The Netherlands – National Risk Assessment 2023

Ministry of Economic Affairs and Climate Policy
Directorate-General for Climate and Energy
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Contents

Executive Summary

The Dutch society is heavily dependent on gas and since a couple of years the Netherlands is reliant on other countries for its gas supplies due to its decision to end the production form the large Groningen gas field as soon as possible. On 1 October 2023 gas extraction from the Groningen gas field will finally end, 60 years after it began because of the safety of the residents of Groningen. The parliamentary committee of inquiry to the gas extraction in Groningen concluded that decision-making about gas extraction in Groningen gave insufficient consideration to the safety, property protection, health and welfare of the people of Groningen. Gas extraction has systematically ignored their interests, resulting in more than 1,600 earthquakes to date.

This is a major change compared to the previous risk assessment, nevertheless there is still some substantial national production from gas fields on and off shore.

Another major change is the change in the flow patterns of gas in Northwest Europe following the invasion of Ukraine by Russia. Since mid-2022 no Russian gas is coming to Germany anymore. In order to compensate for this, several measures have been taken in the Netherlands, on the supply side as well as on the demand side. The LNG import capacity has been doubled from 117 to 234 TWh/year, electricity by coal powered powerplants has been increased and a campaign has been started to promote energy savings by both households and industries. Moreover imports from Belgium and the United Kingdom have been increased.

For the coming years the gas security of supply is most likely to remain unstable given the (geo)political situation. Actions and additional measures, not only at national but also at EU level and in cooperation with (potential) gas producing companies and countries will remain necessary.

All this has an impact on the N-1 infrastructure standard. As required by Regulation (EU) 2017/1938, import and domestic demand are based on realistic expectations at peak circumstances, the N-1 value is still more than 145%. The infrastructure norm conform the regulation is therefore met.

In addition, a more extensive analysis is performed in which the exports to neighbouring countries, in particular Germany, are taken into account and which have been increased considerably in the past year, the N-1 value fluctuates between 70% and little more than 90%.

This 2023 Risk Assessment does not result in a finding which would support the introduction of bi-directional capacity on cross-border points which are not yet bidirectional. This assessment is supported by national assessments of the network and reflected by the absence of expressed market interest, as is registered in accordance with Regulation (EC) 715/2009 Annex 1 article 3.3(1).

Besides still some substantial national production and adequate infrastructure, security of supply in the Netherlands is delivered through an effective gas market. Commercial incentives on shippers/suppliers are vital to provide sufficient gas to customers. The Dutch virtual gas hub TTF is by far the most liquid gas hub in Europe. This highly effective gas market is supported by a legal framework which safeguards fair and equal access to the market as well as security of supply. It should nevertheless not be forgotten that although infrastructure is available, it is in the end up to shippers and traders to supply gas to where and when it is needed in the right amount.

This risk assessment does not identify any new major risk other than the chance of a malicious act. Nevertheless the gas supply situation in general has become more unstable and unsure which may require additional preventive and/or emergency measures to avoid or cope with a supply disruption. This to for instance to ensure a timely and adequate filling of the storages and to deal with the extremely high utilization of some parts of the transport network and potential congestion. These measures will be dealt with in the to be updated Preventive Action Plan and Emergency Plan which will be published later this year.

Introduction

In order to reinforce security of natural gas supply in the European Union and its member states, Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 entered into force (hereinafter referred to as the Regulation), replacing Council Regulation (EU) 994/2010 concerning measures to safeguard security of gas supply. The Regulation aims to prevent so-called protected customers being affected by the adverse consequences of a disruption in the gas supply chain. To this end, the Regulation introduces measures to ensure that all Member States and players on the gas market take action in advance in order to prevent potential disruptions to the gas supply and, if a disruption should occur, to overcome the consequences of this as efficiently as possible.

In the Netherlands The Ministry of Economic Affairs and Climate Policy (MEAC) has been appointed as the national competent authority for (the implementation of) the Regulation. The Gas Act provides that the Minister can request the national gas transmission system operator Gasunie Transport Services (GTS) to perform specific tasks mentioned in the Regulation partly or completely, but the ultimate responsibility remains with the Minister.

This Risk Assessment is an update and further expansion of the previous Dutch Risk Assessments, published in 2011, 2014, 2016 and 2018. These Risk Assessments did not result in a requirement for investments needed to cope with the infrastructure standard defined in Article 6 of Regulation 994/2010 and Regulation 2017/1938. Neither were country-specific difficulties encountered in the implementation.

The 2023 Risk Assessment of the Netherlands is a detailed description of the role of gas in the Netherlands and how the security of supply of this source of energy is upheld. The report gives an overview of all important data related to the role of gas in the Netherlands, the gas transport network and specifies the regulatory requirements of the infrastructure and supply standards. Furthermore, it contains an evaluation of the risks for the security of gas supply for which purpose several scenarios were developed.

In this Risk Assessment, the changed situation with regard to gas flows in Europe after the Russian invasion in Ukraine is taken into account. Since mid-2022 no Russian gas is flowing to Germany, which has resulted in a reversal of the traditional gas flows through the Netherlands (current flows are from west to east, instead of the traditional flows from north/east to west). The gas shortage caused high prices and has led to demand destruction, but also to extra LNG supply, following several measures.

In previous Risk Assessments, the availability of conversion capacity to convert high calorific gas (H-gas) into low-calorific gas (L-gas) was of concern. In the current situation, however, the availability of conversion facilities is not a bottleneck, but uncertainty regarding the supply of high-calorific gas to the Netherlands is a point of concern. This Risk assessment addresses several scenarios in which the gas flows that are to be expected are calculated and assessed in light of the requirements of Annex II, article 5 of the Regulation.

1 Description of the gas system

This chapter discusses the relevant national and regional circumstances, as prescribed in article 7(4)(b) of the Regulation. The paragraphs include information about the role of gas in the energy mix, the role of gas in electricity production and for heating purposes as well as details on national production, storage facilities, market size and actual flows. Furthermore, the network configuration, the safety of the network and the potential for physical gas flows in both directions are detailed.

1.1 Description of the regional gas systems (risk groups)

1.1.1 North Sea gas supply

1.1.1.1 Norway

To be provided by the coordinator of the Norway Risk group (France)

1.1.1.2 Low-calorific gas

For information about the low-calorific gas markets in Belgium, France and Germany we refer to the Task Force Monitoring L-Gas Market Conversion Winter briefing 2023[1]. Information about the infrastructure and low-calorific gas market in the Netherlands can be found in section 1.2 and beyond.

1.1.1.3 Denmark

To be provided by the coordinator of the Denmark risk group (Denmark).

