INDICATIVE INVESTMENT PLAN FLUXYS BELGIUM & FLUXYS LNG 2024-2033

September 2024

Contents

Purpose

The indicative investment plan 2024-2033 sets out all investments needed to keep up with changes in Belgium's natural gas market, to maintain and to upgrade the infrastructure of Fluxys Belgium and Fluxys LNG and to ensure the completion of the targets set to reduce the installations' greenhouse gas (GHG) footprint.

The investments described in this document are provided for reference purposes only and relate to gas transmission and storage infrastructure in Belgium as well as to the Zeebrugge LNG terminal.

Fluxys is committed to ensuring that new major investments are compatible with the energy transition either by reducing its GHG emissions, or by building new infrastructure that is hydrogen compliant.

This document is established in accordance with Art 15/13, §2- 3° of the Gas Decree dd April 12th, 1965.

Outlook for 2024-2033

Changes in the market in Europe and in Belgium lead to some investments and adjustments of Belgium's natural gas transmission infrastructure to make it "fit for the future". Investments preparing for a new jetty in Zeebrugge or the completion of a second path between Zeebrugge and Germany, fit for the transport of hydrogen, are among such projects.

The energy transition is accelerating and Fluxys plans to invest more than 60% of its full investment plan in new molecules infrastructure

Our unconditional commitment to safety calls for recurring investments in maintaining, adjusting, and modernising the network. Furthermore, Fluxys Belgium needs to adapt its network in line with evolving demand from public distribution and industrial customers, considering on the one hand new connection requests and on the other hand structural consumption decline due to better insulation of households or switch to heat pumps.

Fluxys also continues in investing in Digital to enhance its existing tools, integrate new molecules in the processes and improve its operations.

Fluxys is also working hard to reduce its CO_2 footprint and the methane emissions from its network. The target set is 50% reduction (compared to 2017) of GHG emissions by 2025.

Fluxys Belgium is fully committed to help realising the energy transition; more details are provided in an annex to this document. There is a strong desire to reuse as much of the existing natural gas infrastructure as possible to transport future

gases, and an extensive analysis of the technical conditions for repurposing such infrastructure is under way.

Annex: Hydrogen and CO_2 networks

An annex detailing the outlook beyond the current framework of the Belgian Gas Act has been appended to the indicative investment plan 2024-2033, which was drawn up in accordance with Article 15/1, §5 of said Act.

> This annex sets out the future development of hydrogen and CO_2 transmission systems in Belgium, which will be based in part on the reuse of Fluxys Belgium's natural gas transmission infrastructure. Investments will follow demand.

A new law has been published on July 27th, 2023 in the Belgian Law gazette (Moniteur belge-Belgisch Staatsblad), the "Hydrogen Law".

This law :

- Guarantees non-discriminatory access to the hydrogen transport network for all interested parties.
- Defines the rules and procedures for preparing the network development plan and for setting regulated network tariffs.
- Designates the CREG as the regulator for hydrogen transport.

On April 26th, 2024, Fluxys Hydrogen, a subsidiary of Fluxys Belgium, has been appointed as operator for the development and operations of a hydrogen transmission grid in Belgium.

The European gas market

Trends in Gas Year 2022-2023[1]

In Gas Year 2022-2023 Gas consumption in EU27 reached 3,730 TWh (or 330 bcm), down 14% compared to gas year 21-22. Compared to Gas Year 2018-2019, this represents a decrease of 19%. This can also be seen on figure 1, that shows the apparent gas consumption[2] in the EU27 and including UK, Switzerland and the Balkans, based on data from the ENTSOG transparency platform.

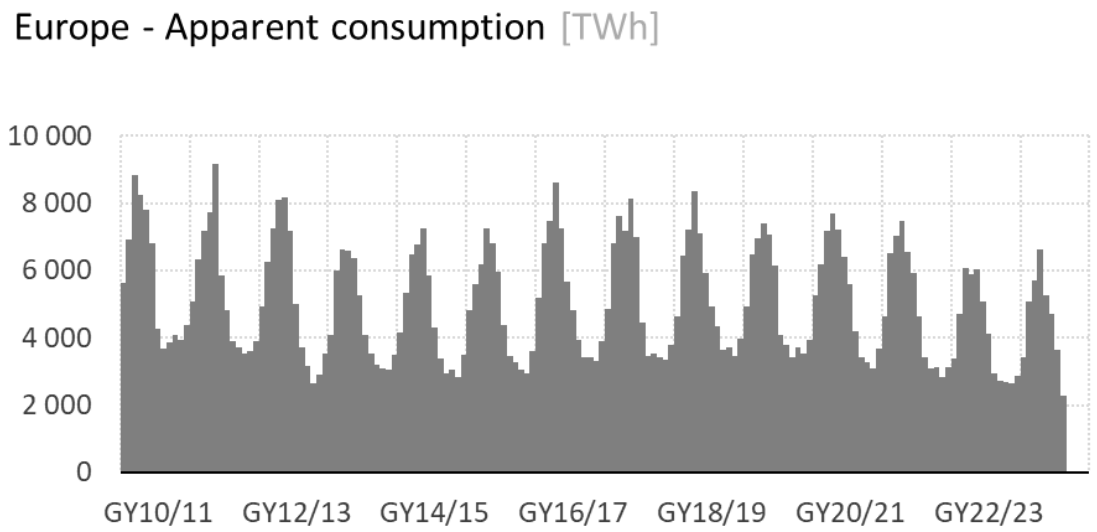

FIGURE 1 : APPARENT CONSUMPTION FOR EU27+UK+CH+BALKANS (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

The European natural gas production reached 400 TWh (or 40.2 bcm), down 10% from production during Gas Year 2021-2022. The Netherlands were the main producer, followed by Romania, Poland and Germany.

As shown on figures 2 and 3, natural gas imported by pipeline from Norway (910 TWh) and as LNG(1,405 TWh) together covered nearly 2/3 of natural gas consumption. Imports from Russia through pipelines have continued their decline, to reach 267 TWh (coming from 954 TWh the previous gas year)

[1] All figures (translated from bcm to TWh) are coming from the "Quarterly Reports On European gas markets" edited by the European Commission.

[2] Apparent gas consumption is calculated as follows: production+imports+storage withdrawal-export-storage injection. This apparent gas consumption is often used when definitive consumption data are not available.

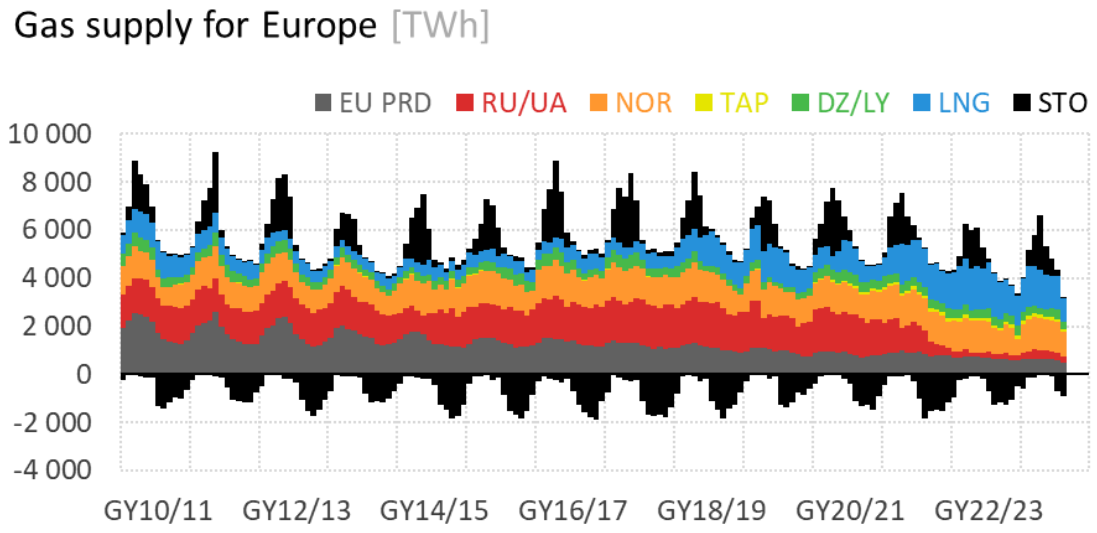

FIGURE 2 : GAS SUPPLY FOR EUROPE (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

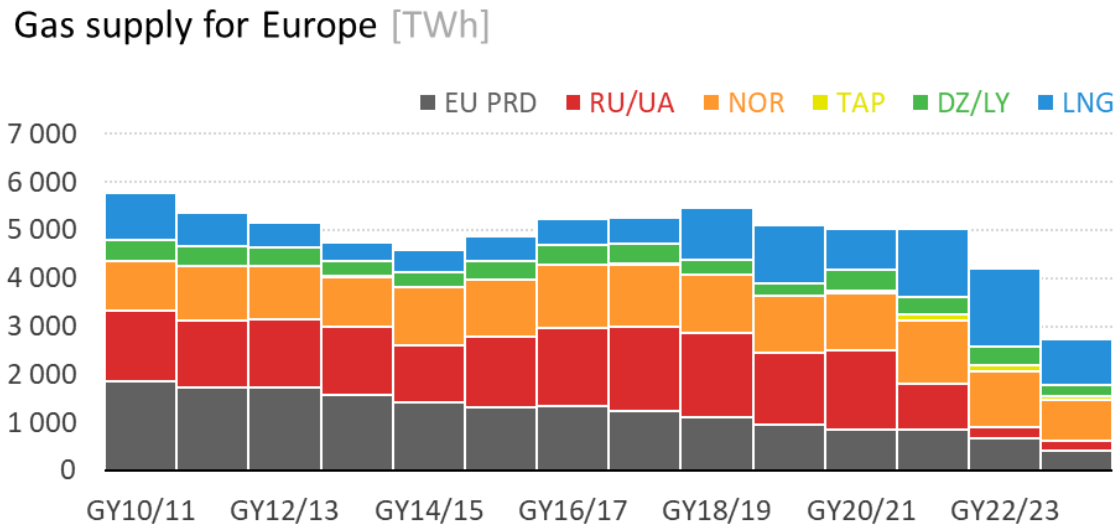

FIGURE 3 : GAS SUPPLY FOR EUROPE (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

For what concerns the LNG supply, figure 4 shows a significant increase of imports compared to previous years as well as the increase in installed regasification capacities (see figure 5). Additional regasification capacity will be added in 2024 and beyond. Up to 535 TWh/y, through FSRUs[3], new land terminals and expansion of existing terminals.

[3] FSRU stands for "Floating Storage and Regasification Unit"

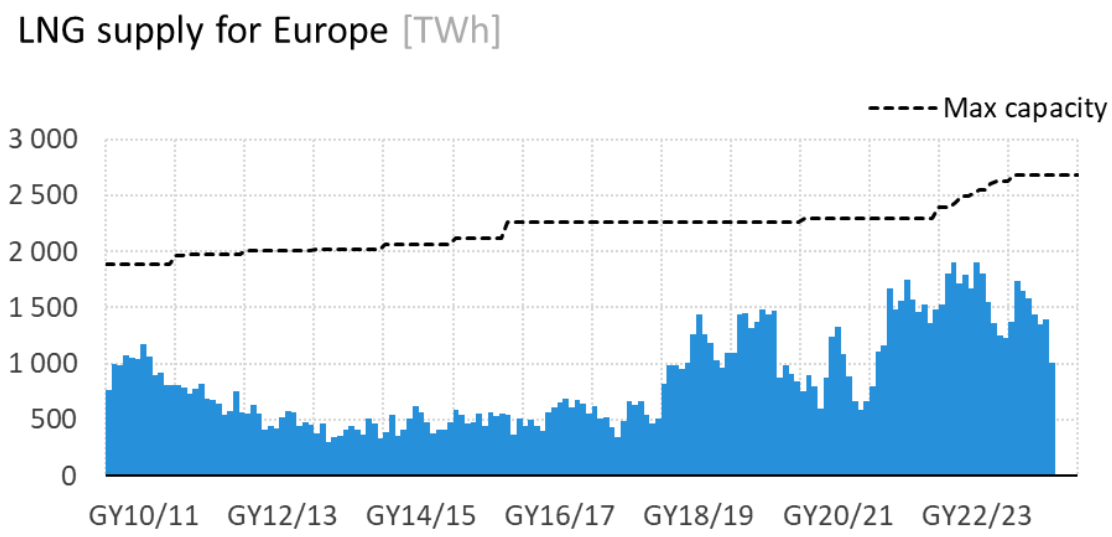

FIGURE 4 : LNG SUPPLY TO EUROPE (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

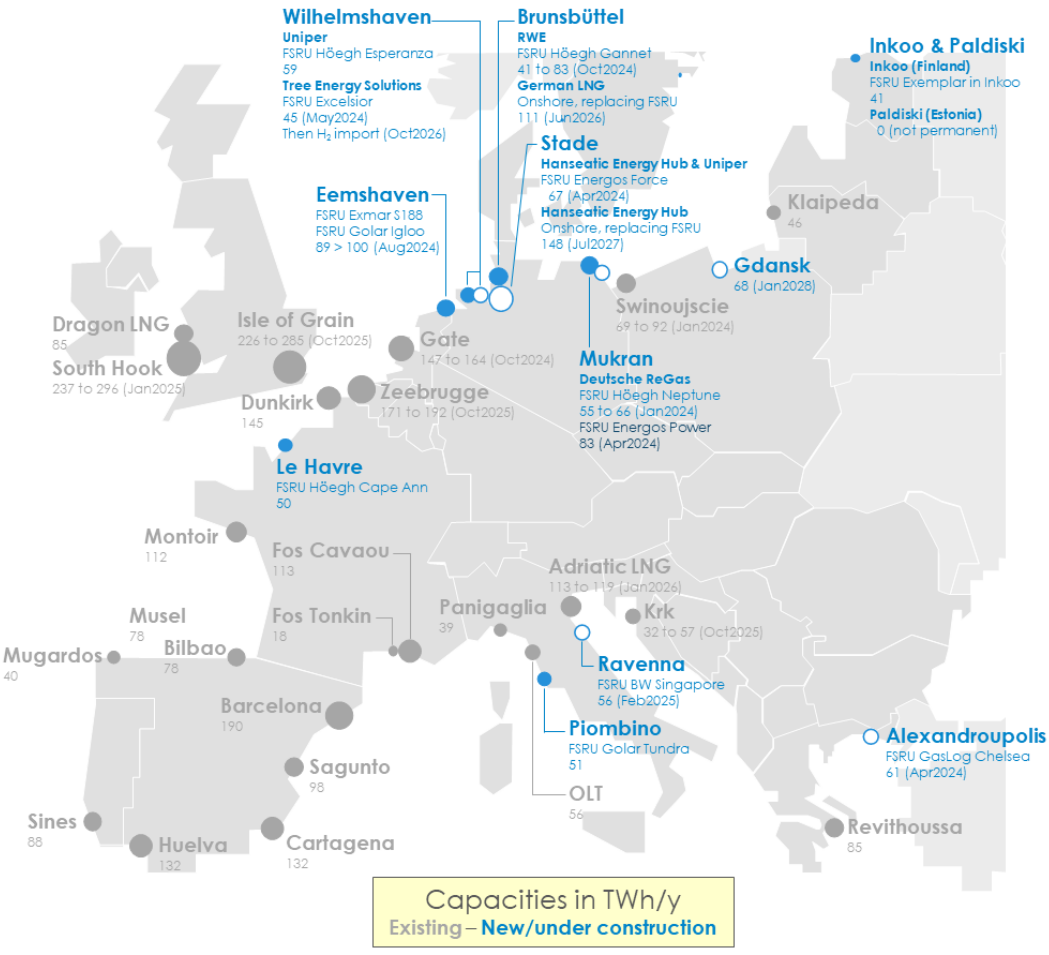

FIGURE 5 : REGASIFICATION TERMINALS (SOURCE : ENTSOG – SYSTEM CAPACITY MAP 2024)

Storages across Europe met the target set by the EU (90% by October 1st) to cope with a cold winter. Figure 6 shows that the filling level in Gas Year 2022-2023 has remained in the upper part of the last ten years' range.

