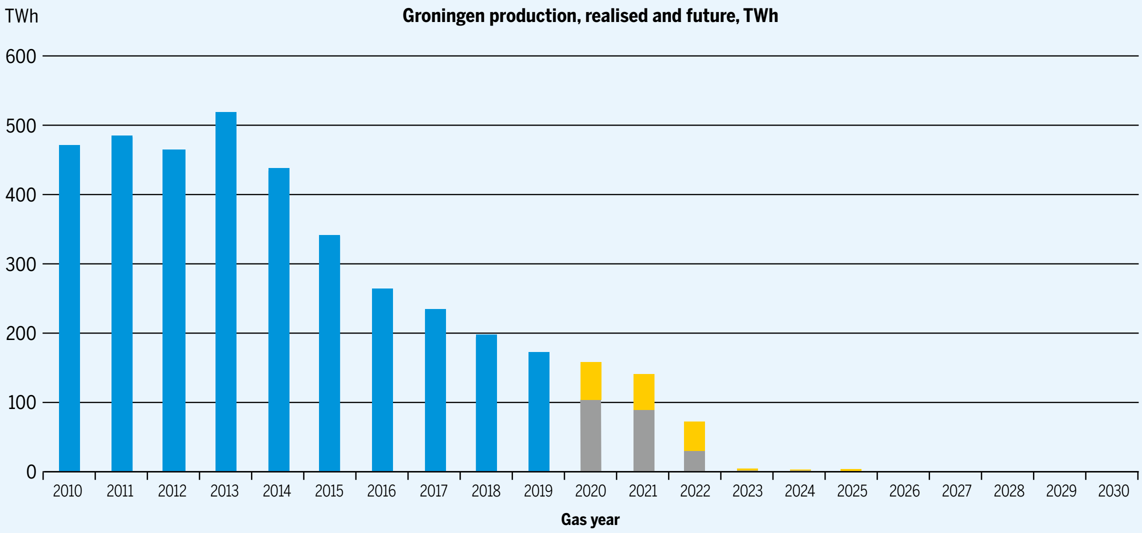


Figure 18: Groningen production, realised and future (Source: NAM (blue), GTS* (grey, needed for an average year and yellow, allowed extra production for a cold year))

* Letter of GTS to Minister of Economic Affairs and Climate Policy, "Finaal advies over maatregelen om de Groningenproductie te reduceren", 25 July 2019, kenmerk L 19.0026

21 www.nam.nl/feiten-en-cijfers/gaswinning.html

The following measures were announced in 2018 to reduce the Groningen production:

- Increase the utilisation of the existing nitrogen facilities for gas year 2018/2019;
- Purchase additional nitrogen (additional nitrogen capacity 80,000 m³/h) for an existing blending facility of GTS which can produce an additional 2.2 to 2.5 bcm (21.5–24.4 TWh) of pseudo L-gas from January 2020 onwards;
- Invest in a new nitrogen plant at Zuidbroek (nitrogen capacity of 180,000 m³/h) which can, starting April 2022, produce up to 7 bcm (68 TWh) of pseudo L-gas in a cold year;
- Nine large industrial clients will be converted from L-gas to H-gas or other sources of energy between gas year 2019–2020 and gas year 2022. This process is planned to become part of binding law in 2020.
- Other Dutch (industrial) consumers have been asked to replace their L-gas industrial processes by H-gas or renewable energy, although in a less binding timeframe.

These additional measures were announced in September 2019 to accelerate the reduction of the Groningen production:

- Further increase the utilisation of the existing nitrogen facilities for gas year 2019/2020
- Fill UGS Norg with pseudo L-gas instead of Groningen gas for gas year 2019/2020;
- Export pseudo L-gas instead of Groningen gas via Oude Statenzijl to the Northern part of Germany as of April 2020;
- Fill UGS Norg with 1 bcm less than the working gas volume used from UGS Norg in the winter of gas year 2019/2020.

As indicated in Figure 19, the analysis made by GTS shows that the production from the Groningen field would not be required after 2022 in an average gas year, taking into account the remaining L-gas demand needs in Belgium, France and Germany that can be supplied by other L-gas imports from the Netherlands. Only in colder than average winters it is possible that some production is still required from the Groningen field in order to maintain security of supply in the L-gas region. The capacity from the Groningen field is necessary until 2026 to guarantee security of supply in the L-gas region.

In order to facilitate the accelerated closure of the Groningen field, the Dutch TSO GTS has advised the Minister of Economic Affairs and Climate Policy to take measures to ensure that there are sufficient gas storages in the Netherlands and also ensure that there is sufficient supply of H-gas into the Netherlands.