1.1.1.4 United Kingdom

Given the BREXIT situation, the activities f the UK risk group have been integrated in the Norway risk group (coordinator: France).

1.1.2 Eastern gas supply

1.1.2.1 Belarus

To be provided by the coordinator of the Belarus group (Poland).

1.1.2.2 Baltic Sea

To be provided by the coordinator of the Baltic Sea risk group (Germany).

1.2 Description of the Dutch gas system

1.2.1 Configuration of national grid

The total length of the Dutch national grid is 135,000 km, from which 11,000 km is high pressure pipelines, operated by GTS. The high pressure gas network is shown on the map below, in figure 1. The Dutch high pressure network is directly connected to Belgium, Germany, Norway and the United Kingdom. Via 1,000 gas custody transfer stations gas is distributed to the Dutch domestic market, such as large

[1] https://www.rijksoverheid.nl/documenten/kamerstukken/2023/03/06/bijlage-task-force-gmcm-winter-briefing-2023

industries, power plants and local distribution companies. The Dutch high pressure network consists of two systems for H- and L-gas respectively. These systems are connected with each other via blending stations where H-gas is converted to L-gas using nitrogen (quality conversion), the conversion capacity is limited by the available N2 capacity (see chapter 1.2.6). The conversion of L-gas to H-gas (reverse quality conversion) can only be carried out within the strict quality boundaries of H-gas, in practice there is only limited reverse quality capacity available.

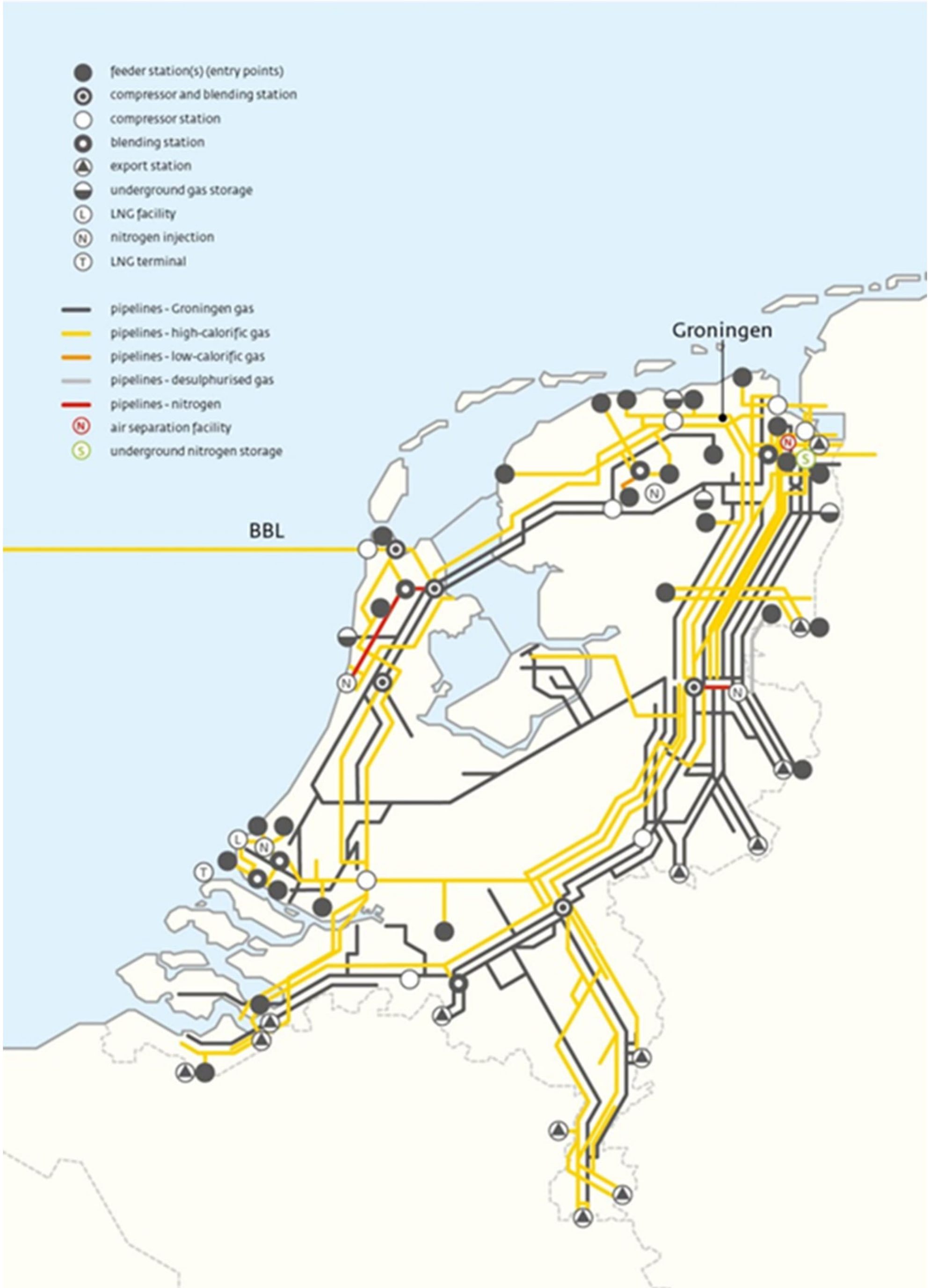


Figure 1: The high pressure gas network in the Netherlands. Source GTS

1.2.2 Configuration of regional grids

In the Netherlands there is a total of 124,000 km of gas pipelines in the regional grids.[2] At the time of writing there were 6 local distribution companies (DSOs) for gas in the Netherlands. The DSOs only transport L-gas. On the map, Figure 2, the service areas of the different distribution companies are displayed:

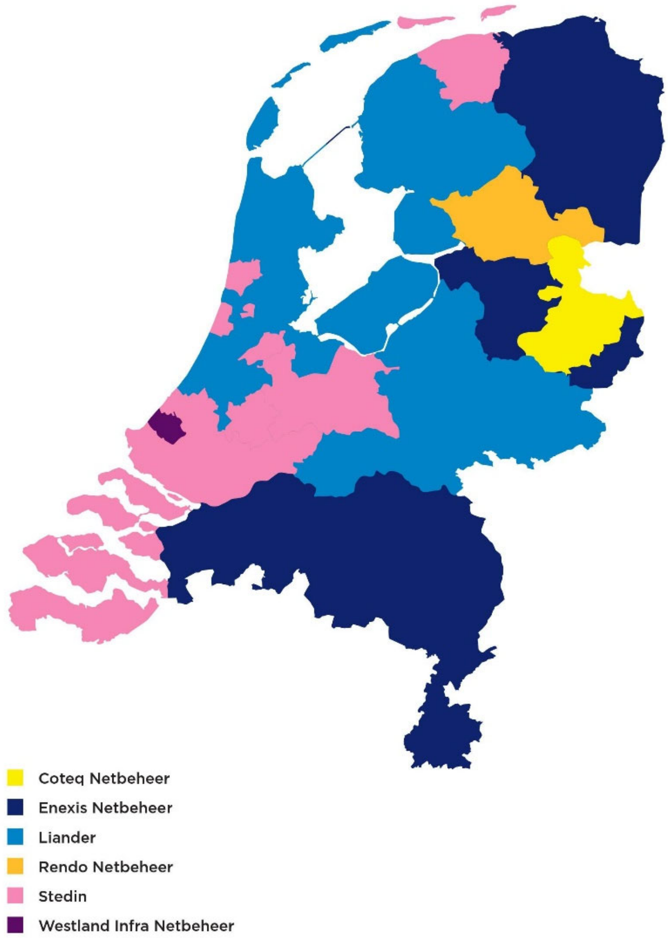


Figure 2: Service areas of the Dutch Local Distribution Companies for L-Gas in 2022. Source: Netbeheer Nederland

1.2.3 Dutch gas market size

Gas is an important energy carrier in the Netherlands. A good illustration of the size of the national Dutch gas demand is the fact that peak[3] demand for gas is almost 10 times as large as the capacity of peak demand of electricity. The Dutch network of gas pipelines, storage facilities and an LNG terminal can supply 10 times as much energy to the domestic market than the existing Dutch electricity grid. This is

[2] Netbeheer Nederland, http://www.netbeheernederland.nl/branchegegevens/infrastructuur/

[3] In this report ¨peak¨ is described as the scenario where temperature is -17 degree, this is complaint with the Dutch regulation (Besluit leveringszekerheid Gaswet)

illustrated by the figure below, where the gas usage is compared to the electricity usage.

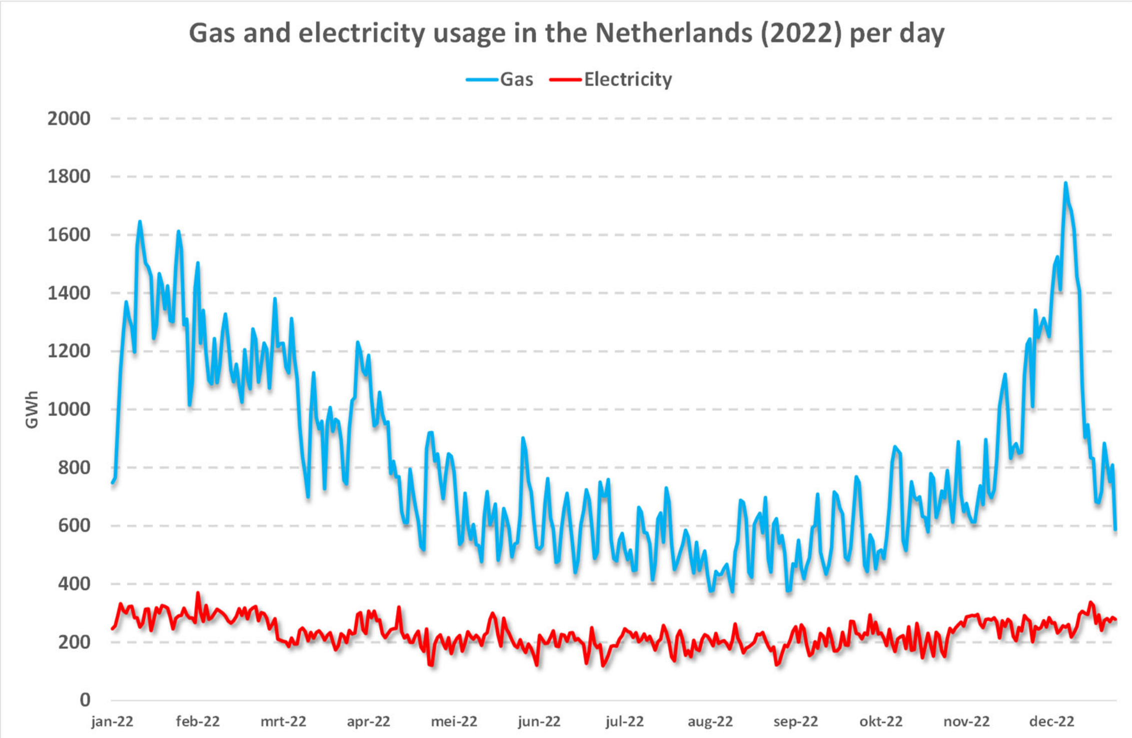


Figure 3: Gas and electricity usage in the Netherlands in 2022. Source: GTS, TenneT

In 2022 GTS transported about 784 TWh. The annual Dutch gas consumption in 2022 of 297 TWh was less than half of the total volume of gas that is transported through the country. This is due to export of indigenous gas and the role of the Netherlands as a transit country. Consumption was also around 80 TWh less than the 2019-2021 average. Depending on climatic conditions, the share of L-gas in the domestic gas demand varies from year to year. In 2022, the L-gas demand was 177 TWh, roughly 60% of the total gas demand.

	2020		2021		2022	
	Yearly TWh	Peak GWh/d	Yearly TWh	Peak GWh/d	Yearly TWh	Peak GWh/d
Build environment	100	2262	113	2225	85	2213
Industry and power generation	118	796	120	836	92	745
Total	218	3058	233	3061	177	2958

Figure 4a: Historic L-gas demand in the Netherlands. Source: GTS

	2020		2021		2022	
	Yearly TWh	Peak GWh/d	Yearly TWh	Peak GWh/d	Yearly TWh	Peak GWh/d
Industry and power generation	167	604	150	727	122	601

Figure 4b: Historic H-gas demand in the Netherlands. Source: GTS

On average the national gas demand slightly decreases, domestic production is in strong decline (see paragraph 1.2.5.2). As a result more volumes have to be imported. Infrastructure has been and will be adjusted to facilitate this.

1.2.4 Sources of gas

1.2.4.1 Gas flows through the Netherlands

The sources of the gas that flows through the Netherlands are indigenous European Union production, LNG and Norwegian gas. Until recently, Russian supply came via Germany to the Netherlands. The figures below show the gas flow from and to neighbouring countries and the yearly utilization rates of the infrastructure that were observed in 2022.