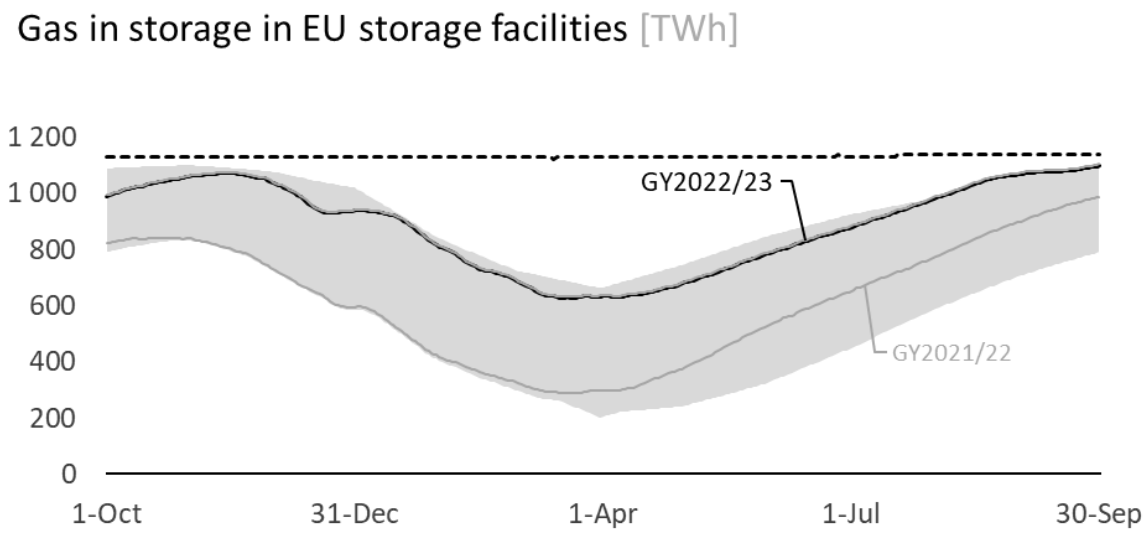

FIGURE 6 : GAS IN STORAGE IN EU STORAGE FACILITIES (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

In summary, figure 7 shows the overall gas flows during Gas Year 2022-2023. The thickness of the lines represents the magnitude (in TWh) of the flow:

- In black: European natural gas production
- In orange: imports from Norway
- In blue: LNG imports
- In red: imports from Russia via pipelines
- In green: imports from North Africa

The blue and black bullets represent respectively the LNG imports in the respective terminals and the natural gas production in the respective countries. The size of the blue and black bullets is proportional to the volumes (in TWh) imported or produced respectively.

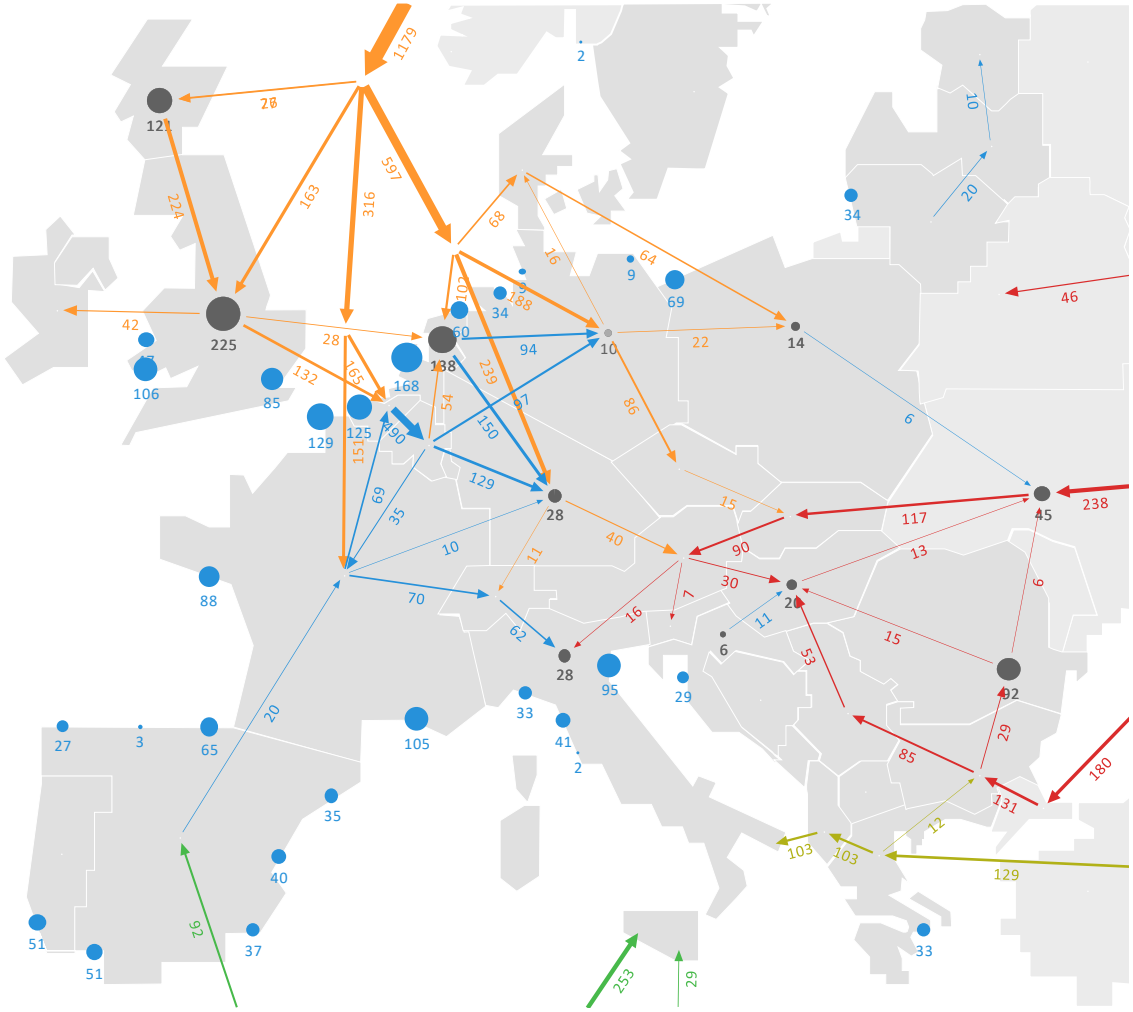

FIGURE 7 : GAS FLOWS (IN TWH) DURING GAS YEAR 2022-2023 (SOURCE: DATA FROM TRANSPARENCY PLATFORM ENTSOG)

For more details on the European gas market situation, please refer to the Quarterly Reports on European gas markets issued by the European Commission.[4]

Outlook for 2024-2033

Based on S&P's consumption forecasts, the gas supply in Europe (EU27 including UK, Switzerland and the Balkans) is expected to grow again slightly in the coming years to peak during Gas Year 2026-2027 and start decreasing afterwards to reach GY 2022-2023 levels again in Gas Year 2032-2033. Supply would mainly come as LNG and through pipelines from Norway. Gas supply through pipelines

[4] See https://energy.ec.europa.eu/data-and-analysis/market-analysis_en#gas-and-electricity-market-reports

from Russia is projected by S&P to decrease to almost zero after Gas Year 2029-2030 (see figure 8).

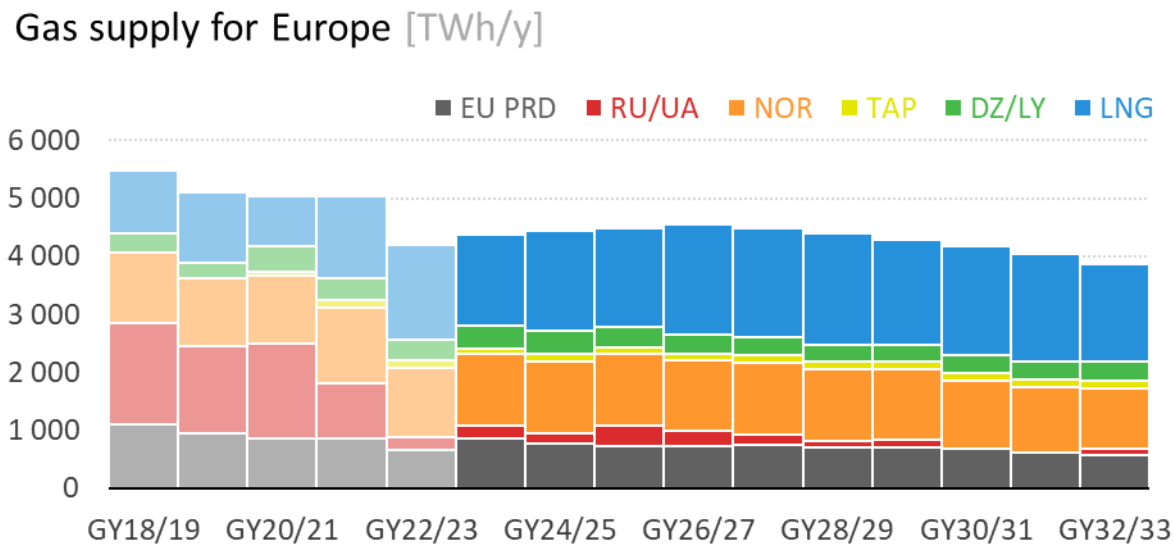

FIGURE 8 : GAS SUPPLY TO EUROPE IN COMING GAS YEARS

ENTSOG TYNDP 2022

The ENTSOG final TYNDP 2022[5] has been published in September 2023. Based on the common scenario set[6] developed by ENTSOG and ENTSO-E, a system-wide assessment of the European gas infrastructure is performed. This is done in a hybrid way by coupling the natural gas network and future hydrogen infrastructure levels, making this the first Hydrogen and Natural Gas TYNDP.

Challenges for both the methane network following the war in Ukraine, and the emerging hydrogen network are captured in the dual gas system model developed by ENTSOG.

The two COP21 scenarios Distributed Energy and Global Ambition have been developed considering the latest RepowerEU objectives. They show a significant natural gas demand reduction and no need for Russian gas in 2030 and 2040 respectively. However, the policy scenarios Best Estimate[7] and National Trends[8] are based on NECPs developed prior to the war in Ukraine. Therefore they do not reflect demand measures taken by Member States in 2022 to reduce the gas consumption. The resulting demand levels cannot be fully met in case of a full Russian supply disruption. Additional LNG import capacities and improved interconnections would be needed to minimise associated curtailments. Potential residual methane curtailment would then be within a range of the demand response that was observed in reaction to high gas prices in 2022.

For hydrogen, two infrastructure storylines were developed. A first one based solely on the submitted hydrogen projects for TYNDP which in many simulation cases would not allow to satisfy the ambitioned overall EU-wide demand. Establishment of hydrogen infrastructure projects is therefore essential to prevent that a hydrogen demand would remain unserved.

To mitigate hydrogen demand curtailments, the second hydrogen storyline adds additional and needed to enable policy objectives and introduces additional hydrogen production from natural gas beyond the scenario assumptions. This can

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[5] https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2022

[6] https://www.entsog.eu/scenarios#entsog-ten-year-network-development-plan-2022-scenarios

[7] The "Best estimate" scenario evaluates the demand forecast on the shorter term (for 2022 and 2025) considering last known local and European regulations as stated in 2020 (at the time of start of the TYNDP 2022 process). See https://www.entsog.eu/sites/default/files/2022-04/entso-e_entsog_TYNDP2022_Joint_Scenario_Report_Version_April2022_220411.pdf page 13 for further details.

[8] The "National Trends" scenario focuses on the medium term, up to 2040, and is in line with national energy and climate policies (NECPs, national long term strategies, hydrogen strategies, etc.) derived from the European targets.). See https://www.entsog.eu/sites/default/files/2022-04/entso-e_entsog_TYNDP2022_Joint_Scenario_Report_Version_April2022_220411.pdf page 14 for further details.

be interpreted as a flexible hydrogen supply potential on top of the scenario values, mitigated in terms of GHG emissions if combined with CC(U)S[9].

Overall, 358 investments were submitted to the ENTSOG TYNDP 2022, including 152 hydrogen projects. These hydrogen projects consisted of on-shore and off-shore transmission pipelines, import terminals and storages (new or repurposed).

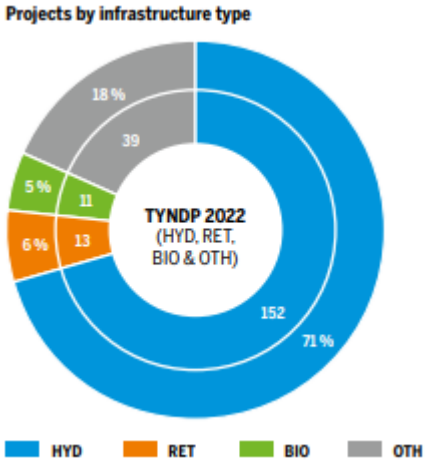

FIGURE 9 : PROJECTS REPRESENTING NEW PROJECT CATEGORIES INCLUDED IN THE TYNDP 2022 PER TYPE OF INFRASTRUCTURE (ABSOLUTE NUMBER OF RESPECTIVE INVESTMENTS AND THE EQUIVALENT SHARE INCLUDING PCI CANDIDATES). HYD STANDS FOR HYDROGEN, RET FOR RETROFIT (BLENDING) AND BIO FOR BIOMETHANE.

The system-wide analysis for methane and hydrogen is complemented by a project-specific CBA assessment of those hydrogen projects that applied for PCI/PMI status under the revised TEN-E Regulation. Based on the results of this CBA analysis, this new PCI and PMI list[10] has been adopted as a delegated act by the Commission in November 2023 and came into force on April 28th, 2024.

For Belgium specifically, the national hydrogen backbone proposed by Fluxys with connections to the Netherlands, Germany and France has been awarded the PCI label. Also, ammonia import terminals in Zeebrugge (Fluxys) and Antwerp (Fluxys/Advario and VTTI) are on the PCI list.

[9] CC(U)S states for "Carbon Capture and (Utilization) Storage"

[10] https://energy.ec.europa.eu/publications/annex-first-union-list-projects-common-and-mutual-interest_en

In the meantime, TYNDP 2024 is already well underway. The Scenario Storyline Report[11] has been published in July 2023 and the development of the quantified scenarios is in full progress. In parallel the gas infrastructure projects have been collected end of 2023, which will serve as a direct input for the hydrogen projects on the second PCI/PMI list under the revised TEN-E Regulation.

[11] https://www.entsog.eu/scenarios#entsog-ten-year-network-development-plan-2024-scenarios

The Belgian natural gas market

Fluxys Belgium and Fluxys LNG natural gas infrastructure

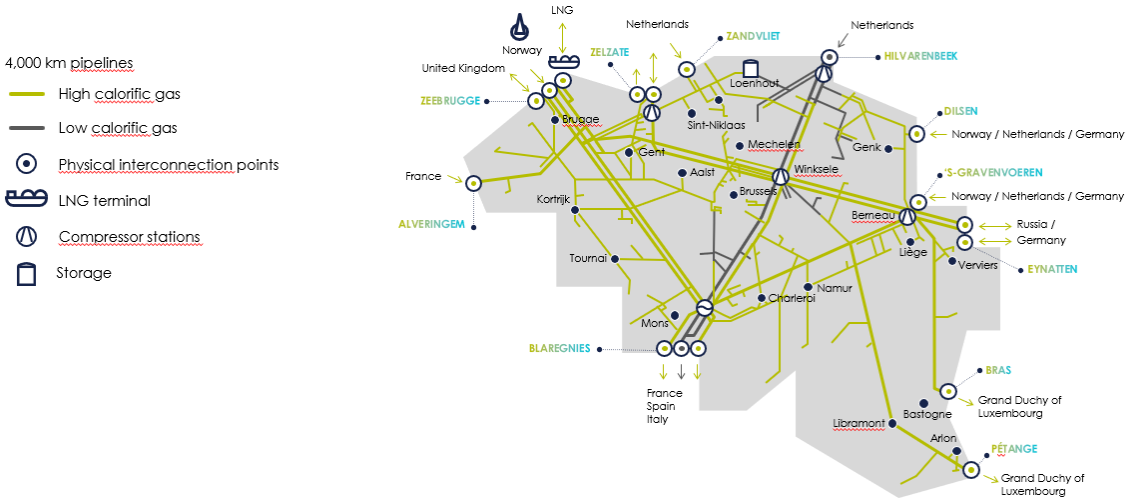

FIGURE 10: FLUXYS BELGIUM AND FLUXYS LNG NATURAL GAS INFRASTRUCTURE

The natural gas transmitted and distributed in Belgium comes from a variety of sources. The chemical composition of the various natural gases is not the same; their heating value and Wobbe index vary. Most of these are 'rich' gases (typical heating value is 11,3 kWh/Nm³). They are interchangeable and are transmitted together in the form of high-calorific natural gas (H-gas). In contrast, the low-calorific natural gas (L-gas) from the Groningen gas field (NL) is quite unique in that it contains up to 14% nitrogen (typical heating value is 10,3 kWh/Nm³). It has a lower heating value and is not interchangeable with H-gas. As a result, Fluxys Belgium's transmission system is split[12] into two networks, which are operated separately.

Market segments

The Belgian transmission system supplies gas to three market segments (or categories of end users):

- Distribution networks, which supply residential customers, SMEs, and the tertiary sector

[12] The migration of L-gas consumers to H-gas is ongoing and will be finalized in Belgium by September 1st, 2024. Only one pipeline will remain in operation, in Belgium, for L-gas in order to transport L-gas from The Netherlands to France until full migration of the L-gas consumers in France.

- Industrial customers, including large-scale combined heat and power (CHP) generation facilities.
- Power plants

The market share per segment varies constantly, according to very different offtake profiles:

- Consumption **in the distribution network** is strongly influenced by the weather conditions.
- **Industrial customers** have a regular offtake pattern.
- **Power plants** take off gas to meet the increasingly volatile demand. While electricity demand is much less influenced by temperature than natural gas demand, the availability of other energy sources (e.g., nuclear energy, solar power, wind power, imports/exports) and price parameters (spark spread of coal vs natural gas) have a significant impact.

Consumption trends in Belgium

Change in the number of degree days

The number of degree days in a year reflects the severity of that year's temperatures. A normal (benchmark) year has 2252 degree days.[13]

For a specific year, if the number of degree days is below or above this benchmark, the corresponding year is respectively considered warm or cold.