Due to the decreasing L-gas export to Germany, Belgium and France, the Dutch TSO GTS is investigating how to utilise the gas infrastructure for hydrogen and carbon dioxide transport. For more information see the energy transition chapter.

2.2 L-GAS MARKET IN GERMANY

The L-gas market historically developed in the north-western part of Germany, close to the indigenous production and the Dutch border. It consists of approximately 4.4 million appliances, supplied via the networks of 5 TSOs and 151 DSOs. Several underground storage facilities are also connected to the TSOs' networks.

Similar to the situation in the Netherlands, the German indigenous production is also declining. Figure 21 shows the historical yearly production volumes for the years 2006 to 2018 as well as the producers' outlooks up to 2029/2030.

Figure 19: L-gas transmission network Germany (Source: TSOs Germany)

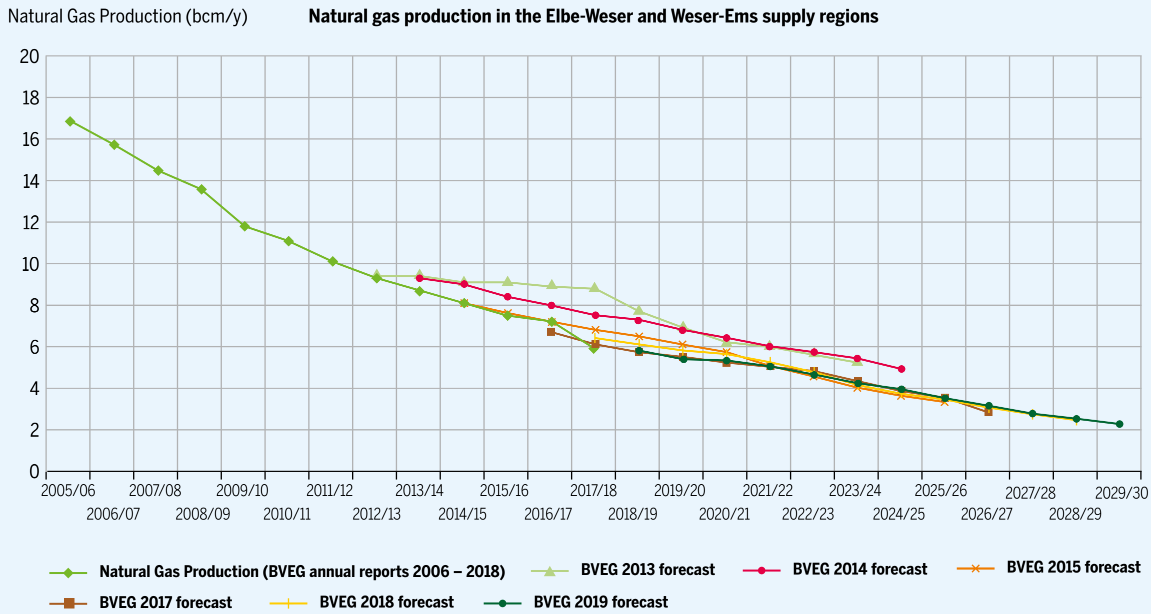


Figure 20: Natural gas production Germany, regions Elbe-Weser and Weser-Ems (Source: Gas Network Development Plan 2020–2030 – Scenario Framework)