Actual cross-border flows in TWh in 2022				
		L-gas	H-gas	Total
Belgium				
	To Belgium	58	18	76
	From Belgium	0	145	145
Germany				
	To Germany	100	159	260
	From Germany	0	28	28
Norway				
	To Norway	0	0	0
	From Norway	0	129	129
United Kingdom				
	To United Kingdom	0	1	1
	From United Kingdom	0	40	40
Gate & EET[4]				
	To Gate & EET	0	0	0
	From Gate & EET	0	176	176

Figure 5: Actual cross-border flows in 2022. Source: GTS[5]

Change in direction of gas flows in 2022
The decrease of Russian gas supply has caused a reversal of international gas flows. As a result, gas flows are increasingly running from west to east and from south to north across Europe as LNG is partly replacing Russian gas supplies. This also encompasses additional gas flows from the UK via the BBL interconnector and via Zelzate towards the Netherlands.

Drop in demand
Gas shortages led to very high energy prices which have caused a drop in gas demand. Gas demand in the Netherlands for industries, power stations, and regional transmission system operators was down by approximately 20-25% in total on a year on year basis (dropped from on average 371 TWh to 297 TWh). Transport volumes were low because of the higher-than-normal temperatures, the high gas prices, and

[4] EemsEnergyTerminal (EET)
[5] The actual flows do not include the flows related to cross-border connections to German storages.

the conversion of the L-gas market outside the Netherlands. The drop in demand on the consumer side is not reflected in transport figures on a one-on-one basis because transport volumes to storage facilities and exports to Germany were up. Exports to Germany peaked in the second half of 2022 after Russian supply to North West Europe ceased completely.

Negative impact on demand/supply balance (TWh) 2022 compared to average 2019-2021	
Decrease of import from Norway	-88
Decrease of import from Germany	-117
Increase of export to Germany	-166
	-371
Positive impact on demand/supply balance (TWh)	
Entry GATE	+88
Import from Belgium (Zelzate)	+88
Entry EET*	+11
Import from UK via BBL	+39
	226
* EET started sept. 2022, Expectation on yearly basis will be around 80 TWh	

Figure 6: Impact of supply demand balance due to the gas crisis. Source: GTS

1.2.4.2. Key infrastructure relevant for the security of gas supply

Identification of key infrastructure is based on the relative size and share in the supply mix.
The following infrastructure is considered to be of great importance to the security of gas supply:

- The gas import station at Emden for importing Norwegian gas, being the largest import terminal and the largest single infrastructure in the Netherlands. Furthermore the import facilities at Zelzate (Belgium) and via BBL from the UK are of great importance.
- The LNG terminals in Rotterdam (GATE) and Eemshaven (EET) are key infrastructures for the import of LNG.
- The Dutch gas production from on-shore and off-shore gas fields.
- The underground seasonal gas storages at Norg, Bergermeer, Grijpskerk and Alkmaar. Norg is the single largest infrastructure in the L-gas region and an important source of flexibility for the protected customers in the Netherlands.
- The blending stations at Wieringermeer, Ommen and Zuidbroek, being the sources of quality conversion to supply the protected customers in the Netherlands.

All these facilities are key infrastructure for security of supply and necessary to overcome the lack of Russian gas and the resulting flow patterns and to facilitate the phase out of the Groningen field.
Due to their importance for the security of supply, the effect of disruption of these facilities is investigated as part of the national risk assessment.
In addition to the mentioned facilities, the compressor stations could also be considered key infrastructures that enable gas transmission in the Netherlands. It

should be noted that all of these stations are designed with redundant capacity (according to N+1 philosophy).

1.2.4.3. TTF, the Dutch gas hub

In essence the Dutch gas hub, the TTF (Title Transfer Facility), is a virtual point in the network of GTS where the ownership of gas (the title) is transferred from shipper A (representing the selling party) to shipper B (representing the buying party). The major virtual gas trading platforms in the European Union consider the TTF market area as price setting area, supporting among others gas spot and forward/futures trade. Trade on the TTF continued to grow steadily from its start in 2003 till March 2022. Although volume traded decreased in April 2022, TTF maintains its leading position in Europe with a market share above 75%. In December 2022 163 traders registered with GTS were actively trading, compared to 147 in December 2017. The volume of gas traded on the TTF in 2022 was 38,356 TWh, compared to 20,962 TWh in 2017.

Although there is a clear physical distinction between L-gas and H-gas there is no need for shippers to be in balance in both qualities separately. Gas on the TTF is traded in energy units (kWh) and not in a specific quality. The entry points and exit points of the GTS system have a designated quality range labelled L-gas or H-gas. Operators of gas production grids and storages have to comply with this quality range when feeding into the system and GTS will arrange for the right quality for the exits.

Figure 7 shows the growth in the number of parties on the TTF, the development in traded volumes and the net volume between calendar year 2017 and calendar year 2022. The very high liquidity of TTF helps to lower costs for consumers and provides confidence for suppliers and investors. TTF showed great resilience when energy prices were very volatile and high in 2022. On average TTF Day-ahead End of Day prices were 123.0 €/MWh in 2022 (min 23.85 €/MWh, max 307.7 €/MWh).

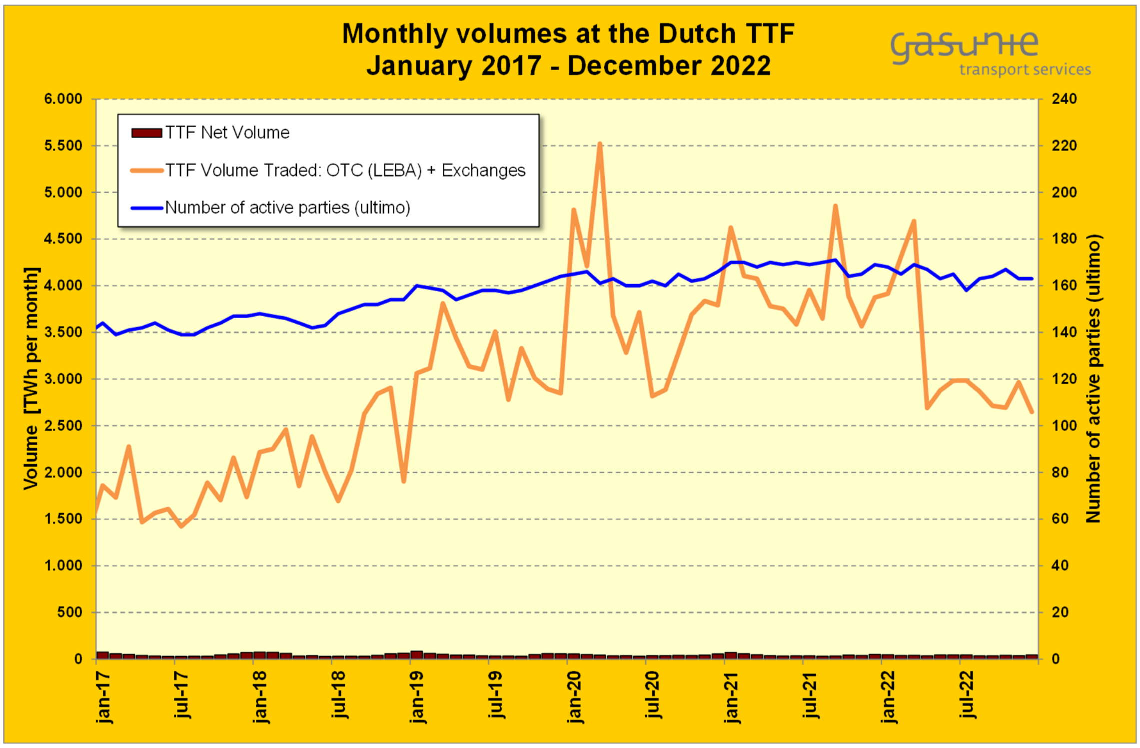


Figure 7: Monthly volumes traded at the TTF 2017-2022.