Figure eleven shows that the average degree days for the period between 2014 and 2023 is 2059, well below the reference year (2252 degree days). If we consider the last two years (2022 and 2023), we can see that it is further below, showing that the last 2 years have been among the warmest of the last 10 years. This has been very helpful for reaching the reduction targets set by the European Commission.

[13] 1991 to 2020, Synergrid benchmark (calendar year). For a given day, the degree day is the difference between 16,5°C (reference in Belgium) and the average temperature of the day (NB: the degree day if the average temperature of the day is greater than 16,5°C is considered as zero). The sum for a given period of the daily degree days reflects the energy required to heat a building.

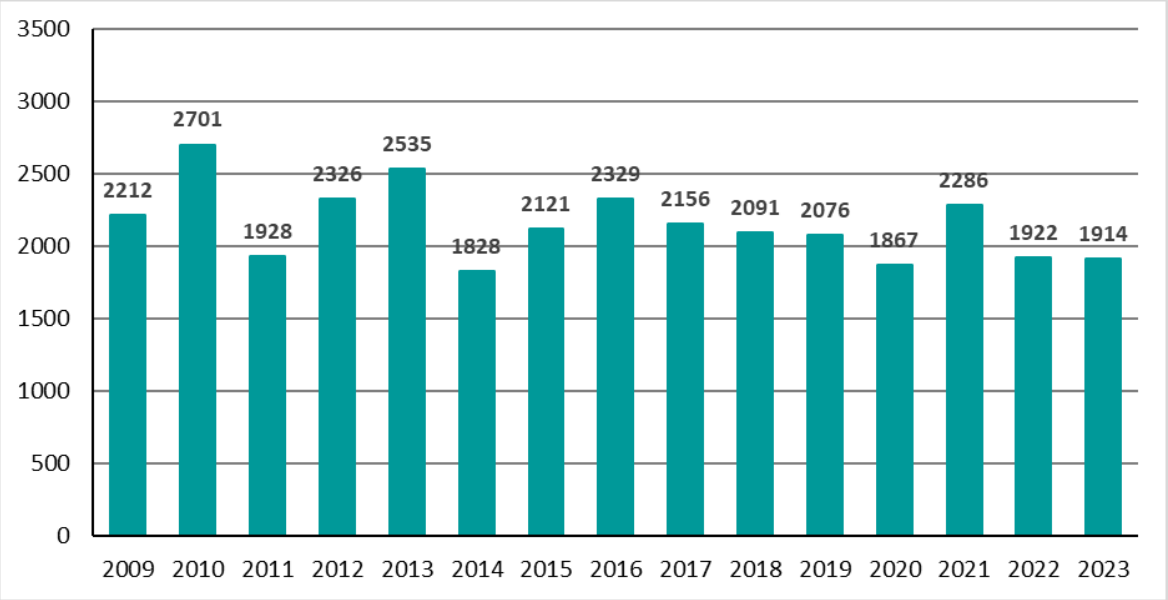

FIGURE 11: DEGREE DAYS (CALENDAR YEAR)

Annual volumes for the Belgian market

In this chapter, all figures refer to "Calendar Years".

In 2014, the year with the lowest total degree days since 2009, Belgium's total consumption decreased substantially (12% down on 2013), falling to 14.7 bcm. It has since picked up again, rising to 17.2 bcm in 2019. Unlike the increase in 2016, the rises in 2017, 2018, and 2019 were the result of increased offtake by power stations and industrial customers, not of a colder winter period. The total consumption was stable in 2020 and 2021, but the low amount of stored gas reserves in Europe caused a rise in gas prices at the end of the year in the context of the war in Ukraine. In August 2022 the European Council imposed a gas consumption reduction with 15%. So, in 2022 the annual consumption already showed a sharp decline. This reduction target has been reconducted from March 2023 until March 2024 and the consumption reduction made by public distribution and industry, that was initiated by the higher gas prices since Q3 2022, continued all over 2023. Compared to the period 2020-2021 the demand in 2023 was 20% lower.

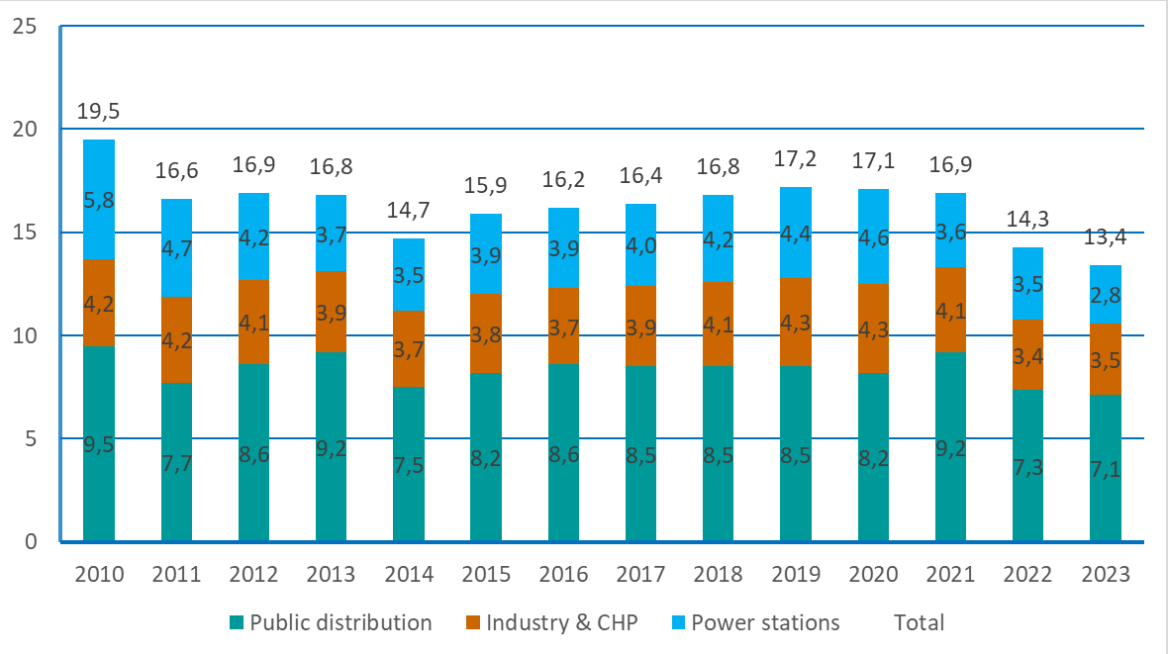

FIGURE 12: CHANGES IN GAS CONSUMPTION IN BELGIUM (IN BCM/YEAR)

Distribution Network

Consumption in the distribution networks is strongly dependant on the temperatures during the year. As stated earlier, 2014 was the warmest year since 2009, which has resulted in a lower consumption. 2010 and 2013 had cold winters and the same can be stated for 2021 that had a colder winter period in February of 2021. From Q3 2022 on, annual consumption declined over 15% due to the impact of the rising gas prices combined with calls from authorities to reduce consumption. We saw in 2023 a stabilization of the consumption, despite a reduction of the gas price (compared to 2022).

Industrial customers (including combined heat and power generation)

Since the 2008-2009 economic crisis, several major consumers have closed, such as the Opel car plant in Antwerp (late 2010), the steel project plant in Liège (late 2014) and the Ford car plant in Genk (late 2014). Once the crisis bottomed out in 2014, industrial consumption rose by around 2.5% per year, hitting 4.3 bcm in 2020, supported by new connections. 2021 showed a slight decline following the rising gas prices in the last quarter of the year followed by a sharp decline that started in 2022. When gas prices exponentially increased, the industry segment reduced its offtake by more than 15%. We have seen a very small increase of the consumption of this segment in 2023 despite a steep decrease of the gas wholesale prices compared to 2022. This translates a very slow recovery of the market on one hand and the fact that the prices of 2023 are still too high for some industrials.

Power plants

The offtake of power plants depends on a wide range of parameters. The amount of renewables, accounting for a rising and remarkable share of the generation mix, will certainly have an impact. Moreover, the offtake pattern of power plants can become more volatile, as highly flexible open-cycle gas turbines and efficient combined-cycle gas turbine (CCGT) units are frequently being used to back up variable and uncertain power generation from solar and wind sources at any time. Other important parameters are the availability (or not) of nuclear power plants, the demand of neighbouring countries and the energy prices. Despite a lower availability of nuclear power plants in Belgium, gas fired power plants reduced their offtakes in 2023 with approximatively 20% compared to the period 2020-2022. Compared with previous years, Belgium has become a net importer of electricity.

Network simulation model

The sizing of a grid is not determined by annual volumes but by peak demand.

Transmission systems are systematically analysed to check that they are *fit for purpose*. Analysing the behaviour of the network during periods of peak demand for capacity makes it possible to determine whether infrastructure needs to be adapted to cope with demand fluctuations. Given the variety of offtake profiles, special statistical methods are used to calculate the peak values for the different market segments.

Distribution Network

Method

Beside obvious elements like the number of customer connections (1), efficiency of the boilers (2) or effectiveness of building insulation (2)[14], consumption peaks are partly linked to the severity of winter weather and must therefore be analysed considering the temperatures recorded.[15] A linear regression considering past offtakes as a function of the ambient temperature is used to extrapolate the peak offtake at -11°C. The standard winter period used for such analyses runs from the start of November to the end of February of the next calendar year.

Assessment of winter 2022/2023

The winter period from November 2022 up to and including February 2023 was rather warm with 1.246 degree days (a benchmark winter[16] has 1.400 degree

[14] (1) and (2) are opposing trends.

[15] The concept of 'equivalent temperature' was introduced to consider the thermal inertia of buildings. This temperature is determined as follows: $T_{eq\ D} = 0.6 \times T_{av\ D} + 0.3 \times T_{av\ D-1} + 0.1 \times T_{av\ D-2}$

[16] 1991 to 2020 (winter months), source: Synergrid

days). During a cold spell that lasted one week, the coldest day at Uccle was recorded on Wednesday December 15th with an equivalent temperature of –2.9 °C.

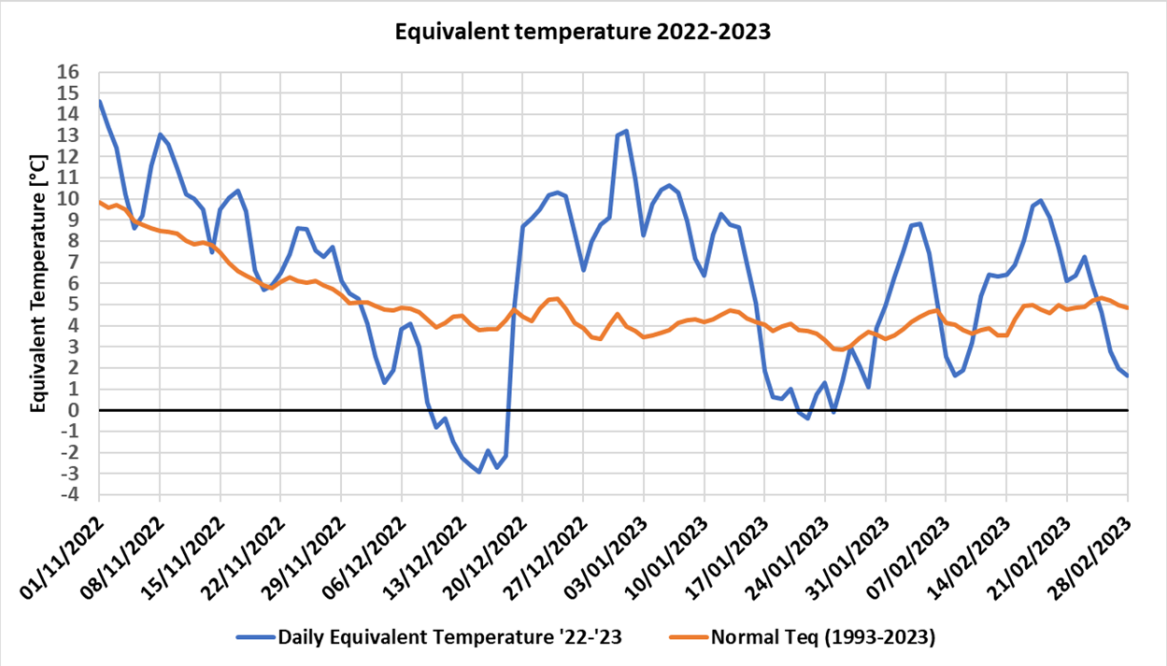

FIGURE 13: TEMPERATURE PROFILE FOR WINTER 2022/2023

Power plants, CHP units and industrial customers

Method

As temperature has very little impact on electricity generation[17] and industrial processes, the analysis for this market segment is based on past offtake coupled with a commercial analysis of development of prospects.

Since industrial customers' peak offtake will not occur at the same time (smoothing effect), absolute peak offtake is adjusted using a regional-level synchronisation factor.

The approach for gas-fired power plants focuses on the possible simultaneous use of all generation facilities, which depends on various external factors such as the availability of renewable sources (sun, wind, water), imports/exports, and the technical availability of the remaining generation facilities.

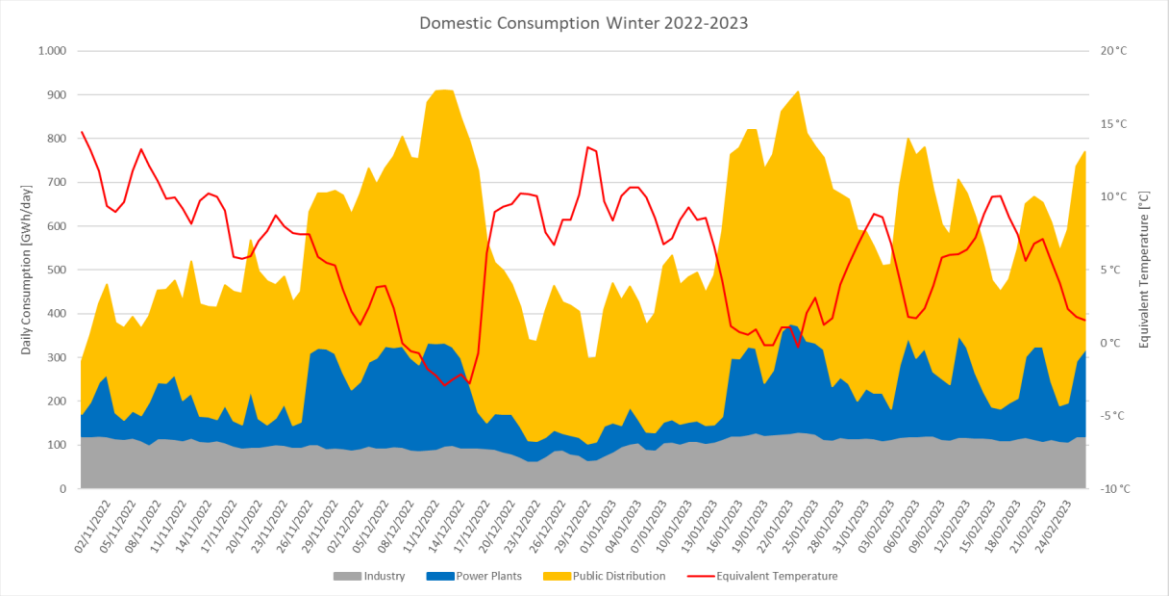

FIGURE 14: DOMESTIC CONSUMPTION IN WINTER 2022/2023

Required investments (domestic market)

Distribution network

The steady rise in the number of active connections has been somewhat offset by several demand erosion factors. Now that public authorities have adopted strict regulations on renovation and new-build projects, houses and buildings are being better insulated and the efficiency of heating systems is constantly improving. Measures to reduce natural gas demand are even reinforced due to the war in Ukraine. Moreover, the increasing energy prices have resulted, as the main driver, in an important decline of the consumption of natural gas.