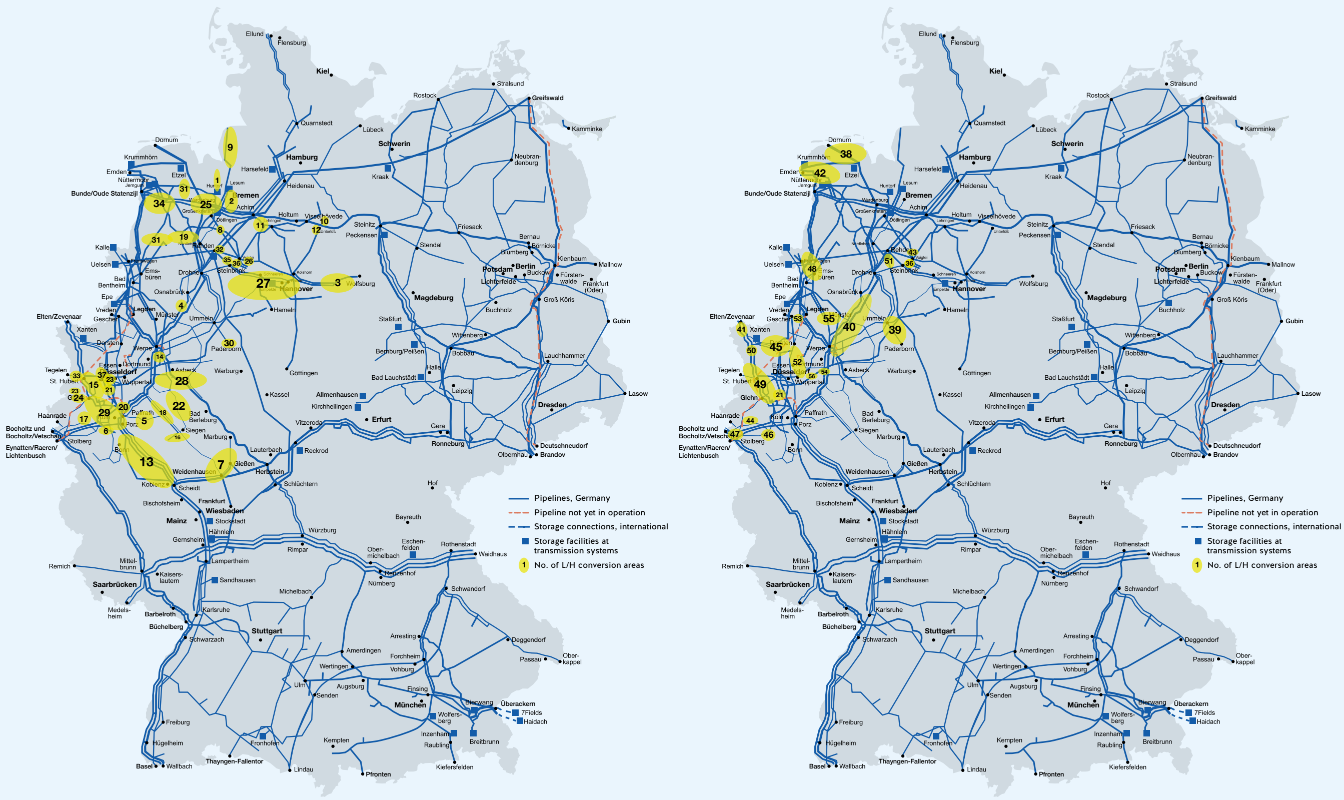


Figure 21: Conversion areas until 2025 (left) and conversion areas from 2026 until 2030 (right) (Source: Gas Network Development Plan 2020–2030 – Consultation Document)

To meet the challenges of declining supply, the German TSOs, in close cooperation with market participants and national authorities, have started a process for market conversion from L-gas to H-gas, which will last till 2030. After 2030, a small L-gas market will remain which will be supplied by the residual domestic production.

The conversion process developed in the national development plan is based on roughly 100 local grid areas. Figure 22 shows the main areas in the period till 2025 and from 2026 to 2030.

The conversion of customers started in 2015 with smaller areas. By the end of 2019 approximately 600,000 installed appliances were successfully converted to the supply of H-gas. The respective grid areas have been switched to H-gas on schedule without major problems.

In the market conversion all appliances of customers supplied with L-gas will have to be checked and adapted to H-gas. The number of customers that can be converted per year is limited by the number of available experts who can handle the adaption.

The conversion of the German L-gas market is therefore planned over a long period (starting in 2015 till 2030) due to the large number of L-gas customers. The number of customers/appliances that will be converted per year is constantly increasing from year 2015 to 2021. A plateau of roughly 550,000 appliances will be reached in 2021. In 2019, 319,000 appliances were converted. For 2020, 394,000 appliances are planned to be converted to H-gas.

For the conversion of some areas in the later stages of the plan extensive technical changes on the system are required. The long planning horizon of the conversion plan allows for technical adaption of the system in time.

On the transport system side, adaptation of the infrastructure is needed not only in order to connect the (former) L-gas system to the H-gas grid but also to enhance system capacity for the additional volume that is needed to supply the converted market.

The national network development plan 2018 identifies more than 70 projects related to the market conversion from L-gas to H-gas. The complexity of these projects ranges from single valves and metering stations to new pipelines and compressor stations. About 357 km of new pipelines and 283 MW of additional power on compressor stations are needed to enhance the transport system for the market conversion by 2028.