1.2.5 Gas production in the Netherlands

1.2.5.1. History of production

In 1959 one of the world's largest gas fields was discovered in the Netherlands, the Groningen gas field, located in Groningen province in the northeastern part of the Netherlands. The Groningen gas field is owned and operated by the Nederlandse Aardolie Maatschappij BV (NAM), a joint venture between Royal Dutch Shell and ExxonMobil with each company owning a 50% share. The Groningen field produces gas that falls within the L-gas Wobbe range.

The Groningen field has been producing natural gas for more than 60 years. It had an estimated total production volume of 27,300 TWh of which ~77% is produced. The government of the Netherlands announced in March 2018 its decision to terminate natural gas production from the Groningen field as soon as possible, in order to guarantee safety in the area of Groningen against the risk of earthquakes resulting from natural gas production. From the start of the GY 2022/23, the Groningen field is only needed in cases of extremely low temperatures, unexpected (out of spec) gas qualities, transportation limitations, a shortage of H-gas and in case of a severe disruption elsewhere in the system. To be able to guarantee production in those circumstances the field will operate on minimum flow during the entire gas year 2022/2023 to ensure that additional production is possible when necessary[6].

To achieve the goal of terminating production from the Groningen field as soon as possible, measures were taken. Some of them are already executed, like enabling the gas storage Norg to be filled with pseudo G-gas, exporting pseudo G-gas via Oude Statenzijl to Germany and GTS buying extra nitrogen to extend the efficiency of the existing nitrogen conversion facility Wieringermeer. Some of the measures are not yet operational, such as the realisation of the new nitrogen plant Zuidbroek II. This plant is expected to be fully functional on 1 October 2023.[7]
Furthermore, a number of large industrial customers are and will be converted from L-gas to H-gas.
Possibilities to accelerate the market conversion in Germany, Belgium and France have also been investigated. By gas year 2029/30, exports of L-gas to these countries will be reduced to nearly zero. Notably, the optimisation of the conversion planning in Belgium is expected to allow for higher conversions in the gas years 2022/23 and 2023/24, indicating a potential reduction of Belgium's L-gas imports from the Netherlands to 0 by gas year 2024/25 instead of gas year 2029/30.

In addition to the Groningen field, the Netherlands extracts gas from smaller fields since 1970. Since then, over 495 small gas fields have already been discovered in the Netherlands, of which 221 are producing at the time of writing. The smaller fields predominantly produce H-gas.

1.2.5.2. Forecasted indigenous production

The Dutch Ministry of Economic Affairs and Climate Policy has announced in a decision dating 31 March 2023 that it aims to close down the Groningen field in 2023 or 2024

[6] L-Gas Market Conversion Review – Winter briefing 2023

[7] The exact date of commissioning will be communicated via the official channels (REMIT messages)

at the latest. The draft decision for the allowed production from the Groningen field for gas year 2023/2024 was published in June 2023[8]. In the draft-decision the Cabinet announces the cutting of gas production to zero as from 1 October 2023. However, the field will not be closed permanently as we are not sufficiently certain of adequate supplies of high-calorific gas in the coming year. The Cabinet will therefore retain the option to extract a limited quantity of gas at the 11 existing production sites in particular extremely exceptional situations. This would mean temporarily regulating up to standby in the event of imminent severe cold in order to quickly respond if key production resources fail in those circumstances. The final decision will be made before 1 October 2023.

Below, the expected production from Dutch small fields until at least 2035 is provided:

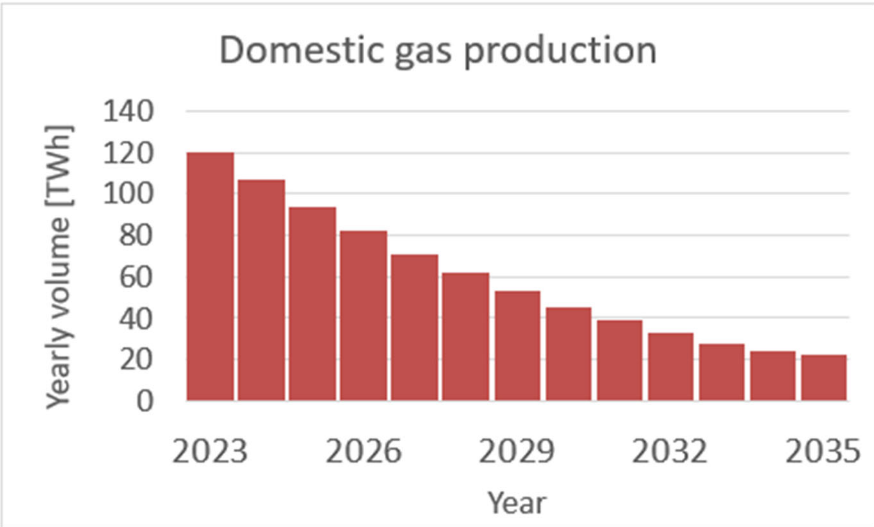


Figure 8: Estimated production of Dutch small fields. Source: GTS, own analysis based on information provided by gas producers

1.2.6 Quality conversion facilities

In addition to the L-gas production from the Groningen field, GTS has the capability to perform quality conversion. Currently, GTS operates five facilities to dilute H-gas with nitrogen to make L-gas[9]. The combined nitrogen production capacity is at the moment 707,000 m3/h. Preparation for a sixth facility (Zuidbroek II) is currently under way, adding an extra capacity of 180.000 m3/h to ensure that enough L-gas can be produced when production from the Groningen field is stopped.