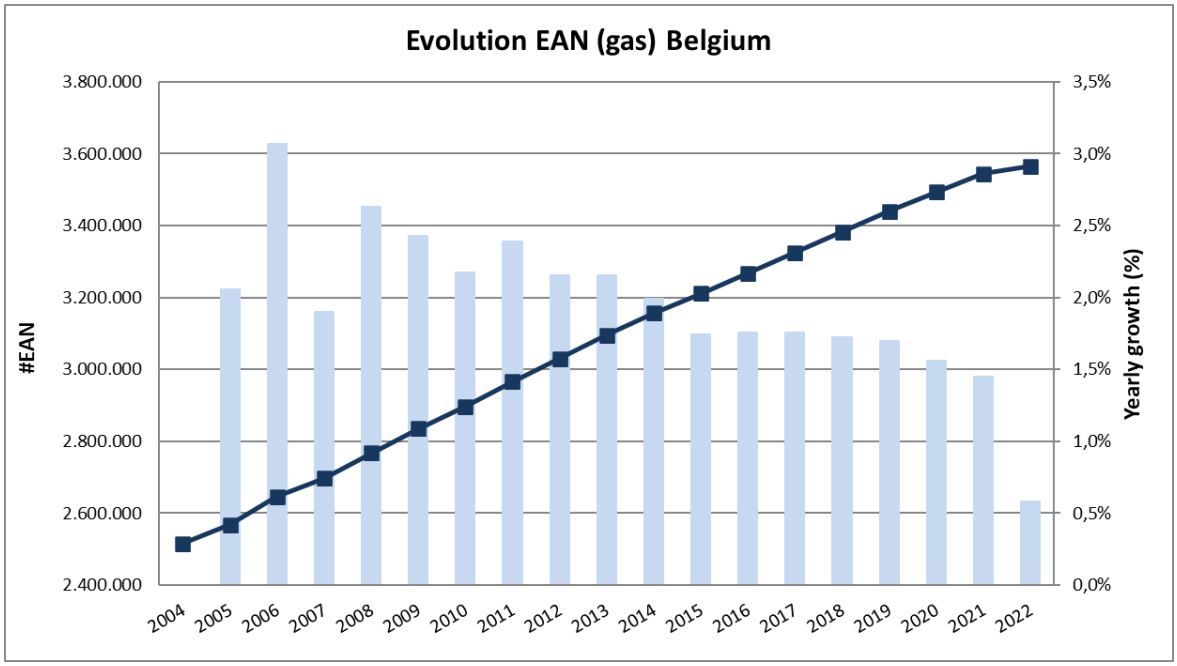

FIGURE 15: INCREASE IN THE NUMBER OF EAN ACCESS POINTS (SOURCE: SYNERGRID)

Due to the combination of these erosion factors and the decline in the number of new connections to the distribution network, a decline of the natural gas consumption in the public distribution segment is possible, although local growth in some areas is not excluded.

Use of the available capacity in the networks is continuously monitored in cooperation with the distribution system operators (DSOs) based on detailed analyses and simulations. Investments identified as necessary to support local/regional growth remain limited.

Industrial customers

The outlook for industrial consumption is still a mixed picture. While several industrial customers wind down their production in Belgium, each year new industrial projects are also launched. In most of the cases, the existing networks hosting the new connections have enough capacity to supply the new end users. However, where large-scale projects coincide with the construction of new power plants, investments may be required.

Power generation

As elsewhere in Europe, natural-gas-fired power generation in Belgium has been under considerable pressure for some time. Gas-fired power plants are typically used to balance the electricity grid. Thanks to a favourable spark spread[18], a higher base load has gradually been observed again in recent years.

[18] Difference between the price a producer can get for a kWh of electricity produced and the cost of natural gas required to produce this kWh of electricity.

Gas-fired power plants have the advantage of being able to start up quickly while emitting considerably less CO_2 than coal-fired power plants. Thanks to their flexibility, they provide the ideal back-up needed for intermittent power generation from wind turbines and solar panels.

The (partly) decommissioning of Belgium's nuclear generation facilities during the coming years was decided by the Belgian government. As a result, an important amount of nuclear generation capacity is set to be phased out in the very near future (2 GW in 2025). Alongside increased import capacities and the steady growth of wind and solar energy, natural-gas-fired generation facilities will also have to be further expanded, including the replacement of existing units that will reach the end of their technical and economic life in the upcoming years. State-of-the-art CCGT units with capacities up to 850 MW are now available. These efficient generation units are expected to be developed . These new units need also to be fit for the energy transition and be carbon neutral by 2050. This will be possible by running either on hydrogen or thanks to carbon capture.

More specifically, the Capacity Renumeration Mechanism (CRM) launched by the government resulted in the decision to build two additional CCGT generation facilities, for a capacity of 1,7 GW by 2025[19].

In addition to these new units, the older, less efficient power plants can be expected to be used as peak units for several years before being decommissioned. The result is an increase in the need for synchronous peak capacity. It has also to be noted that the new aforementioned units are located in eastern Belgium while supply is expected to come mainly from western Belgium (zone Zeebrugge), increasing the capacity needs in the backbone. This situation, together with the finalization of the L/H migration (see L/H conversion, page 37) shifting ca 5 bcm of consumption from the L-gas system to the H-gas system, led to the decision to reinforce the backbone between Zeebrugge and Brussels.

Other sectors

The transport sector

Compressed natural gas (CNG) and liquefied natural gas (LNG) are two natural gas products that are very well suited to use in the transport sector. The combustion of methane releases less CO_2 than that of conventional fuels such as diesel, petrol, and liquefied petroleum gas (LPG). Natural gas is also a *cleaner fuel in terms of particle emissions*[20]*, reduces* NO_x *by 70% and* CO_2 *by 20%*

[19] Power plants of Seraing and of Les Awirs.

[20] CREG 2018, Study on the cost-effectiveness of natural gas (CNG or compressed natural gas) used as fuel in cars

[21] Please note that the quality conversion service will be stopped with the finalization of the L/H conversion.

Since LNG takes up 600 times less space than the same amount of energy in gaseous form under atmospheric conditions, it is especially suitable for use in heavy-duty long-haul road transport (as an alternative to diesel) and shipping (as a substitute for heavy fuel oil).

Transit at Belgium's borders

General description

With all its interconnection points, the Belgian network is connected to most sources supplying the European natural gas market, namely:

- natural gas supplied by pipeline from Norway, the UK, the Netherlands, Germany and France.
- LNG supplied from producing countries via the LNG terminals at Zeebrugge and Dunkirk.

Physically, the natural gas supplied is consumed in Belgium or transported across the country's borders for sale at other gas trading points or for consumption on end-user markets in Europe. Fluxys offers several services which allow to transport natural gas on Interconnection Points:

- **Entry/Exit**: a capacity product to access the Belgian market area, trade on ZTP, supply the Belgian domestic market and connect to neighbouring markets.
- **Zee Platform**: a service for transporting unlimited quantities of natural gas between two or more interconnection points in the Zeebrugge area for a fixed monthly price.

The figure below provides a general overview of the transmission services in Belgium[21]:

[21] Please note that the quality conversion service will be stopped with the finalization of the L/H conversion.

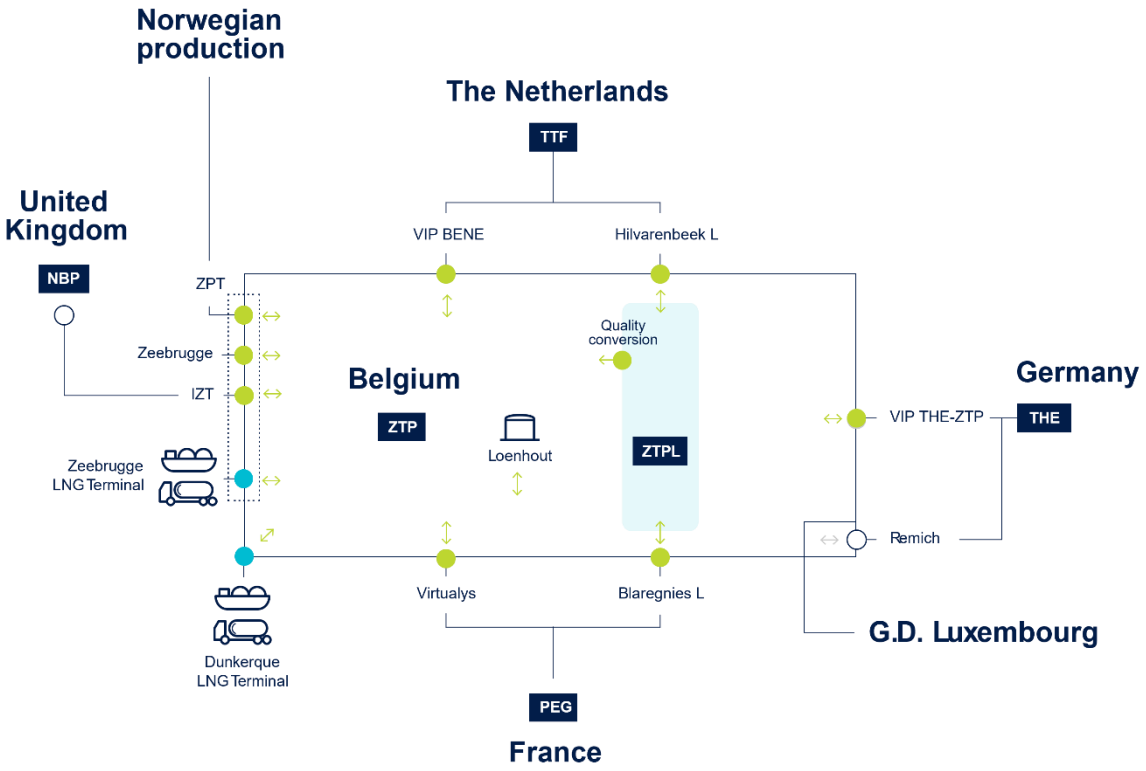

FIGURE 16: FLUXYS BELGIUM TRANSMISSION SERVICES

Overview of annual allocations at border points (grouped by country)

The overview in this section covers the period up to and including 2023.

The figure below provides an overview of the average volumes imported and exported (allocations) in 2019-2023.

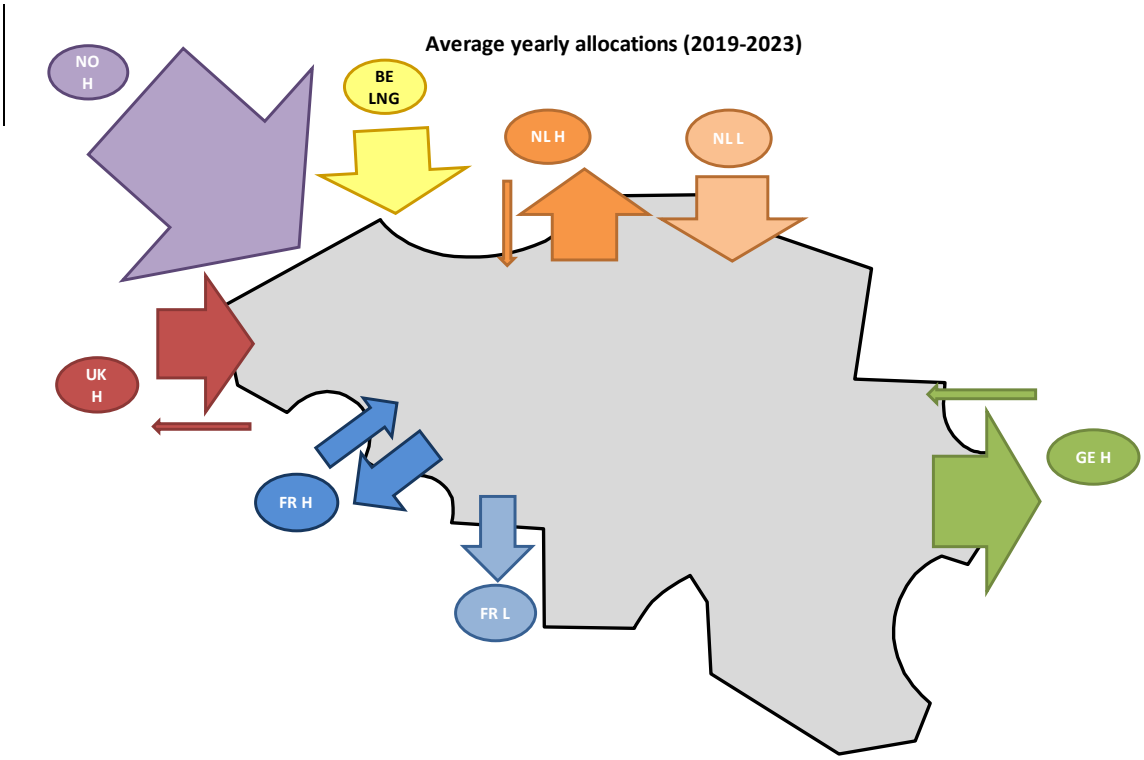

FIGURE 17: ALLOCATIONS AT BORDER POINTS, 2019-2023

Natural gas imports

The total annual average volume of gas entering the Fluxys Belgium network has significantly changed during the last two years: from approximately 350-400 TWh per year (2019-2021), to almost 600 TWh in 2022 and 500 TWh in 2023.

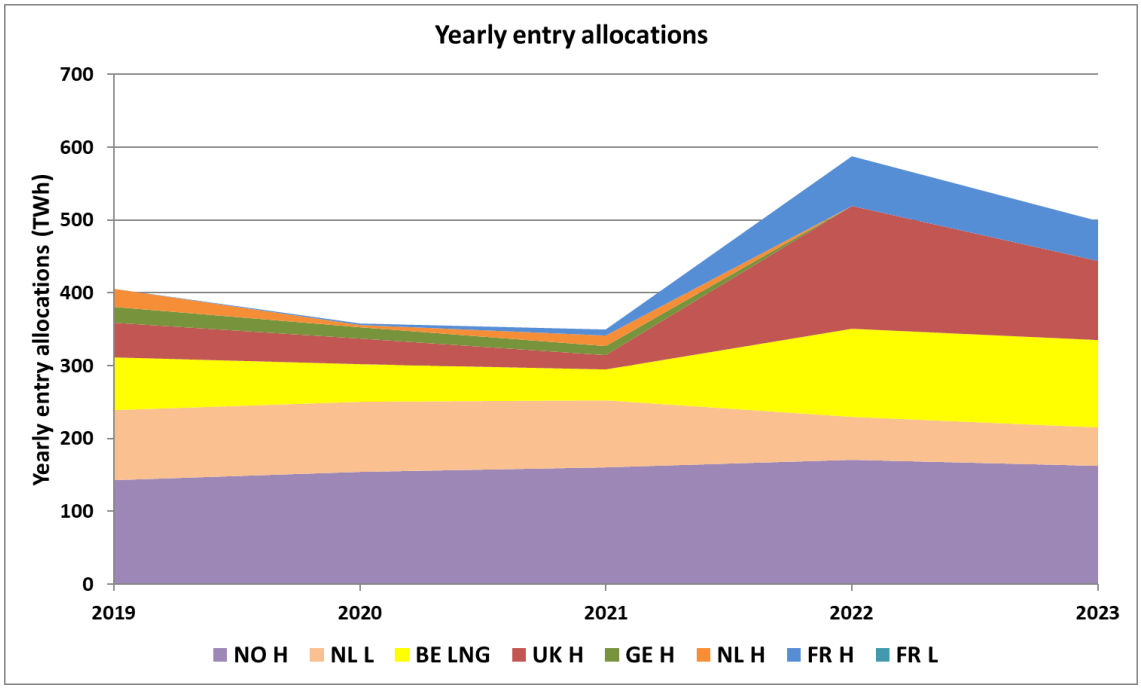

FIGURE 18: ANNUAL ENTRY ALLOCATIONS

The Norwegian gas pipe (Zeepipe) is the main supply route to Belgium(stable around 150 TWh). H-gas supplies from the Netherlands have been declining since 2019. L-gas from the Netherlands is in decline due to the L-H conversion process. After the finalization of the L-H conversion in Belgium (September 2024), L-gas from the Netherlands will only cross Belgium to supply France, which is also in a conversion process, due to be finalized in 2028.

Volumes from the UK fluctuate usually between approx. 25 and 50 TWh per year before 2022 but increased sharply in 2022 to satisfy the high requirement of natural gas for continental Europe due to the reduced supply of Russian gas. The supply in 2023 remains at a high level, although without reaching the record volumes of 2022 (due to the lower required annual volumes to the Netherlands and Germany – see figure of Exit Allocations).

The increase of LNG volumes and – to a lower extend – of supply from France can be explained in the same context.

The volumes imported from Germany before 2022 were already relatively low. It is worth noting that virtually all imports came from the (former) Gaspool market area.

Natural gas exports

The total annual average volume of gas (L- and H-gas) transported to neighbouring markets was approximately 150-200 TWh on the period 2019-2021. In 2022 a significant peak of more than 400 TWh has been realised. Although that

amount was not reached in 2023 (approximately 350 TWh), the export volume is still double that of the period before 2022.