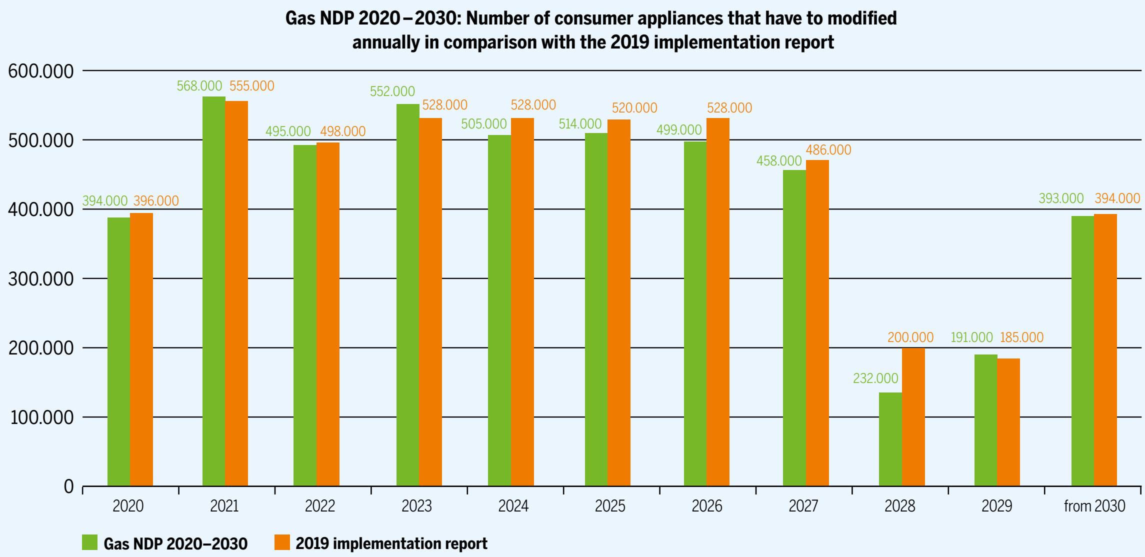


Figure 22: Number of consumer appliances to be converted annually by 2030 compared to the gas Network Development Plan 2020–2030 (Source: Gas Network Development Plan 2020–2030 – Consultation Document)

2.3 L-GAS MARKET IN BELGIUM

The Dutch authorities have announced that exports of L-gas to Belgium, France and Germany will cease by 2030. To guarantee security of supply, Belgium, France and Germany have started converting the L-gas market to H-gas. There is plenty of H-gas available and the existing L-gas transmission infrastructure can be re-used for H-gas, resulting in an economically optimal solution for all users.

At the request of the Belgian authorities, Synergrid (Federation of Electricity and Gas System Operators in Belgium) produced an indicative conversion timetable (see figure below). This indicative timetable is based on repurposing as much existing Belgian infrastructure as possible with a view to avoiding investments that are only necessary for the transition period.

For the conversion to be a success, Fluxys Belgium has to gradually adapt its grid to ensure the continuity of transmission services for both converted and non-converted markets. The required adjustments have been assessed, costed and included in the Fluxys Belgium indicative investment plan for 2020–2029.

The conversion phases scheduled for 2016 to 2019 were completed as planned with around 90,000 connections already converted over this period, including some industrial users directly connected to the Fluxys Belgium grid.

The main changes to be made to the transmission system involve connecting and gradually integrating L-gas transmission infrastructure into the H-gas transmission system. Following the conversion timetable, existing connections between the L and H grids will be adapted, if necessary, in order to selectively supply H-gas to distribution system operators and industrial customers.

However, on some parts of the grid, the capacity of the existing connections will not be sufficient and some upgrades will have to be made, especially on connections between the major L-gas (north-south) and H-gas transmission routes (east-west).