Facility		Status	Capacity N2 (m3/h)	Capacity pseudo-G* (GWh/d)
Ommen	Baseload	Operational	146,000	291
Wieringermeer	Baseload	Operational	295,000	588
Zuidbroek I	Baseload	Operational	16,000	32

[8] https://open.overheid.nl/documenten/ronl-60499260c88debc6c1e27f708640b9f48afe714b/pdf

[9] One cubic meter of nitrogen can produce between 7 and 8 cubic meters of L-gas, depending on the Wobbe index of the H-gas source.

Pernis	Back-up	Operational	60,000	120
Heiligerlee (cavern)	Back-up	Operational	190,000	379
Zuidbroek II (when completed)	Baseload	Planned	180,000	359

* Approximation, capacity depends on Wobbe value of H-gas

Figure 9: Quality conversion facilities.

1.2.7 Gas storage in the Netherlands

Indigenous gas production played an important role in compensating for fluctuations in North West European market demand. The decline in gas production in North West Europe is causing a decrease in the availability of this natural flexibility. Storage facilities are playing an increasingly greater part in order to compensate for this declining production flexibility. To this end, it is important to make a distinction between storage facilities that can provide supplies for summer-winter variations and those that can absorb relatively short peaks in the gas demand. Depleted gas fields (DGF) are extremely suitable for absorbing seasonal fluctuations or to satisfy peak demand. Salt caverns (SC) are often used for shorter peaks, but can, when having a large storage volume, also be used to balance out seasonal supply and demand.

The following table lists the storages in the Netherlands. The storage operators provided the 100% data publicly to GIE and the 30% data to GTS.[10]

Facility/ Location	Type	Operator	Working gas TWh	Withdrawal 100% GWh/day	Withdrawal 30% GWh/day	Injection GWh/day
EnergyStock	SC	EnergyStock BV	4	431	431	310
Grijpskerk[11]	DGF	NAM	24	620	225	154
Norg	DGF	NAM	59	801	702	281[12]
Alkmaar	DGF	TAQA Energy BV	5	360	360	40
Bergermeer	DGF	TAQA Energy BV	48	469	446	448

Figure 10: Storage facilities in the Netherlands. Source: https://agsi.gie.eu/#/ (Norg, Alkmaar, Grijpskerk and EnergyStock store L-gas, Bergermeer stores H-gas).

Besides access to storages located on Dutch territory, the Dutch gas network has access to German storage facilities. The figure below shows the capacities at Interconnection Points connecting these storages and the GTS grid.

The L-gas cluster is dedicated and only suitable for the Dutch grid. The H-gas storages in Germany are mostly connected to the Dutch and German grid and serve the TTF market area as well as the THE market area.

Location	NWP	Entry capacity (GWh/day)	Exit capacity (GWh/day)
Cluster Enschede/Epe storages (L)	Cluster	314	211

[10] Public storage data can be found at https://agsi.gie.eu/#/

[11] After approval by the Dutch Ministry of Economic Affairs and Climate Policy, NAM has decided on April 1, 2022 to convert the storage from a H-gas storage to a L-gas storage.

[12] Since storage Norg is filled with pseudo G-gas and this gas cannot be transported via the Groningen production system, this is the injection capacity of Norg at the connection point with the GTS-network.

Cluster Oude Statenzijl storages (H)	Cluster	840	386

Figure 11: Capacities at Interconnection Points connecting German storages to the GTS grid. Source: GTS

The storages connected to the GTS network have two crucial functions from a security of supply-perspective. First, storages are necessary to ensure that LNG imports in summer can be stored for usage in the winter. Second, in the winter, storages are needed to provide peak supply and the winter volume.

1.2.8 LNG in the Netherlands

On the Maasvlakte in Rotterdam, Gate terminal has built the first H-gas LNG import terminal in the Netherlands, which is operational since 2011. The terminal consists of three storage tanks, two jetties, small scale LNG, and a process area where the LNG is being regassified. Annual throughput capacity has been increased from 130 TWh to 166 TWh in the summer of 2022, and will be further increased to approximately 220 TWh in the future, by adding an additional tank

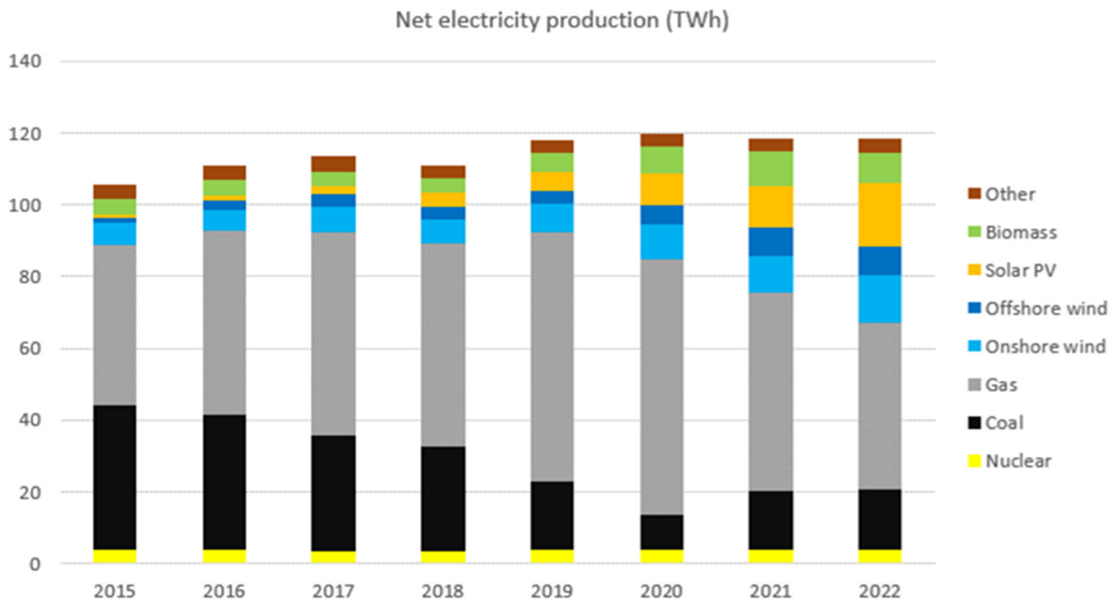
In response to gas supply insecurities and the EU requirement to be less dependent on Russian gas, Gasunie (in cooperation with the Dutch government) has contracted a new floating LNG terminal which is mourned in the Eemshaven area, called the EemsEnergyTerminal (EET). The terminal consists of two Floating Storage Regasification Units. EET's ambition is to be able to handle 80-90 TWh of natural gas before the end of 2023, and then to grow to 90-100 TWh.[13] The current throughput capacity of the terminal is around 50-60 TWh on annual basis. The terminal has been operational since 15 September 2022 and is operating at higher capacity since March 2023. The expansion of Gate terminal and the development of EET has resulted in an increase of the national LNG import capacity to around 250 TWh annually.