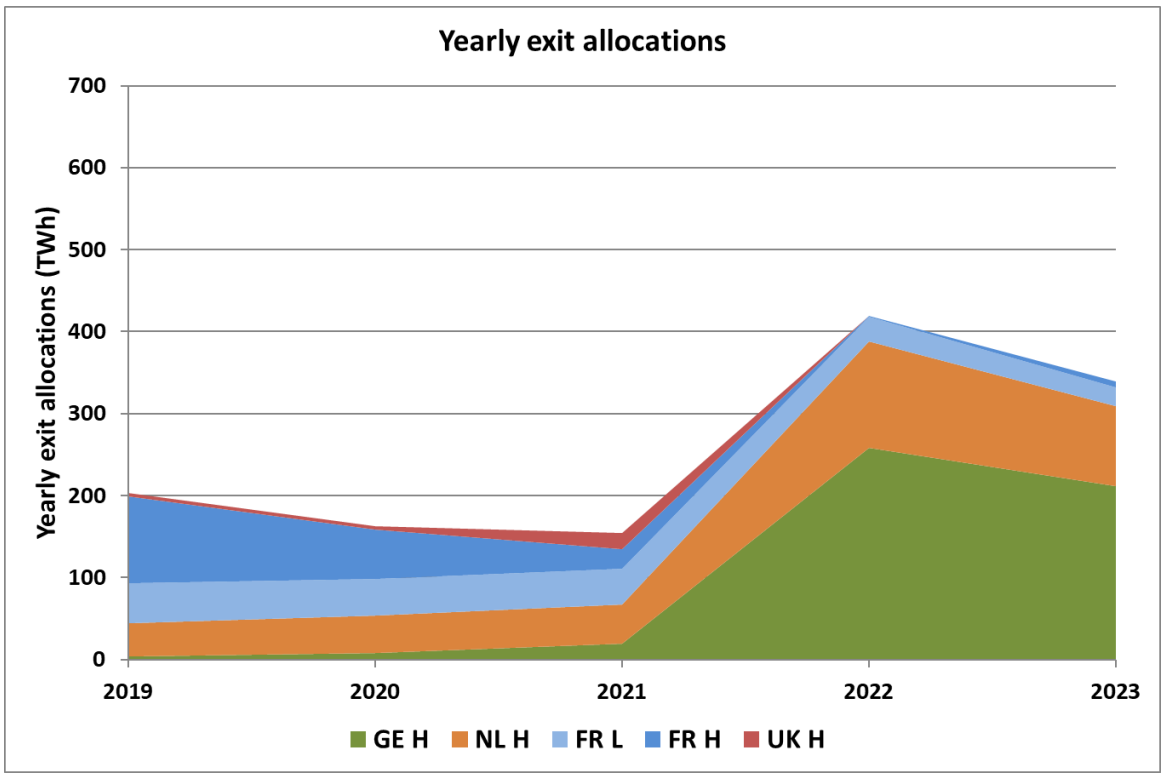

FIGURE 19: ANNUAL EXIT ALLOCATIONS

Until 2021, between 50% and 80% of this volume was intended for the French market. The share of L-gas was stable (approx. 50 TWh/y) during that period. The transmission of H-gas was declining with only very limited volumes in 2022 and 2023.

Also the volume of gas transported to the UK has experienced a marked decline since 2019.

Volumes transported to Germany and to the Netherlands have been sharply increasing in 2022 and (to a lower extend) in 2023, due to the war in Ukraine and the significant reduction of supply of Russian gas.

Gas transmitted to Luxembourg is not included in the above graph, as Belgium and Luxembourg form a single market.

Fluctuations in daily allocations at border points

Fluxys Belgium analyses network load and use of capacity supplied to neighbouring networks based on simultaneous daily and hourly flows. This allows to check how the available capacities are being used by the market. In function

of this use, a reallocation of capacities could be analysed and eventually proposed to the market.

Natural gas imports

The graph below shows the change in daily flows simultaneously injected at various border points on the Fluxys Belgium network (2019-2023). For the period 2019-2021, an average of around 40-45 GWh/h of gas is injected into the Fluxys Belgium network, with peaks over 70 GWh/h. During 2022 and the first half of 2023, the total amount of injected gas has significantly increased, with peak values higher than 80 GWh/h (although these values have already been reached in 2018). The second part of 2023 shows a decline of the entry volumes.

It has to be noted that, compared to previous years, huge entry allocations were seen in 2022 and 2023 mainly from UK (Interconnector) and FR H (Alveringem), translating the response of the market to bring gas to Germany and Central Europe because of the reduction of the gas import by pipeline from Russia, due to the war in Ukraine.

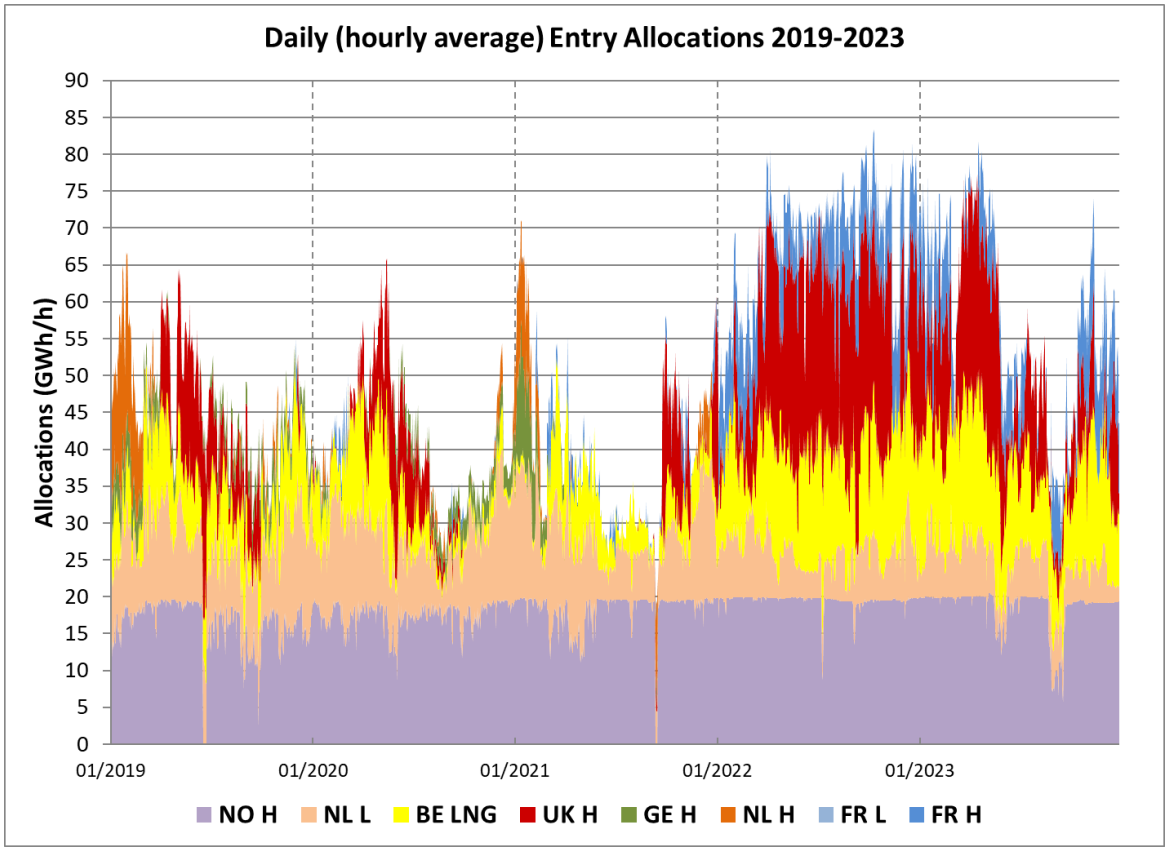

FIGURE 20: DAILY ENTRY ALLOCATIONS

The graph[22] below provides details of the use of injected capacity in 2019-2023.

[22] This graph is based on a calculation of the daily net value of the allocations.

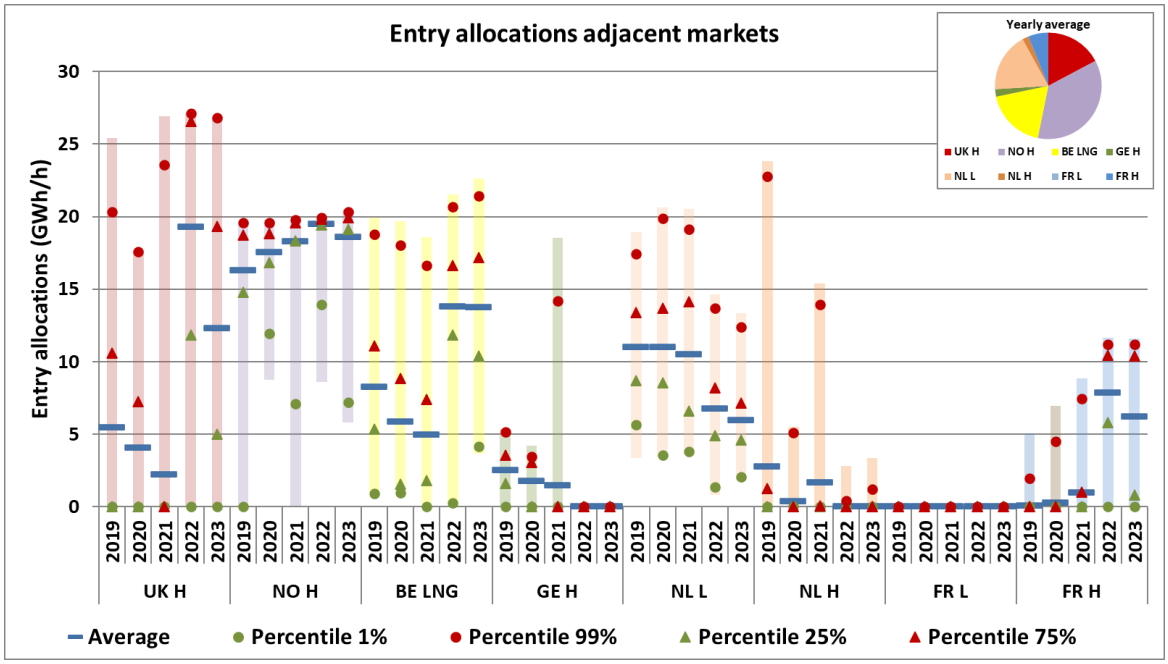

FIGURE 21: ENTRY ALLOCATIONS, NEIGHBOURING MARKETS

Note that the total import capacity of the H-gas network is sufficient to respond to an increase in the domestic market (e.g. because of the L/H conversion and the planned new power plants).

Natural gas exports

The following graph shows the change in daily flows simultaneously exiting various border points on the Fluxys Belgium network (2019-2023).

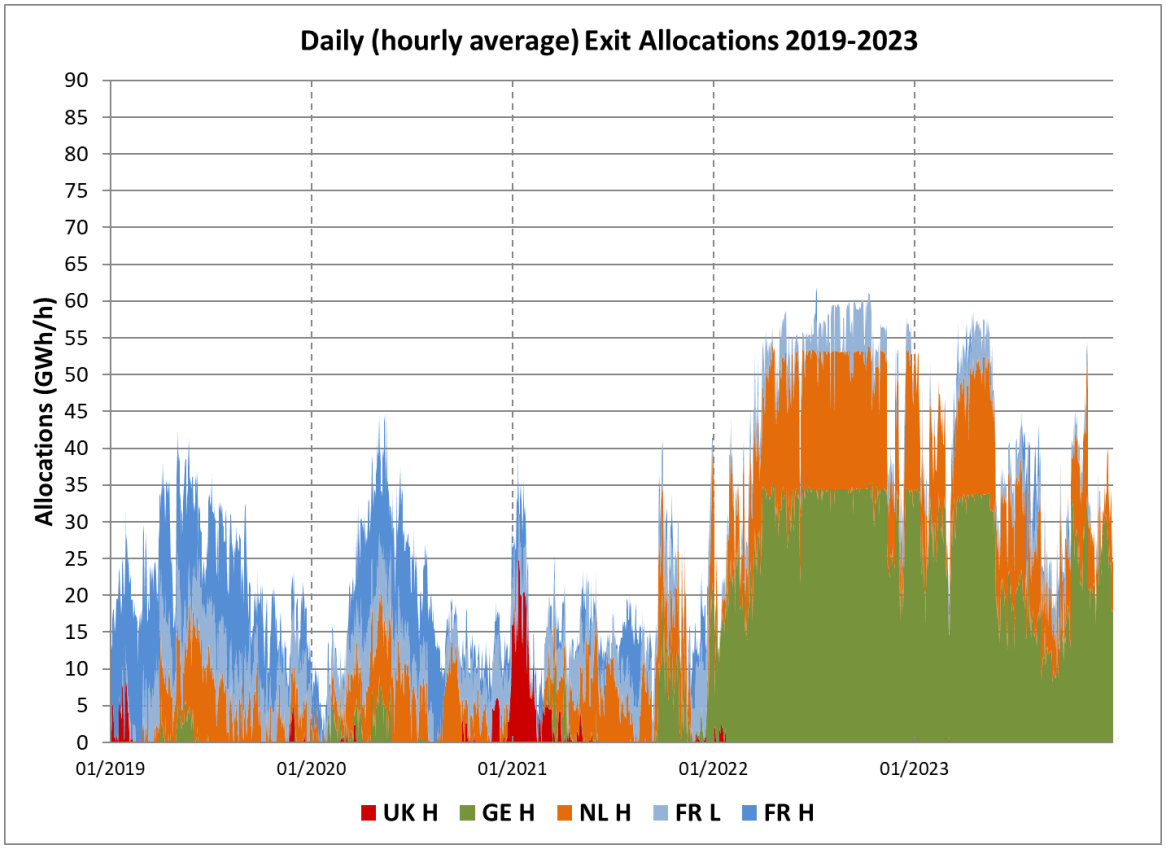

FIGURE 22: DAILY EXIT ALLOCATIONS

For the period 2019-2021, an average between 17 and 24 GWh/h was transported to adjacent countries. There were substantial transit flows towards the UK in winter 2020-2021. From 2022 new peak flows, up to 60 GWh/h, have been reached. These very high flows were due on the one hand to the reduction of natural gas imports by pipelines from Russia, and the low level of gas in storage in Europe at the start of the winter period 2022-2023 on the other hand. The Fluxys network had no problems handling this peak transmission. The second half of 2023 shows a reduction of the exit volumes (although still reaching a relatively high value). This is due on one hand to the target set by the European Commission to reduce energy consumption by 15%, and to the obligation of filling the gas storages to 80% before the winter 2022-2023 and to 90% for the following winters.

The graph[23] below provides an overview of the use of capacity supplied to each market area in 2019-2023.

[23] This graph is based on a calculation of the daily net value of the allocations.

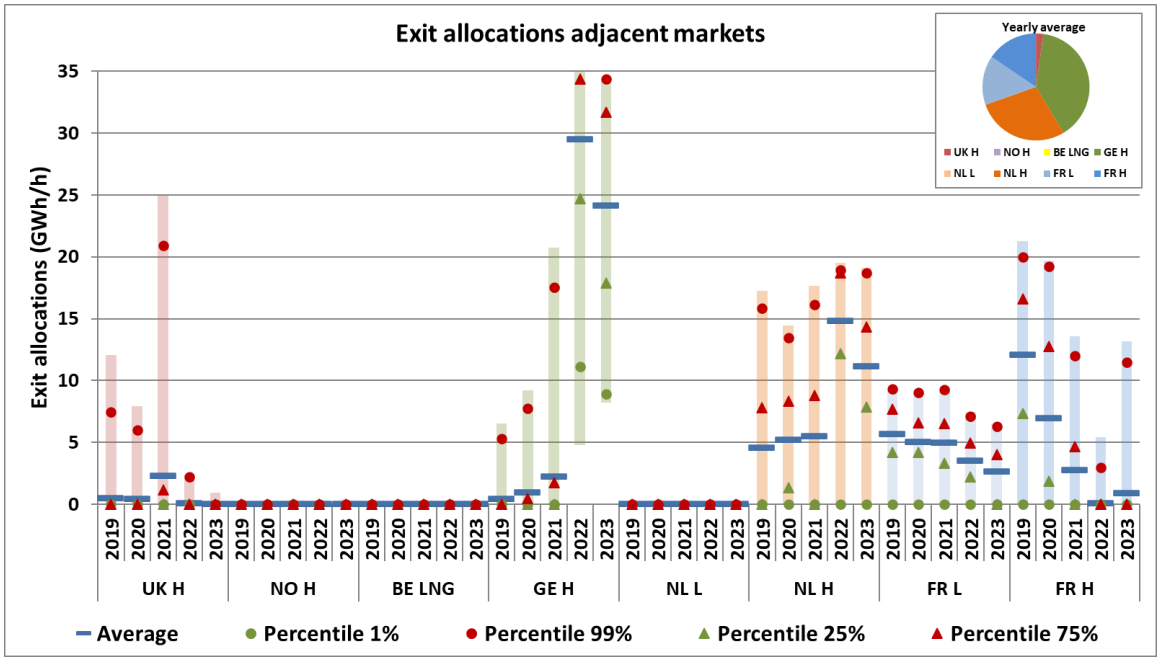

FIGURE 23: EXIT ALLOCATIONS, NEIGHBOURING MARKETS

Until 2021, the highest average daily flow was transported to the French market (H- and L-gas). The French market also had the average closest to peak consumption (higher load factor). From 2022, the flows to Germany and the Netherlands significantly increased, while the transport to France sharply decreased, certainly for the H-gas market.

Change in domestic demand and transit

Domestic demand

Fluxys Belgium updates its projections of future natural gas consumption in terms of both annual volume and peak demand to public distribution, industry and power stations. These projections are based on a statistical analysis of past consumption, internal analyses of future demand, various (inter)national reports on energy conversion, market surveys and Elia's latest adequacy studies for power plants.

These projections are used to evaluate the transmission system.

Consumption projections are studied for different scenarios. The figure below shows the range within which the predicted total annual consumption fluctuates in each scenario (calculated for an annual average temperature). The consumption range has been challenged in case energy prices remain high, implying a decrease of the demand in the distribution system and the industry sectors (except for power plants) of 15% (based on the observed demand reduction in the winter of 2022-2023).

The increase in 2025 is based on the growth of natural gas consumption for electricity generation.