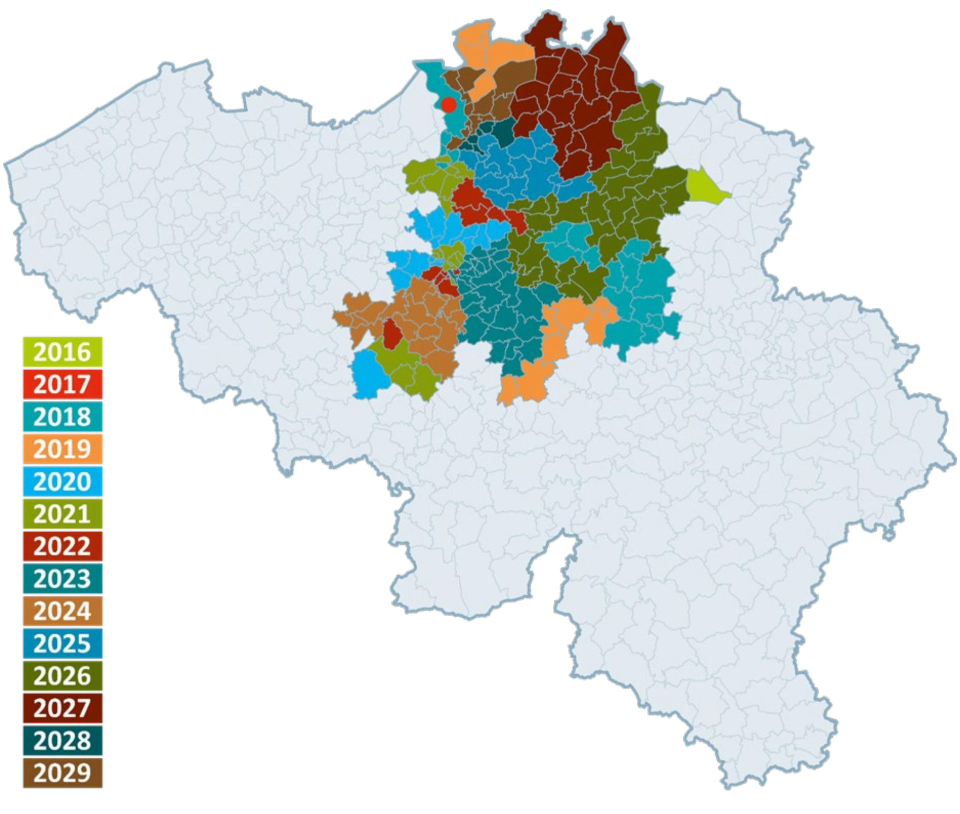


Figure 23: Indicative timetable for the conversion of the L-gas market (Source: Synergrid)

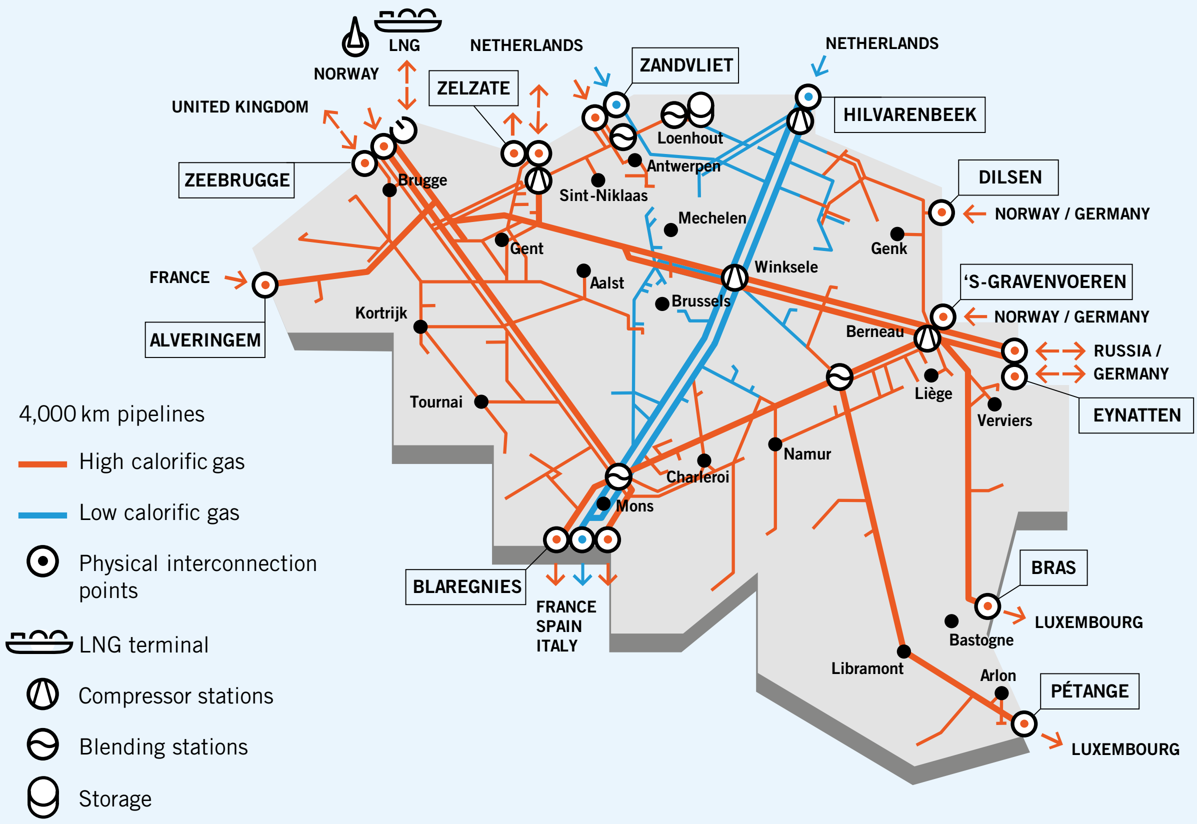


Figure 24: Gas network Fluxys Belgium (Source: Fluxys Belgium)

Maintaining capacity to the L-gas markets that are not yet converted is a significant constraint, especially as regards export capacity to the French market that needs to be guaranteed. Since there is only a single entry point for L-gas at Hilvarenbeek and a single exit point at Blaregnies (for transmission to France), one of the two parallel L-gas pipelines (Dorsales) will need to continue transmitting L-gas until the conversion of the French market is complete. To this end, there is close coordination between Fluxys Belgium and the Dutch and French TSOs (GTS and GRTgaz).