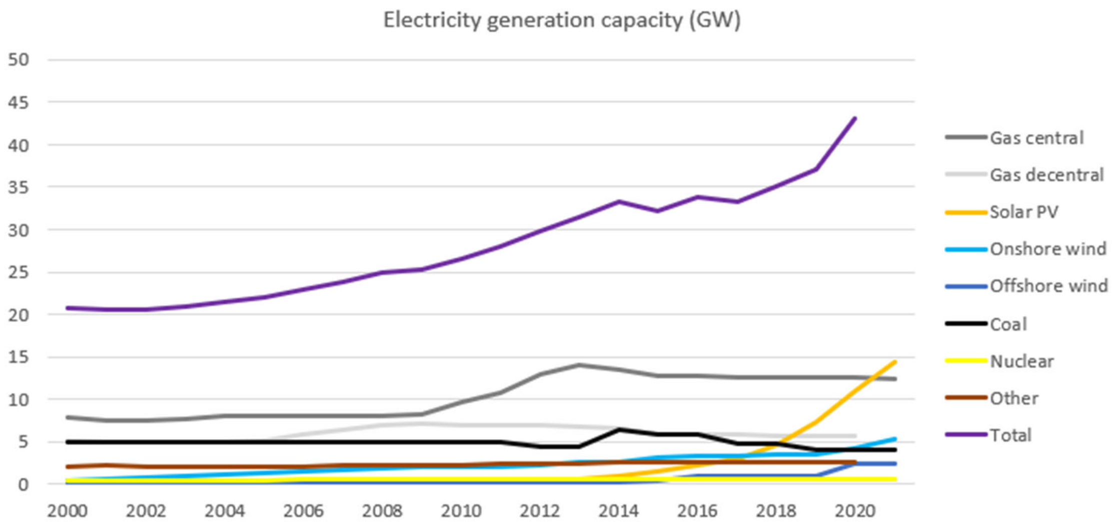
1.2.9 Role of gas in power generation

Gas fired power generation plays an important role in the supply of electricity in the Netherlands. This is illustrated in the figures below, which show the installed power generation capacities and dispatch of the various sources.[14] Between 2015 and 2020 the market share of gas fired generation increased from 40% to almost 60% of domestic production, primarily due to a reduction in coal fired generation. Since 2020 the dispatch of gas fired power stations has decreased again to approximately the 2015 level. This is primarily driven by the uptake of renewables and the recent increase in gas prices. Since 2015, gas fired installed capacity remained rather stable, however some of the capacity has been ¨mothballed¨. With the projected increase of variable solar and wind generation, gas fired power stations are expected to become increasingly a source of flexibility.

[13] https://www.eemsenergyterminal.nl/en/latest-news/eemsenergyterminal-at-full-production

[14] Net electricity production taken from CBS (https://opendata.cbs.nl/#/CBS/nl/dataset/84575NED/table)
Generation capacities taken from KEV 2022 (https://www.pbl.nl/publicaties/klimaat-en-energieverkenning-2022)





Figures 12 & 13: Electricity production and generation capacity.

2 Infrastructure standard

2.1 Introduction

Article 5 of the Regulation sets minimum requirements in respect of the infrastructure. The infrastructure of every member state must be capable of coping with the disruption of its single largest gas infrastructure (the so-called N-1 indicator), even during a day of exceptionally high gas demand. The calculation set out in the next paragraphs uses the following formula:

$$N-1[\%] = \frac{EP_m + P_m + S_m + LNG_m - I_m}{D_{max}} \times 100, \; N-1 \geq 100\,\%$$

2.2 Parameters and sources of the N-1 formula

The Regulation describes how the parameters of the formula should be calculated. This paragraph describes for the Netherlands how the values of the different parameters are determined.

2022 has been chosen as the reference year. The parameters make no distinction between low-calorific gas (L-gas) and high-calorific gas (H-gas).

Demand side parameter

D max — the total daily gas demand (in GWh per day) of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years (national legislation requires a more conservative reference temp of -17).

GTS annually recalculates the total expected daily gas demand in the Netherlands for the coming years. For the N-1 calculation, the peak demand figures of the Klimaat-en energieverkenning 2022[15] scenario as provided for 2024 of the GTS Investment Plan 2022[16] were calculated. Demand-side measures are not applied in the Netherlands and are therefore not included in the D-max calculation.

Supply side parameters

EP m — the technical capacity of entry points (in GWh per day) other than production, LNG and storage facilities covered by P m, S m and LNG m: the sum of the technical capacity of all border entry points capable of supplying gas to the calculated area.

The Dutch transport network is directly connected to four countries, Belgium, Germany, Norway and the United Kingdom. Except for the connection with Norway, the other H-gas connections are bi-directional. The connection with the United Kingdom can be operated bi-directly since mid-2019. The direction of the flow can be changed based on market demand.

[15] https://www.pbl.nl/en/publications/climate-and-energy-outlook-of-the-netherlands-2022

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

The table below gives an overview of the maximum border capacity in GWh/d in 2023. The entry capacities for the N-1 calculation are considered after applying the so called lesser rule to the available transport capacities on both sides of the border. The result of the lesser rule calculations is presented in the table below.

Entry point [GWh/d]	GTS capacity	NNO capacity	Lesser rule capacity
Emden EPT (Gassco)	878	878	878
VIP THE-H	511	582	511
VIP BENE-H	428	428	428
BBL company	168	168	168
Total			1.986

Figure 14: Overview of maximum border capacity in GWh/d.

According to Regulation 2017/1938 Article 5(4a) bi-directional capacity is not required for (cross border) connections to gas production facilities. This applies to the L-gas system, as it connects several countries to the L-gas production locations in the Netherlands and Germany. As a consequence, no bi-directional capacity is offered for L-gas interconnections with Belgium and Germany.

Furthermore, an exemption has been given under Regulation 994/2010 for the following H-gas interconnection:

- The interconnection at Vlieghuis as this is a dedicated pipeline to a power plant.

This exemption will have to be reviewed under the current Regulation.

S m — maximal technical storage deliverability (GWh per day): the sum of the maximal technical daily withdrawal capacity of all storage facilities which can be delivered to the entry points of the calculated area, taking into account their respective physical characteristics.

The number of storages capacity used as input for the N-1 formula is higher than the number listed in the overview of Dutch storages, because the Netherlands has also direct access to storages in Germany. **Fout! Verwijzingsbron niet gevonden.** It shows the capacities of all UGS in the beginning (100% full) and near the end (30% full) of the heating season.