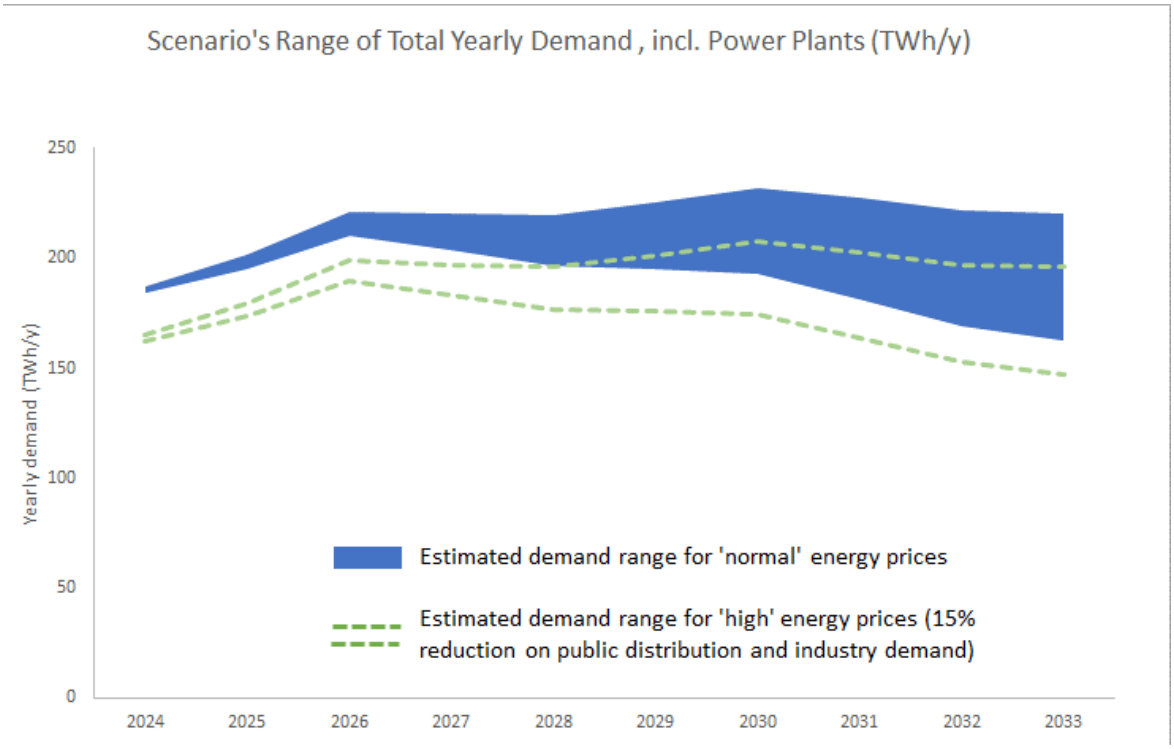

FIGURE 24: PROJECTION OF ANNUAL NATURAL GAS CONSUMPTION (H- AND L-GAS)

Considering the new power plants (2 units of 850 MW each) to be in operation by 2025, simulations indicate that the total entry capacity of the H network would still accommodate the peak demand, even after the complete integration of the current L-market into the H network. Nevertheless, if we consider a structural west-east flow pattern (entry exclusively from the Zeebrugge zone), the current main west-east axis would need to be reinforced to provide flexibility[24] and continue to allow higher exports to Germany, the Netherlands and France. Hence Fluxys built a first phase of this reinforcement consisting of ca 50 km of a DN1000 pipeline between Desteldonk and Opwijk[25]. This phase is fully operational. A second phase linking Zeebrugge (Knokke) to Desteldonk (ca 55 km also DN1000) was decided (also fit for hydrogen). The completion of this second phase is expected by late 2026 and would allow to make a full redundant pipeline path available between Zeebrugge and the German border at Eynatten. This will allow to dedicate one of the paths to hydrogen when both the domestic consumption and transit of natural gas decline as a result of the energy transition on one hand, and that the hydrogen demand increases on the other hand.

Outlook for exports (transit)

In addition to supplying the Belgian market[26], the network is also used to transport natural gas to neighbouring countries.

Transmission to France

In its 'Bilan prévisionnel pluriannuel et Plan décennal de développement 2022-2031' (03/2023),[27] GRTgaz describes three possible demand scenarios with a decrease of gas consumption in France of respectively 39%, 18% or 16% between 2021 and 2030. The expected peak volumes also show a significant decline.

The observed H-gas flows (average and peak) from Belgium to France have already decreased significantly since 2022. France has become a net exporter to Belgium.

In the context of the L/H conversion, the volume of L-gas transported by Fluxys Belgium to the French market will gradually decrease and cease completely after 2028 and no later than 2030. There is currently no need to offset this reduction by increasing the transmission of H-gas to France.

[24] To cope with intraday demand fluctuation

[25] This pipeline is fit for hydrogen

[26] Luxembourg is considered in the Belgian market as both countries form one single market for natural gas.

[27] https://www.grtgaz.com/sites/default/files/2023-04/Plan-Decennal-de-Developpement-2022-2031.pdf

Transmission to the UK

In its 'Gas Ten Year Statement December 2023'[28] , National Gas describes four possible gas-demand scenarios ranging from a relatively slow decrease to a significant decline in UK's gas demand for both annual volume and peak demand. At the same time the country's own gas production levels continue to fall. As indicated in the Gas Winter Outlook 2023[29], gas from national production and Norway continue to be the main source of supply to UK with LNG, GB storage, and the European interconnectors providing flexible supplies to meet total demand. At present, the available transmission capacity towards the UK (via Interconnector) is sufficient to respond to market signals (arbitrage flows) while contributing to the country's security of supply.

Transmission to Germany

Germany's Network Development Plan 2022-2032 has been published in December 2023. The TSOs have calculated several (LNG) variants, especially with a view to replacing Russian natural gas volumes.

On the Belgian-German border in Eynatten, record volumes to Germany have been measured since the beginning of the war in Ukraine due to the decreasing flow from Russia. For the coming years, flows are expected to remain high, even when considering the LNG facilities planned in Germany. Investments on the VTN pipeline in Belgium will assure the exit capacity.

Transmission to the Netherlands

In its published investment plan 2022-2032[30], GTS sets out three scenarios showing falling gas demand. Together with an increasing transit from the Netherlands to Germany, additional exports to the Netherlands have already been observed and are likely to continue during the next years.

Outlook for imports

Imports from Norway

Imports from Norway are Belgium's main source of natural gas, which is delivered as a stable base load. No significant change in the quantities supplied is expected soon.

LNG imports

LNG will keep on playing a key role in the security of supply for the European countries. With the war in Ukraine, a sharp increase in imports of liquified natural

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[28] https://www.nationalgas.com/sites/default/files/documents/GTYS-2023_1.pdf

[29] https://www.nationalgas.com/sites/default/files/documents/17148_NGT_Winter_Outlook_2023_AW07_0.pdf

[30] https://www.gasunietransportservices.nl/en/gasmarket/investment-plan/investment-plan-2022

gas (LNG), particularly from the US has been observed. The capacity from Fluxys' LNG terminal in Zeebrugge has increased in 2024 up to approximately 30 GWh/h.

Imports from France

Imports from France have been possible since late 2015 thanks to the new Alveringem interconnection point. The gas may come from the Dunkirk terminal or from TRF, the French gas trading point. There is a noticeable trend towards higher volumes being transported through Alveringem to Belgium. LNG's role in supplying Europe will be a decisive factor in the further development of this entry point too.

Imports from the UK

Imports from the UK (via Interconnector) vary greatly depending on the country's overall supply/demand balance and are substantially influenced by market forces in Europe. We have seen record levels of interconnector exports to continental Europe over the last years. The rise in exports of gas from UK to Europe is largely due to the impact of reduced gas flows from Russia. The future usage rate is hard to predict, but the inter-market balancing function is expected to retain its importance and peak use is expected to continue.

Imports from Germany

The volumes from Germany are very low and are expected to remain at the same level for the coming years.

Imports from the Netherlands

L-gas imports will gradually decline because of the L/H conversion, which should be finalised on September 1st 2024 for the Belgian market. Nevertheless, transmission of L-gas will continue until the L-H conversion is finished in France. H-gas imports are highly dependent on market forces but are expected to remain low during the coming years.

L/H conversion

Introduction

Exports of L-gas from the Netherlands to Belgium, France and Germany will cease by 2030. To guarantee security of supply, Belgium, France, and Germany decided to convert the L-gas market to H-gas. Two reasons for that: there is sufficient H-gas available and existing L-gas transmission infrastructure can be used for H-gas or repurposed for new usages.

The Dutch government decided to close production at the Groningen site on October 1st, 2024. The respective law has been adopted by the Dutch Senate on April 14th, 2024.

At the request of the Belgian authorities, Synergrid has devised an indicative conversion schedule.[31] The indicative schedule is based on repurposing as much of the existing Belgian infrastructure as possible with a view to avoiding investments that are only necessary for the transition period.

Optimising the conversion programme

Due to the increase of earthquakes in Groningen, the Dutch Government requested to evaluate a possible acceleration of the conversion program. In 2020, TSOs and DSOs identified opportunities to optimise the L/H conversion schedule. As a result, according to the new schedule, the entire Belgian natural gas market has been converted to H-gas in September 2024. However, the transit of L-gas from the Netherlands to France will continue for several years.

[31] The Federation of Electricity and Gas System Operators in Belgium (http://www.synergrid.be/ (in French or Dutch))

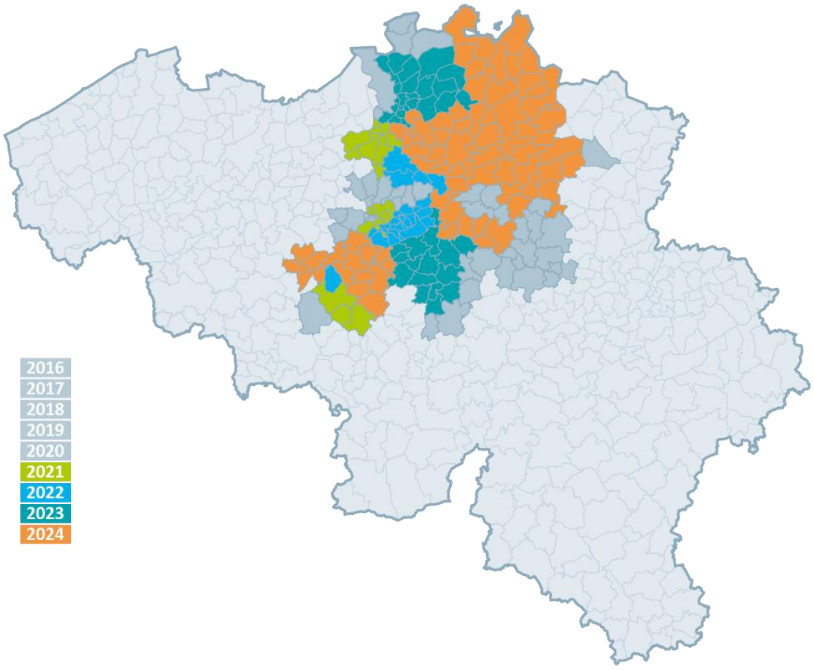

FIGURE 25: INDICATIVE SCHEDULE FOR THE L/H CONVERSION BY MUNICIPALITY (SOURCE: SYNERGRID)

Adjustments to the Fluxys Belgium network

The related adjustments to the Fluxys network have been carried out, mainly in the compression station of Winksele allowing to finalize the migration in 2024.

Entry capacity for the new H market

Conversion period

L-gas customers affected by the conversion need to be supplied with H-gas at each stage of the process. Given that the Hilvarenbeek/Poppel entry point is only supplied with L-gas at present, the companies shipping gas to these customers need to hold entry capacity at another (H-gas) entry point on the Fluxys Belgium network.

Fluxys Belgium's assessments currently suggest that there is enough H-gas entry capacity to absorb the needs of the 'new Belgian domestic market' for H-gas capacity. Higher future flows from West to East were already strongly related to the replacement of L-gas in France and Germany or the Netherlands. In the current geopolitical situation high future flow rates are expected towards the German market, so these assessments have been reviewed concluding that despite disposing of enough Entry capacity, transmission capacity from West to East has to be increased, to reinforce this backbone. This involves completion of the second RTR pipeline between Desteldonk and Opwijk in a first phase, that is

currently scheduled to be commissioned by Spring 2024. A second phase between Zeebrugge and Desteldonk (Evergem) is being decided shortly to complete the path.

Post-conversion period

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

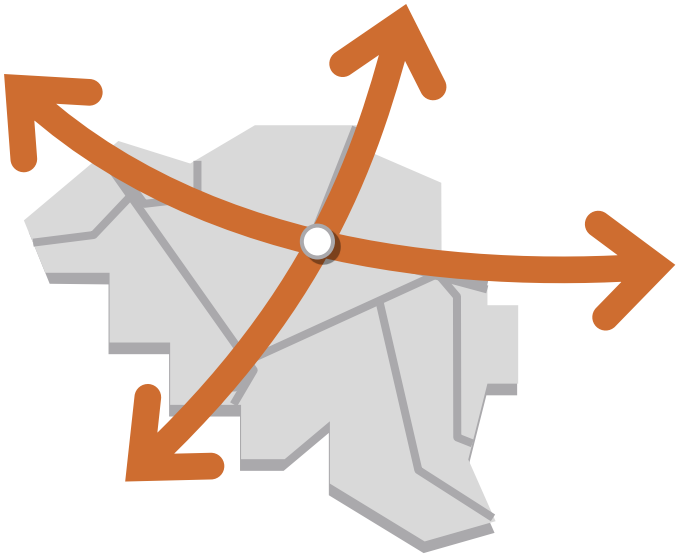

FIGURE 26: POTENTIAL CONTRIBUTION OF THE FLUXYS BELGIUM NETWORK TO THE H-GAS SUPPLY IN EUROPE (SOURCE: FLUXYS BELGIUM)

Developments concerning LNG

Considering the market interest in LNG supplies at Zeebrugge, Fluxys LNG looked into increasing its regasification capacity at the terminal.

The binding phase of the open season process, organised in November 2020, was a success. Fluxys LNG therefore decided to expand the regasification capacity on 15 February 2021, with an additional 8.2 GWh/h available from 2024 onwards, reaching additional 10.2 GWh/h as of 2026.

The chosen regasification method uses the heat of seawater to avoid having to burn natural gas. This lowers the carbon dioxide emissions of the LNG Terminal significantly.

FIGURE 27: ZEEBRUGGE LNG TERMINAL

Moreover, considering the success of LNG truck-loading activities, largely due to the rapid rise in the number of trucks powered by LNG, Fluxys Belgium has decided to build four additional truck-loading bays. While the average annual number of loading operations has been around 1,450 since 2017, it raised to 6,500 in 2022 and is expected to rise to 8,000 in 2024, the current maximum capacity of 8,000 loading operations.

These four new loading bays will be operational by the end of 2024 with a total of 24,000 loading operations a year.

Finally, it is worth reminding here that in 2020, Zeebrugge became the first LNG terminal in Europe to obtain official certification to make available bio-LNG. Bio-LNG is carbon-neutral and offers both freight companies and shipowners the opportunity to take the step towards complete decarbonisation.

Developments concerning biomethane

Status of biomethane today

Biogas is produced from organic matter and is neutral in terms of its contribution to the greenhouse effect. At present, there are almost 200 active biogas production units in Belgium, mainly used to produce local heat or electricity. But biogas can also be purified and transformed into biomethane, which can be injected into the natural gas distribution or transmission system, hence being made available to any gas consumer.

Biomethane has the potential to make a significant contribution to Belgium's energy and climate goals, making it possible to increase the share of renewables in the country's energy mix and therefore to reduce greenhouse gas emissions.

A study conducted by the Green Gas Platform (a joined initiative between Gas.be, Valbiom & Biogas-e) has shown that realistically, biomethane could generate 15.6 TWh[32] by 2030, equivalent to around 8% of Belgium's natural gas consumption in 2019. A new study has been launched by Gas.be to evaluate the additional potential offered when including other production techniques than anaerobic digestion like pyro-gasification.

FIGURE 28: BIOMETHANE PRODUCTION

Injecting biomethane into natural gas networks

[32] 'Quelle place pour le biométhane injectable en Belgique' study conducted by the non-profit Valbiom at the request of Gas.be into the potential of injectable biomethane in Belgium: https://www.gas.be/sites/default/files/pdf/laybrochPotentielBiomethaneFRv10BAT.pdf (in French)

Existing natural gas networks are an important means of enhancing the use of this zero-carbon gas, whether this is biomethane or gas from renewables, meaning that its environmental benefits can be enjoyed by society: the agricultural sector, citizens, businesses and public authorities.

At present, units that convert biogas to biomethane inject it into the distribution network. The first facility for injecting biomethane into the distribution system in Belgium was inaugurated in late 2018. In 2023, 7 facilities are injecting biomethane in the distribution networks.

Over the next few years, the expectation is that new facilities will be built to inject biomethane into the distribution system and also directly into the natural gas transmission system. Many projects are currently under consideration. Green Logix in Lommel will be the first to inject biomethane into Fluxys' Belgium transport grid by the end of 2024.

Reduction of greenhouse gas emission

Go4net0: -50% emissions for our activities in Belgium in 2025

Our Go4net0 program aims to cut greenhouse gas emissions (CO2 and CH4) linked to our activities in Belgium with 50% by 2025, compared to the reference year 2017. Concretely, in figures, we wish to pass from 250 kilotons to 125 kilotons CO2 equivalent.