As such, the Belgian market can only be converted by gradually supplying H-gas from the second Dorsale, primarily from a yet-to-be-built interconnection at Winksele at the crossroad of the major H-gas transmission axis Zeebrugge-Eynatten and the Dorsales, in the heart of the L-gas market awaiting conversion. With that in mind, the conversion process will run from south to north, gradually pushing back the L-gas to the entry point at Hilvarenbeek.

At each stage of the conversion process, the affected L-gas customers need to be supplied with H-gas. Since the Hilvarenbeek entry point is only supplied with L-gas at present, the companies shipping gas to these new customers need to have entry capacity at another (H-gas) entry point on the Fluxys Belgium grid.

Fluxys Belgium's assessments currently suggest that on the whole, there is enough H-gas entry capacity to absorb the 'new Belgian domestic market's' needs for H-gas capacity. The Fluxys Belgium indicative plan for 2020–2029 therefore does not include new investments aimed at boosting H-gas entry capacity. These assessments will be reviewed based on signals and indications from the market, particularly needs relating to the replacement of L-gas in France and Germany.

Following their conversion to H-gas, the main west-east and north-south transmission pipelines on the Fluxys Belgium grid will be able to play a major role in replacing L-gas on the German and French markets, in terms of both diversity and security of supply and access to LNG sources.

2.4 L-GAS MARKET IN FRANCE

The L-gas network is supplying the Northern region of France, representing around 10 % of national gas demand, and 1.3 million customers.

It is supplied by one entry point from Groningen through Belgium at Blaregnies / Taisnières L. The L-gas network also includes a peak-conversion facility from H-gas to L-gas at Loon Plage, and an underground storage (UGS) facility at Gournay. The H-gas and L-gas balancing zone have been merged into PEG Nord since April 2013.

Figure 25: L-gas and H-gas networks in France (Source: GRTgaz)

Considering the end of the Dutch L-gas exports by 2030 and the recent decision to limit production at Groningen, the continuity of transmission to consumers must be ensured by converting the L-gas network into H-gas, which already supplies most of French consumers. This will require modifications of the gas network, in addition to an intervention at each consumer to take an inventory of appliances using natural gas, and potentially apply new settings, or even replace them.

Establishing a legal and regulatory framework was a prerequisite for the finalisation of the conversion plan, in order to define the operating schedule, the responsibilities of the different stakeholders, and the technical requirements. A decree from the French Government, issued on March 23rd 2016 (n°2016-348), specifies the regulatory framework and the general organisation of the conversion operation. It introduces a pilot phase between 2016 and 2020, a coordination committee led by national authorities, and a draft joint conversion plan by the network and storage operators.

Operators joined forces to work closely with the public authorities on preparing a draft conversion plan for submission to the relevant ministerial authorities on 23 September 2016. This plan was then subject to an economic and technical evaluation by the CRE.

This conversion plan is based on a breakdown of the current L-gas consumption into 20 geographical sectors. Each sector will be converted independently and successively, from Dunkerque to Taisnières, enabling a gradual conversion until 2029 at the latest, with a conversion rate compatible with the interventions required for each of the 1.3 million customers.

The first sections to be converted during the pilot phase are the areas around Dunkerque, Grande Synthe, Doullens and Gravelines, which are close to the H-gas network. To prepare for conversion of these sections between 2018 and 2020, GRTgaz has prepared the required modifications on the transmission network, which include connections between the L-gas network (67.7 bar) and the H-gas network (85 bar) and a 2 km pipeline between Brouckerque and Spycker. Doullens was the first area to be converted in France which started April 2019.

A second phase of adaptation of the transmission network will be needed for the full deployment of the conversion, currently planned from 2021. A final investment decision (FID) has been taken in 2019 for the works to be commissioned by 2023, including modifications of Loon-Plage station in order to start injecting H-gas in the L-gas network; modifications of Taisnières station to reduce minimum flow limit and improve the H>L blending facilities; the construction of a new pipeline between Béthune Sud and Lens of 300 mm diameter and approximately 12 km (if no other solution is possible); the connections of L-gas network and H-gas network at different locations; the installation of new isolation valves in order to ensure safe separation between H-gas and L-gas; and the adaptation of field instrumentation for gas quality control and GCV computation.

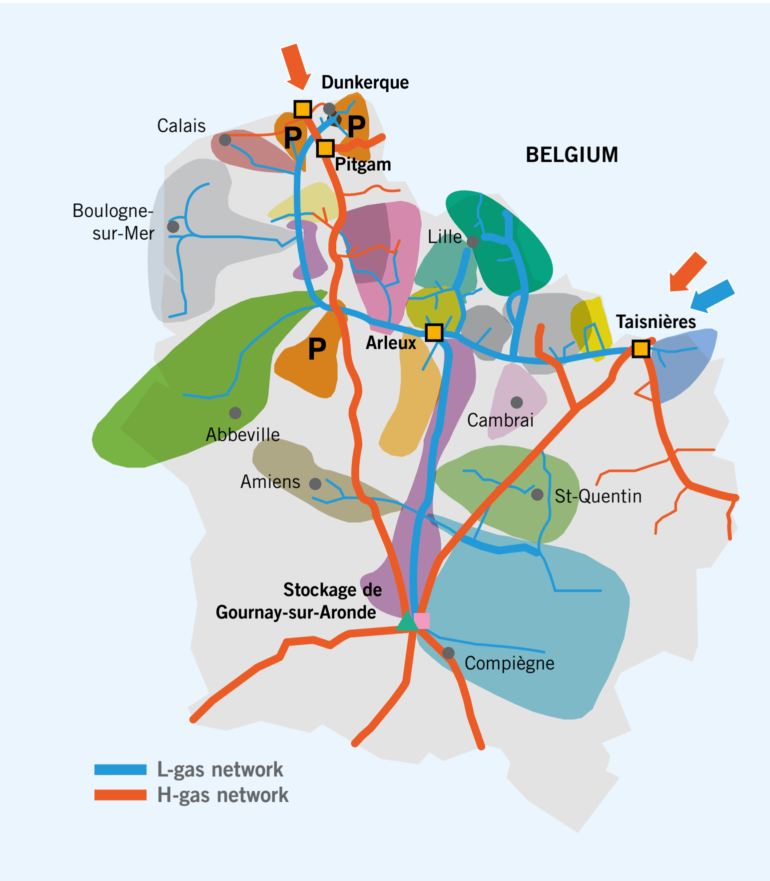


Figure 26: Clustering of L-gas conversion process (Source: GRTgaz)

The conversion plan will have consequences for GRTgaz's transmission service. Firstly, a gas referred as 'L plus gas' will be used so that customers' appliances can be adjusted to H-gas configuration before inflows of H-gas are launched. This 'L plus gas' is compliant with the specifications of L-gas, but with a Wobbe index that is stable within a smaller range (in the upper level of the L range). Specifications related to 'L plus gas' have already been integrated into Dutch regulations for gas transmitted to Belgium and France since 1 April 2016.

Secondly, the „peak" H-gas to L-gas conversion service at Loon-plage will be phased out by the summer of 2021. This will be followed by a reduction in firm entry capacity at Taisnières L from 230 GWh/day to 115 GWh/day in 2025 as one of the two Artois Est pipelines between Taisnières and Arleux will be converted to H-gas (it being noted that storage at Gournay should operate with L-gas until 2026).

These changes correspond to GRTgaz's current forecasts, which reflect the draft conversion plan submitted to the authorities on 23 September 2016. In particular, the dates referred to above may change if the conversion schedule currently planned is revised.

2.5 SUPPLY ADEQUACY OUTLOOK

This section compares the outlook of L-gas demand and supply evolution until 2030 when conversion processes are supposed to be finalised in Belgium, France and Germany.

In January 2020, the International Energy Agency (IEA), the European Network of Transmission System Operators for Gas (ENTSOG), Gasunie Transport Services (GTS), and the Netherland's Ministry of Economic Affairs and Climate Policy completed the L-gas Market Conversion Review report[22] under the umbrella of the Task Force Monitoring L-gas Market Conversion, which consisted of government representatives, representatives of transmission system operators (TSOs) and energy market regulators from Belgium, France, Germany, and the Netherlands, and an observer from the European Commission.

The review report was aimed at monitoring the progress of the L-gas market conversion in Belgium, France and Germany and the activities in the Netherlands to increase the production of pseudo L-gas and reduce the consumption of L-gas in the Netherlands, as well as the overall security of supply developments within the low-calorific market region.

An important part was the supply-demand balance for the four L-gas consuming countries for the coming years. In Figure 28, the red line indicates falling demand in the entire L-gas region for the next ten gas years. The bars indicate the different sources of supply. The study showed that demand within the entire L-gas region can be covered by production from the Groningen field, production in Germany, enrichment of L-gas and H-gas blended with nitrogen.