FIGURE 29 : PROGRESS ON REDUCTION OF GHG EMISSIONS

CO2: additional ORVs welcome at the LNG Terminal in Zeebrugge

FIGURE 30 : ORVS AT THE ZEEBRUGGE LNG TERMINAL

Three additional seawater open rack vaporizers (ORV) were tested in Zeebrugge from September 2023 and put into operation on January 1, 2024. With a positive impact on CO2 emissions. These ORVs make it possible to significantly reduce the consumption of fuel gas for the regasification of LNG, thus contributing to a significant reduction in CO2 emissions at the Terminal compared to 2022. Other initiatives are underway elsewhere in the company to reduce CO2 emissions, in

particular via the replacement of gas engines with electric motors in Loenhout. On the other hand, studies are being carried out to identify ways how to further reduce our emissions.

Methane: our many initiatives are bearing fruit

Methane has a greenhouse effect 29.8 times greater than that of CO2. Many actions have already been carried out on the field and others are underway to quickly reduce our methane (CH4) emissions.

Our teams are actively working on four areas:

- Pneumatic emissions: these are methane emissions from the devices that operate our valves on the network. In total, more than 750 devices are being replaced: by the end of 2023, we had already carried out more than 500 replacements.
- Fugitive emissions: these are losses detected on parts of our network which are not perfectly sealed, such as flanges or fittings or valves. Campaigns are regularly organized, also with external partners, to detect and treat them as far as possible.
- Methane emissions during planned interventions: this is gas released to the air to be able to work on a pipeline in complete safety. Today, we first make sure to consume as much gas as possible in the pipeline. Then we use different technical solutions to limit venting before intervention to the strict minimum.

FIGURE 31 : MOBILE RECOMPRESSION UNIT

- A mobile recompression unit allows gas to be sucked from a section of pipeline to inject it elsewhere in our network.
- For interventions releasing smaller volumes of gas, one can also opt for a Clean Enclosed Burner (CEB) or mobile flares. This means the gas is burnt in a controlled manner to avoid releasing methane into the atmosphere, thus limiting our impact on the environment.

- Operational methane emissions: these are the quantities of gas released to the air when our compressors start and stop. Initiatives and projects are underway to limit these releases as much as possible. One of them is explained below (Green 2.0:Weelde).

Green 2.0: further reduction of methane emissions in Weelde

In 2021, our colleagues at Weelde implemented the GREEN concept (Gas Recuperation and Energy Efficiency for Nature) to capture the seal gas from our Taurus compressors and use it wisely. This year, they continued their momentum with Green 2.0., to also reduce methane emissions from process gas. A project entirely carried out by the entire Weelde team.

OGMP 2.0

At the beginning of 2021, Fluxys Belgium joined the Oil & Gas Methane Partnership (OGMP 2.0), an initiative of the United Nations Environment Program (UNEP). More than 120 gas and oil companies in more than 70 countries are now members of OGMP. These companies commit to reporting detailed data on their methane emissions according to a well-defined approach and structure. A credible and objective way for these companies to show the progress made to reduce methane emissions linked to their activities.

To achieve this, many Fluxys colleagues were called upon. Some to facilitate data collection by developing files, others to automate reporting.

The data reported for the year 2022 are summarized in the IMEO annual report that UNEP published on December 1 as a prelude to COP28 in Dubai.

Indicative investments up to 2033

Fluxys Belgium and Fluxys LNG plan investments totalling **€1,474 million[33] over the period 2024-2033.**

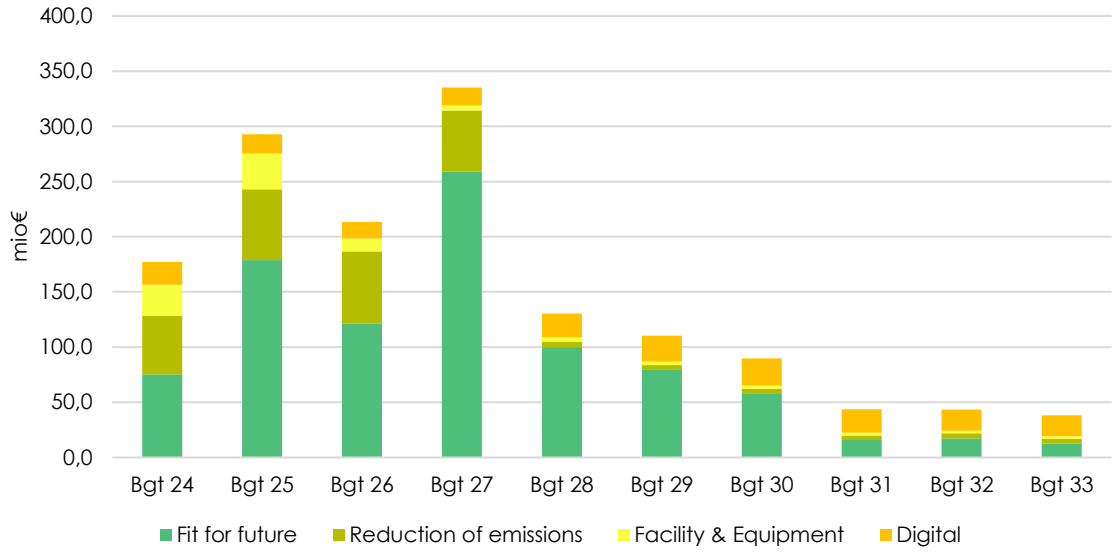

FIGURE 10 : 2024-2033 INVESTMENT PLAN BY AREA

Investments will be made in the following areas:

- **Fit for the future:** €917 million
- **Reduction of emissions:** €264 million
- **Facility & Equipment:** €95 million
- **Digital:** €198 million

Thanks to the investments made in recent years, the Belgian gas transmission network is sufficiently dimensioned, has significant entry capacity (>10 mcm(n)/h), is bidirectional, and well-integrated with other gas transmission systems in North-West Europe.

Approved projects account for €162 million, or 11% of the total amount. These are projects scheduled to be rolled out in the near future (2024-2026). For most of the allocated amounts (€1,152 million), the projects have been identified but no decision has been made yet. In addition, an amount of €160 million has been earmarked for needs not precisely defined yet.

[33] In constant euros

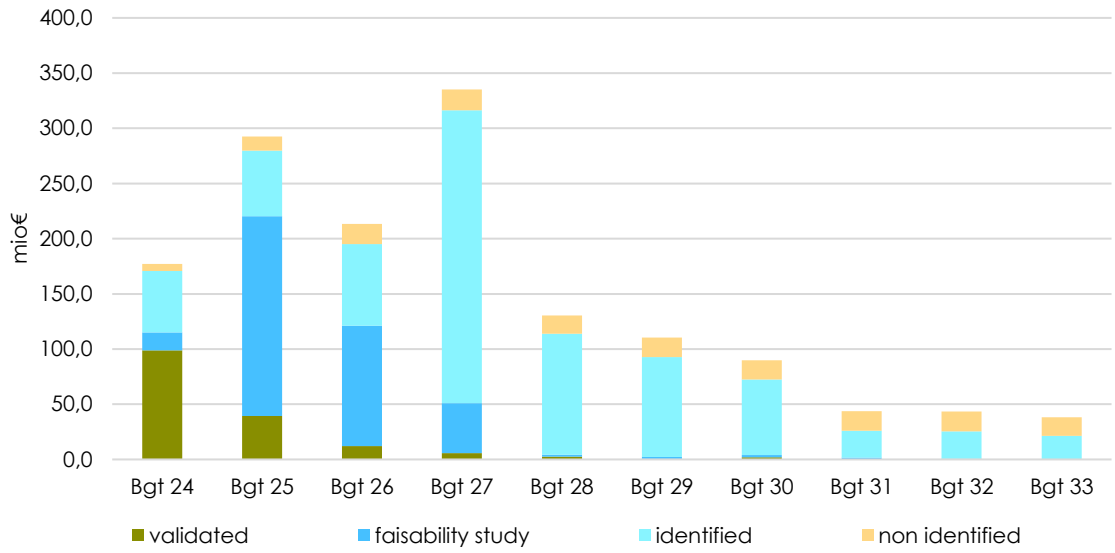

FIGURE 33 : 2024-2033 INVESTMENT PLAN MATURITY LEVEL

The total value of the investment plan is higher than the previous version of the plan (€147 million more than for the period 2023-2032).

The amounts shown are indicative and may change depending on whether the projects in question are given the final go-ahead or on changes to the planned technical solutions or market conditions.

Fit for the Future

Earmarked amount: **€917 million**

This investment primarily encompasses the adaptation and adjustment of the infrastructure to ensure the integrity of the network and of the facilities, including the LNG Terminal in Zeebrugge and the storage plant in Loenhout. The amount includes renewal of valves and facilities, LH conversion and restructuring of pipelines.

It also includes the reinforcement of the pipeline network required due to the change of the flows pattern because of the geopolitical situation, as well as network developments to transport the green energy carriers of the future.

Reduction of emissions

Earmarked amount: **€264 million**

This investment category encompasses all planned projects intended to reduce the environmental impact of Fluxys Belgium and Fluxys LNG operations (their carbon footprint in particular) This includes plans to reduce the emissions at the LNG Terminal in Zeebrugge and in the storage plant of Loenhout.

Facility & Equipment

Earmarked amount: **€95 million**

This amount encompasses the investments required to reinvest appropriately in various buildings and equipment.

Digital

Earmarked amount: **€198 million**

This amount encompasses the investments required to develop new applications for managing and marketing gas flows and boost the digitalisation.

Annex

Hydrogen and CO_2 transmission systems

Context

European energy and climate policy

The European Union aims to achieve **carbon neutrality by 2050** by means of the **Green Deal**[34] adopted by the European Parliament in January 2020. The European Commission also announced in September 2020 a goal of reducing greenhouse gas emissions by 55% compared with 1990 levels. These aims are reflected in actions to be taken in many sectors, of which energy is a central pillar.

As such, an EU **Strategy for Energy System Integration**[35] was published in July 2020. This strategy promotes the coordinated planning of the energy system, across multiple energy carriers, infrastructure and consumption sectors, paving the way for an effective, affordable and wide-reaching decarbonisation of the energy system. Energy system integration strives for energy efficiency, particularly by exploiting synergies between different sectors. It also incorporates the use of low-carbon fuels, more specifically hydrogen, when direct electrification is not feasible, efficient or cost-effective. The energy system must become 'multi-directional' and integrate decentralised production units to supply energy, as well as providing for horizontal exchanges of energy between consumption sectors. Lastly, energy system integration must open up the additional flexibility needed to increase the share of variable renewable sources, more specifically through storage technologies.

At the same time, the European Commission also published a **hydrogen strategy for a climate-neutral Europe**[36] (the EU Hydrogen Strategy). This document highlights the role hydrogen needs to play in an integrated energy system to decarbonise industry and the transport, power and building sectors in Europe. Hydrogen can serve as the energy carrier for uses not suitable for electrification and provide a storage solution to balance flows from variable renewable energies. The strategy's priority is to develop the direct production of hydrogen from renewable energies such as wind and solar energy. However, in the short and medium term other forms of low-carbon hydrogen will be needed to rapidly reduce greenhouse gas emissions and support the development of a viable market.

The European Commission's Hydrogen Strategy sets out a phased approach:

- From 2020 to 2024: installation of 6 GW of renewable hydrogen electrolysers and production of up to 1 million tonnes of renewable hydrogen

[34] European Commission, The European Green Deal, COM(2019) 640, December 2019

[35] European Commission, Powering a climate-neutral economy: An EU Strategy for Energy System Integration, COM(2020) 299, July 2020

[36] European Commission, A hydrogen strategy for a climate-neutral Europe, COM(2020) 301, July 2020

- From 2025 to 2030: installation of 40 GW of renewable hydrogen electrolysers and production of 10 million tonnes of renewable hydrogen
- From 2030 to 2050: renewable hydrogen production technologies reach maturity and renewable hydrogen will be deployed on a large scale across all hard-to-decarbonise sectors

As part of the post-COVID-19 **recovery plan for Europe,**[37] the Commission focused on investments to accelerate the energy transition, such as technologies for producing renewable energy and green hydrogen, and sustainable energy infrastructure.

On May 18th, the European Commission presented the plan RepowerEU aiming at reducing before 2030 the dependence on Russian gas. This plan consists of three main axes: diversify the natural gas sourcing, reduce the domestic consumption and accelerate the energy transition.

Role of gas and gas infrastructure

The transition to a zero-carbon energy system requires major investments and a paradigm shift. A concerted, cross-sectoral approach will be needed to achieve the targets set at European level.

The existing gas infrastructure must be used to accomplish these aims:

- **High-volume, low-cost energy transmission**: Historically, gas infrastructure has been designed to transmit large volumes of energy over long distances, with minimal losses and costs. The gas transmission system can be repurposed to transmit decarbonised gases like biomethane or green hydrogen.
- **Energy storage and flexibility:** Europe is currently home to considerable gas storage capacity, which can be used in the future to store gases produced using renewable energies.
- **Transmission of CO_2:** Some sectors will be unable to switch to green energy sources in the short term. This is particularly true of certain industrial processes. In such cases, carbon capture solutions will be needed, alongside the necessary CO_2 transmission infrastructure, to take the captured CO_2 to sites for reuse (CCU) or storage (CCS).

Hydrogen transmission in Belgium

At present, production of and demand for hydrogen in Belgium are mainly linked to industry (especially in oil refining or ammonia production processes). Hydrogen production is currently based on the reforming of methane (natural gas).

It is widely accepted that demand for hydrogen is set to increase. In a recent study into the role of gases and electricity in a carbon-neutral system in 2050, the Federal Planning Bureau suggested that annual demand for hydrogen as an

[37] NextGenerationEU, European Commission, May 2020

energy carrier in Belgium will total between 80 TWh and 99 TWh, depending on the scenario.[38] On October 29th, 2021, the Belgian federal government adopted its first hydrogen strategy on the proposal of the Energy Minister, Tinne Van der Straeten. On October 12th, 2022, the federal government validated an update of this strategy[39]. The volumes could be produced in Belgium through the electrolysis of water, which would produce green hydrogen, provided that the electricity used comes from renewable sources.

Existing gas transmission infrastructure could be used to facilitate the development of hydrogen as an energy transmission carrier. In fact, where several gas pipelines are present, synergies could be unlocked to repurpose one of these pipelines to transmit the hydrogen needed, for example, in the transition of industrial processes or for transport.

CO_2 transmission in Belgium

In addition to green gases, CCS/CCU will have to be developed for sectors where it is difficult to cut emissions to meet Europe's CO_2 emission reduction targets (a 55% decrease by 2030 and net zero by 2050).

In 2020, Belgium's total CO_2 emissions amounted to 106.4 million tonnes of carbon dioxide[40] (Mt CO_2 excluding LULUCF). Figure 34 illustrates the CO_2 emissions related to the use of energy and feedstock (industrial processes and products) by sector. Industry accounts for the bulk of emissions (39.1 Mt, 16 Mt of which are linked to feedstock), followed by transport (26.0 Mt) and residential heating (22.1 Mt).

[38] Federal Planning Bureau, 'Fuel for the Future – More molecules or deep electrification of Belgium's energy system by 2050', October 2020

[39] See : https://economie.fgov.be/en/themes/energy/sources-and-carriers-energy/hydrogen/belgian-federal-hydrogen

[40] Source: www.climat.be (in Dutch or French)

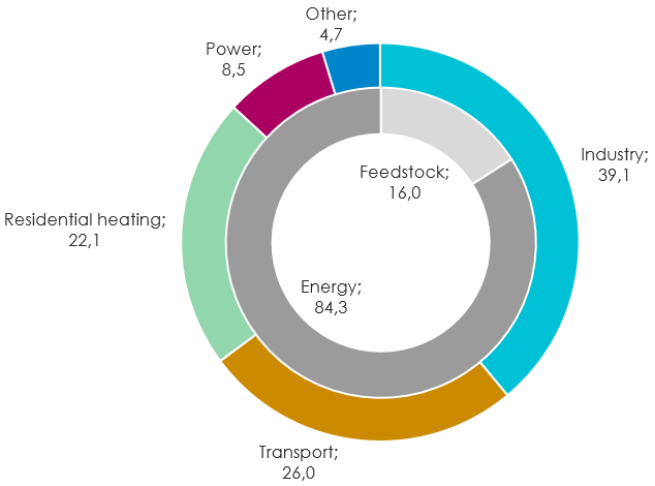

FIGURE 34: CO2 EMISSIONS IN BELGIUM LINKED TO THE USE OF ENERGY AND FEEDSTOCK PER SECTOR IN MT (2018)

CO_2 networks linking emitters and wells (CO_2 storage and use) would allow the development of competitive carbon-reduction technologies. CO_2 liquefaction terminals could be required to ship CO_2 to sequestration sites.

Fluxys Belgium's network can play a vital role here by reusing part of the natural gas transmission infrastructure to transport/export CO_2 from industrial sites in Belgium to CO_2 use/storage facilities.

Technical studies

Fluxys has invested in determining the conditions for reusing existing pipelines to transport hydrogen and/or CO_2. Partnerships with other TSOs (National Gas, GRTgaz, OGE, HNS (NL) and CREOS in particular) have been established.