It is the conclusion of the first Task Force report from January 2020 that the continuous adaptation of system operators' infrastructure carried out in the context of the L-to-H conversion programmes (transmission, storage and distribution) were consistent with the L-gas demand and supply projections available at that time.

It must be noted, however, that the outbreak of COVID-19 in Europe has delayed field conversion works since March 2020. As a result, the countries involved recognise a potential impact on their respective conversion plans. The impact on the L-gas supply and demand projections will be assessed in a second report of the L-gas Market Conversion Monitoring Taskforce, which is scheduled to be finalised in September 2020.

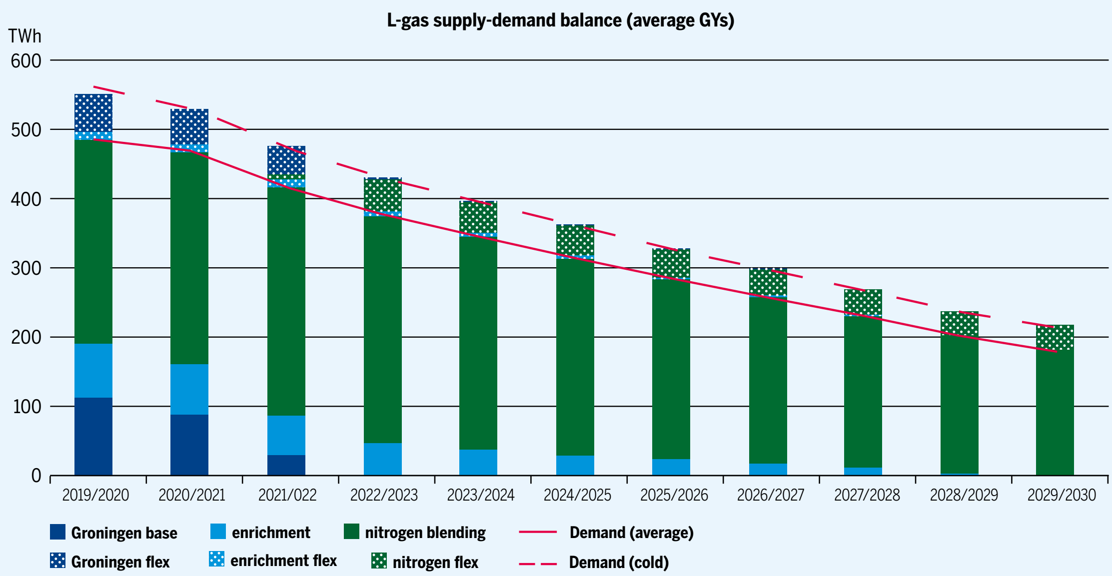


Figure 27: L-gas supply-demand balance projection in an average and cold year (GY 19/20–GY 29/30) (Source: Task Force Monitoring L-Gas Market Conversion – Winter Report 2020)

22 https://www.tweedekamer.nl/downloads/document?id=0c830534-a254-4f4d-90c4-297c5014e89f&title=L%20-%20Gas%20Market%20Conversion%20Review.%20Winter%20Report%202020.%20Task%20Force%20Monitoring%20L-Gas%20Market.%20Conversion.pdf

2.6 PROJECTS OF COMMON INTEREST

The infrastructure projects related to the L/H conversion in Belgium and France as promoted by Fluxys Belgium and GRTgaz have been acknowledged as Projects of Common Interest (PCI) as of 2017. In the 4th PCI selection this status has recently been renewed by the European Commission, reconfirming these projects as essential infrastructure needs in North-West Europe.

CONCLUSION


Picture courtesy of EUGAL

This report represents the fourth edition of the NW GRIP as prepared by the TSOs of the NW Region.

The first part of the report provides an overview of projects and initiatives that gas TSOs are involved in to facilitate the decarbonisation of the gas infrastructure across North West Europe. These initiatives demonstrate the commitment of TSOs from the NW Region to actively engage in the decarbonisation of the gas and energy system as a whole. The technologies adopted vary from Member State to Member State, reflecting the differing focuses of national policies.

The second part of the report describes the developments in the L-gas region. It is shown that there is sufficient L-gas supply to cover security of supply (SoS) needs in the different L-gas consuming countries. It can also be concluded that the measures to increase conversion capacity and reduce L-gas demand in the Netherlands and the planned L to H infrastructure conversion in France, Belgium and Germany are on track. Furthermore it is key to maintain good international cooperation and alignment between the concerned countries in order to ensure security of supply in the L-gas region for the coming years.

The NW GRIP TSOs hope that this report offers a valuable insight in the main dynamics of the NW Region and welcome any stakeholder feedback for further improvements in the future.

LIST OF FIGURES

LEGAL DISCLAIMER

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