Preliminary results show that the lion's share of existing infrastructure is fully compatible, with some necessary adaptations, including the maximum operating pressure.

Development of future hydrogen and CO_2 transmission systems

Europe's backbone for hydrogen transmission

The figure below is the result of an exercise to define European hydrogen transmission infrastructure, which was published in July 2020 by a group of 11 TSOs. This exercise, which Fluxys participated in, was based on the reuse of some existing natural gas transmission facilities. The authors of the study envisage the development of a hydrogen network linking consumption and production centres with 6,800 km of pipelines by 2030. The infrastructure will develop further in the 2030s, and will comprise 23,000 km of pipelines by 2040.

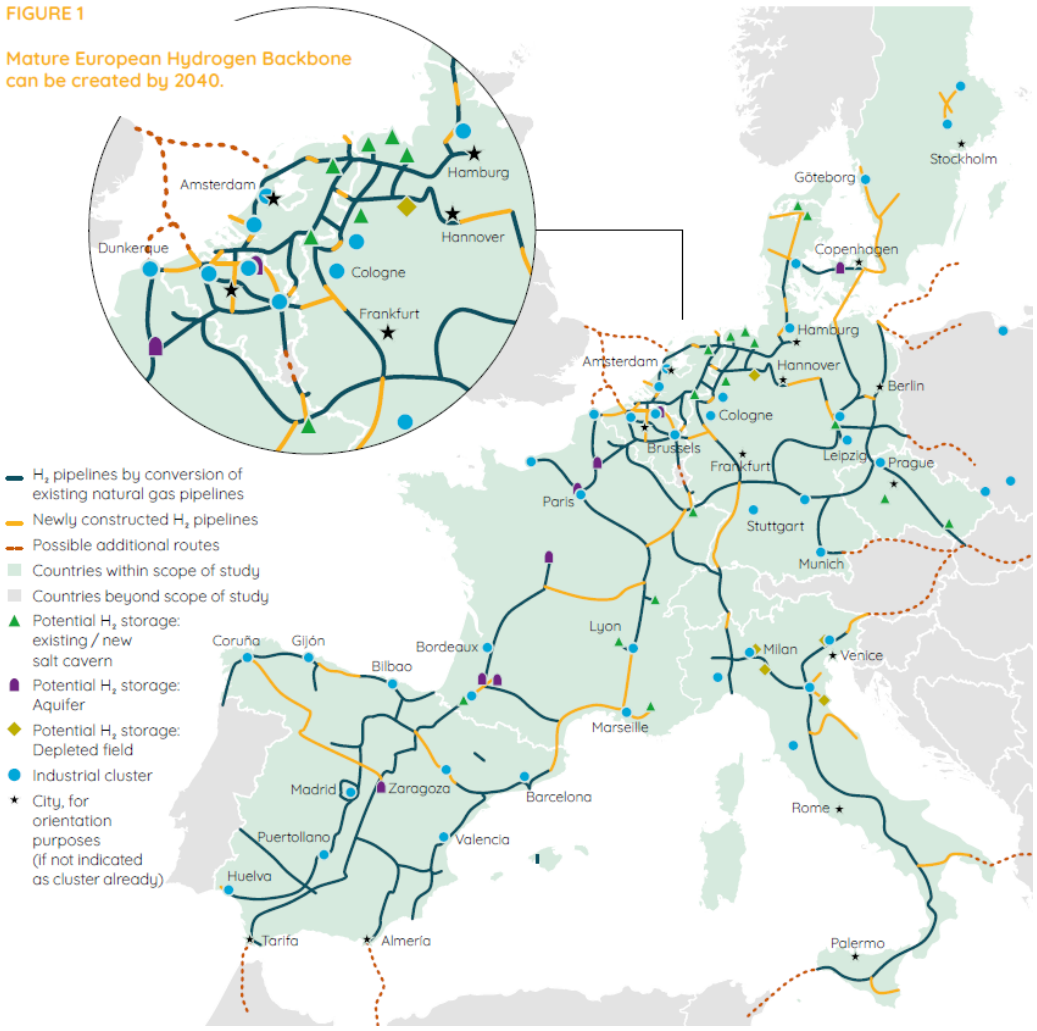

FIGURE 35: EUROPEAN HYDROGEN BACKBONE (SOURCE: GUIDEHOUSE, JULY 2020)

Long-term vision of a Belgian H_2/CO_2 backbone

The figure below sets out a long-term vision for the development of future H_2 and CO_2 transmission systems in Belgium. These networks connect the main regions identified for hydrogen demand and production and CO_2 emissions, and are connected to the various neighbouring markets.

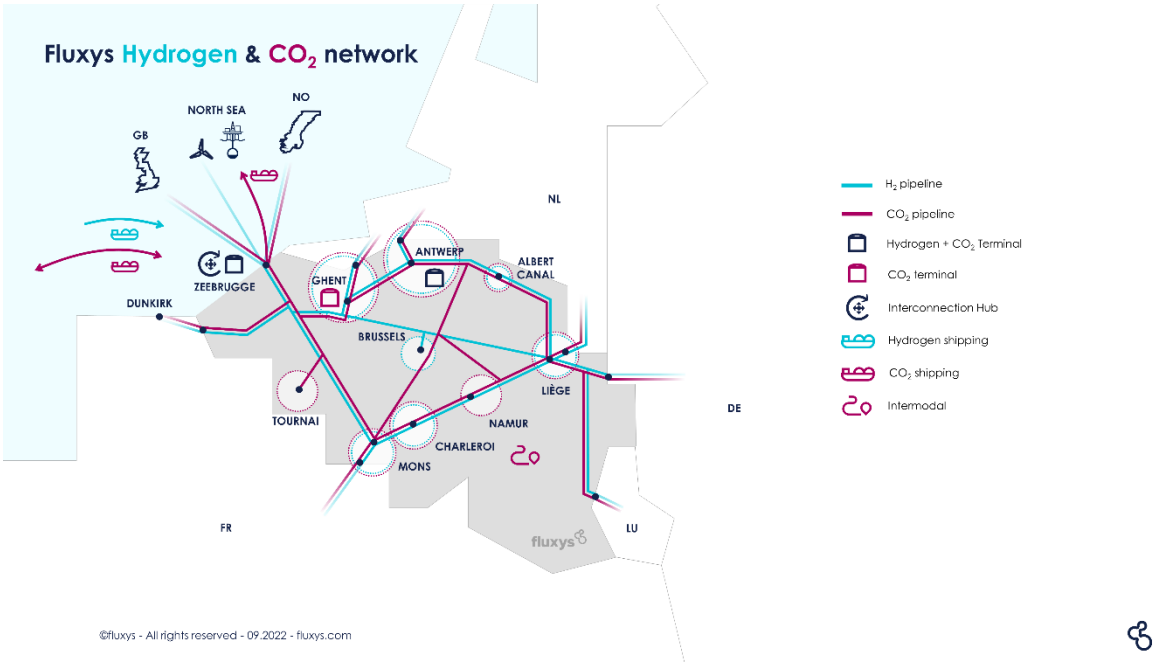

FIGURE 36: LONG-TERM VISION OF THE H2/CO2 BACKBONE

This H_2 and CO_2 transmission backbone partly follows the route of the existing natural gas transmission system, and combines repurposed and new pipelines. It is connected to the ports of Antwerp and Ghent, the Zeebrugge terminal and the industrial zones of Hainaut, Liège and Limburg, as well as to Brussels. The network is also connected to neighbouring countries: the Netherlands, Germany, France and Luxembourg. A connection with the UK is also possible via Zeebrugge.

The H_2 backbone will enable the transfer of hydrogen between industrial clusters in Belgium as well as the import and export of hydrogen. Through multiple interconnection points, producers, transporters and end customers should be able to trade on a growing hydrogen market in Europe, supported by a liquid trading market.

The CO_2 backbone complements the hydrogen backbone. It enables the transmission of CO_2 captured for example in current hydrogen production processes. More broadly, industrial processes that are difficult to decarbonise will benefit from transmission infrastructure that makes it possible to collect CO_2 emissions. The captured CO_2 can be exported to a storage site or reused more locally in another industrial process.

The H_2/CO_2 backbone will be key to the decarbonisation of the Belgian energy system. It will allow both the supply of hydrogen, which will gradually become green (i.e. be produced from renewable energy), and the transmission of captured CO_2 to industrial processes that are harder to decarbonise.

Vision on the hydrogen and carbon dioxide backbones

The figure below shows the long term view in the development of an H_2/CO_2 backbone.

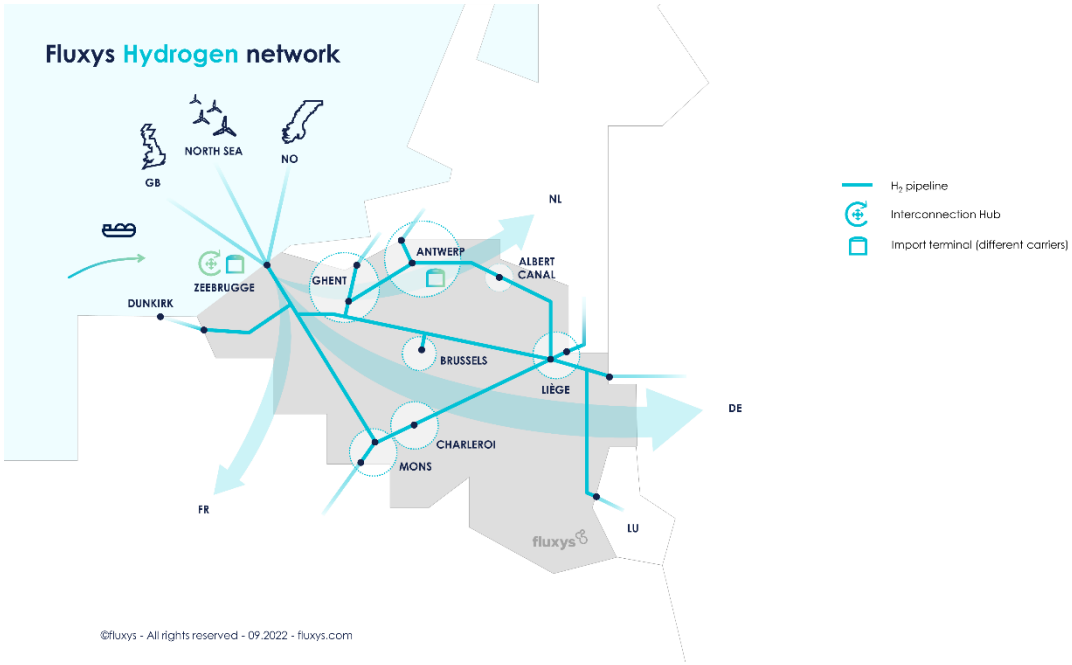

FIGURE 37: VISION FOR THE DEPLOYMENT OF THE H2 BACKBONE

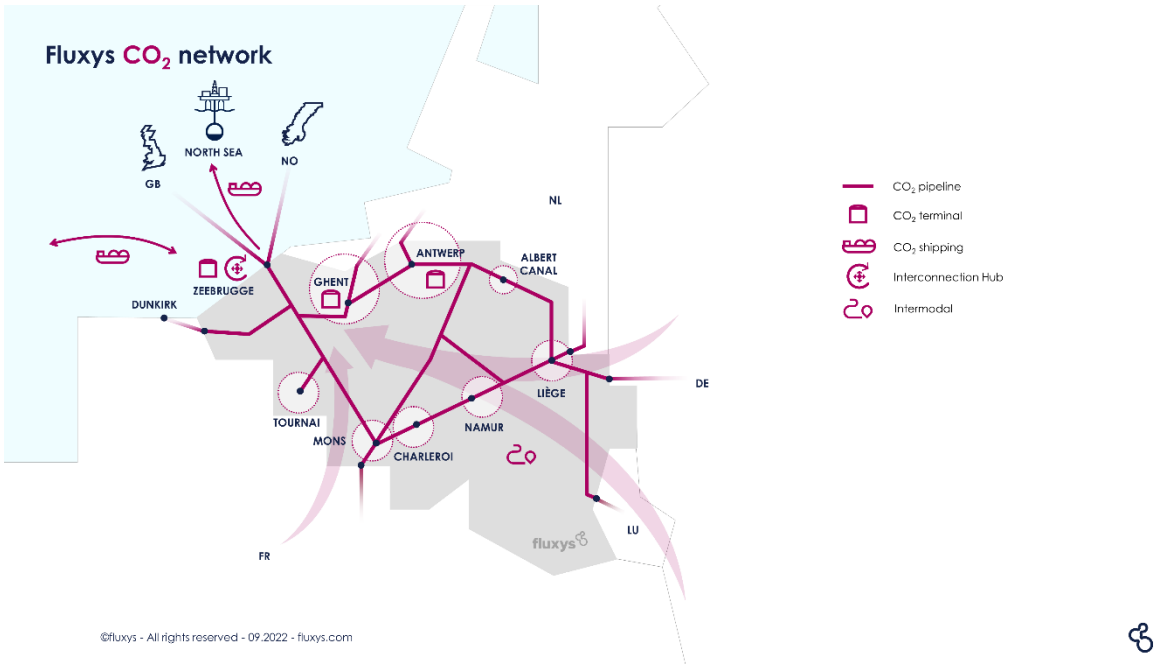

FIGURE 38 : VISION FOR THE DEPLOYMENT OF THE CO2 BACKBONE

Eight H_2 production/consumption and CO_2 emission balancing zones, six H_2 connection modules between such zones, and eight interconnections with neighbouring countries have been identified as potential first steps in the development of the H_2 network.

Balancing zones

The balancing zones are regions where current and future hydrogen consumers could be connected to facilitate the supply of hydrogen, either as a raw material or as part of a transition to hydrogen as a decarbonised energy carrier. The 'grey' hydrogen produced at methane reforming sites could gradually be replaced by 'blue' hydrogen (produced using captured CO_2) and 'green' hydrogen (produced from renewable energy).

A local CO_2 network would be a useful complement to the H2 backbone in this region, either for export for storage or for reuse in chemical processes and help to reduce industrial greenhouse gas emissions.

The following balancing zones have been identified (see figure 37):

- Antwerp
- Brussels
- The Albert Canal
- Ghent
- Hainaut
- Liège

Interconnections with neighbouring countries

Zelzate (Netherlands) interconnection

This interconnection with the Netherlands enhances the coordination of the H_2 and CO_2 networks, which are attracting interest from industrial players on both sides of the Belgian-Dutch border in the North Sea Port zone.

Zandvliet (Netherlands) interconnection

This additional interconnection enables the joint development of the hydrogen market with the Netherlands (in particular with the Rotterdam region). Hydrogen produced from wind energy in the Netherlands could be imported to the Antwerp zone via this interconnection point in particular.

CO_2 could also be exported from the emitters in the port of Antwerp to storage sites via this route.

Blaregnies (France) interconnection

Once Module 2 (with its 'Antwerp-Brussels' and 'Brussels-Hainaut' links) has been established, this interconnection with the Hainaut zone will link the players (producers and consumers) in the Hauts-de-France region to the future North-West European hydrogen market.

's-Gravenvoeren (Netherlands) interconnection

This additional connection to the Netherlands provides access to the industrial area of Dutch Limburg. This increased capacity would boost the competitiveness of Belgium's hydrogen supply as well as security of supply and provide further export routes.

Eynatten (Germany) interconnection

The Liège zone can be linked to Germany via Eynatten and provides access to the Ruhr and the Rhine industrial areas, thereby promoting the cross-border trading of hydrogen. Germany is likely to become a major consumer of hydrogen.

Alveringem (France) interconnection

As described above, the connection between the Belgian hydrogen transmission system and France (the Dunkirk terminal via Alveringem) provides opportunities to optimise hydrogen supply/consumption for the Antwerp, Ghent and Zeebrugge areas.

Indicative investments up to 2033

Indicative estimates have been made to meet demand for hydrogen and CO_2 transmission by 2033. It goes without saying that these amounts will evolve as the scope and technical specification of these networks become clearer in the future.

The future hydrogen and CO_2 transmission systems will combine repurposed and new pipelines.

Hydrogen transmission system

An indicative estimate has been devised for a hydrogen network by 2033, linking the industrial sectors of Antwerp, Ghent, Hainaut and Liège/Meuse Valley as well as Brussels and the Zeebrugge terminal and connected to the Netherlands, France and Germany.

Such a network represents an indicative investment of approximately €1,030 million (in constant 2023 euros) by 2033[41].

CO_2 transmission system

By 2033, Fluxys plans to develop a CO_2 transmission system to collect emissions from industry in the port of Antwerp, the Ghent industrial zone, the industrial areas of Hainaut and the Meuse Valley, the industrial zone of Albert Canal and a connection to Germany, for reuse or export (by pipeline or via a liquefaction terminal).

The indicative investment associated with these development plans is currently estimated at approximately €2,253 million (in constant 2023 euros) by 2033[42].

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[41] This amount only concerns the transmission system. Hydrogen terminals are not included in this amount. For the period 2024-2033, an additional amount of €793 million is foreseen for these terminals.

[42] This amount includes the investment for a dense phase pipeline between Zeebrugge and Eynatten. It does not include the investment for liquefaction terminals which is evaluated at €351 million.