Storage facility (GWh/d)	Capacity (100% full)	Capacity (30% full)
EnergyStock	431	431
Norg	801	702
Grijpskerk	620	225
Alkmaar	360	360
Bergermeer	469	446
Epe storages	356	356
Peakshaver	199	199
Oude Statenzijl storages	840	840
Total	4.076	3.559

Figure 15: Overview of storage facilities in GWh/d.

P m — maximal technical production capability (in GWh per day) means the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area.

This parameter comprises of the Groningen field and the other gas fields on the Dutch continental plateau (small fields). Under peak demand and/or emergency situations the maximum production capacity from the Groningen field is used. Therefore the production capacity for 2023 as projected in the GTS Investment Plan 2022-2032 is the input for this variable. However, on 31 March 2023, the State Secretary for Mining decided to close 6 of the 11 production clusters of the Groningen field, the consequence is that only in very special circumstances these clusters can be taken into production again.

Besides the Groningen field, in The Netherlands a large number of small fields are active, the total production capacity of these fields is take into account.

Entry point	Capacity [GWh/d]
Groningen field (11 clusters)[17]	1,032
Small fields	294
Total	1,326

Figure 16: Overview Dutch production in GWh/d.

LNG m — maximal technical LNG facility capacity (in GWh per day): the sum of the maximal possible technical daily send-out capacities at all LNG facilities in the calculated area, taking into account critical elements like offloading, ancillary services, temporary storage and re-gasification of LNG as well as technical send-out capacity to the system.

The Netherlands has the potential to supply gas to the market via two LNG terminals, the GATE terminal on the Maasvlakte in Rotterdam and the Eemshaven Energy Terminal (EET).

[17] It is the intention of the Dutch government that no use is made of this capacity after 1 October 2023, unless exceptional circumstances warrant this.

LNG terminal	Capacity [GWh/d]
Gate	504
EET	360
Total	864

Figure 17: Overview of LNG terminals in GWh/d.

I m — technical capacity of the single largest gas infrastructure (in GWh per day) with the highest capacity to supply the calculated area. When several gas infrastructures are connected to a common upstream or downstream gas infrastructure and cannot be separately operated, they shall be considered as one single gas infrastructure.

Up until 2015, the Norg storage facility was the single largest gas infrastructure in the Netherlands. However in 2016, the two Emden import terminals were merged into one commercial entity, effectively (technically) becoming the new single gas infrastructure with the largest capacity.

2.3 Setup of the N-1 calculations

The current situation differs compared to the previous version of this risk assessment because of the Russian invasion of Ukraine and the resulting consequences for the supply of gas to Europe. This situation has led to a different setup of this chapter of calculating the N-1 results. The calculation has been built up in three analyses, which are:

I. Analysis where entry and import are based on technical/infrastructurural capacities and demand under peak circumstances without taking the expected flows/capacities into consideration

   This is formally not in line with article 5 of the SoS regulation, which prescribes to take into account gas consumption trends, the long-term impact of energy efficiency measures and the utilisation rates of existing infrastructure. Nevertheless the calculation gives some indication of the resilience of the available infrastructure.

II. Analysis where entry, import and domestic demand are based on realistic expectations at peak circumstances

   This analysis is fully compliant with article 5.

III. Analysis where entry, import, *export* and domestic demand are based on realistic expectations at peak circumstances

   In this analysis the assumptions above are further adapted to realistic circumstances by adding the export to neighbouring countries to the "D real" parameter. This is the best estimate of the actual security of supply situation, as the Netherlands is the only L-gas supplier for Germany, Belgium and France and has always been an important transit country for H-gas. Especially in the current situation where Germany is not supplied anymore by Russian gas and not yet by significant direct LNG supplies, Germany is fully reliant on imports from Norway, Belgium and the Netherlands. The results are calculated for two scenarios with varying parameters to reflect the uncertainties. The first (high) scenario is a combination of high supply and low demand, the second (low) scenario is a combination of low supply and high demand, resulting in a bandwidth. The resulting bandwidth is calculated for both the 100% and 30% underground gas storage (UGS) deliverability.

The parameters for which the situation is unclear and the chosen levels are:

Parameter	Belonging to…		Highest outcome formula [GWh/d]	Lowest outcome formula [GWh/d]
Groningen field	P real		469	0
Oude Statenzijl caverns	S real		420	0
Domestic and L-gas export market	D real		3,525	4,147

Figure 18: Overview of parameters in GWh/d.

Results of the outcome for the three analyses of the N-1 formula:

	100% UGS deliverability	Reduced UGS deliverability (30% full)
Analysis I	234%	218%
Analysis II	146%	130%
Analysis III	69% - 93%	60% - 83%

Figure 19: Overview of N-1 formula results in GWh/d.

The most important characteristics of the three analyses are:

Analysis I
- Groningen 11 clusters operational
- Supply based on technical capacities

Analysis II
- Groningen 5 clusters operational
- Supply based on realistic assumptions

Analysis III
- Supply based on realistic assumptions, export added
- Three parameters varied between two levels:
    - Groningen 0 or 5 clusters operational
    - Import German caverns via Oude Statenzijl 0% or 50% of max capacity
    - L-gas market 90% or 100% of KEV/Taskforce values

See Appendix 2 for a complete and detailed overview of the calculations.

3 Identification of risks

In this chapter the most important risk of gas distribution in the Netherlands are described as well as the risk factors at several instances, which could make that risk materialise, their likelihood and consequences. This list of risk factors is non-exhaustive.

3.1 Political

The invasion of Ukraine by Russia has led to major changes in the Northwest European gas supply and thus to gas supply in the Netherlands. Since mid-2022 no Russian gas is coming to Germany anymore. In order to compensate for this, several measures have been taken in the Netherlands, on the supply side as well as on the demand side. The LNG import capacity has been increased from 117 to 234 TWh/year, electricity by coal powered powerplants has been increased and a campaign has been started to promote energy savings by both households and industries. Moreover imports from Belgium and the United Kingdom have been increased.
For the coming years the gas security of supply situation is most likely to remain unstable given the (geo)political situation. Actions and additional measures, not only at national but also at EU level and in cooperation with (potential) gas producing companies and countries, such as the EU Energy Platform and the EU gas storage regulation (Regulation (EU) 2022/1032), will remain necessary.

With regard to L-gas and the developments related to the gas production in the area of Groningen, the Netherlands has always informed and consulted the Member States connected to the L-gas network about national political discussions on L-gas, such as the discussions on the allowed Groningen gas production. The security of gas supply in neighbouring countries has always been part of the assessment on allowed L-gas production and will be part of the future assessments of the L-gas situation.

3.2 Technical

The technical risks of failure to transport gas are related to failure of the transport system itself.. For every identified unwanted top event the associated threats are analysed. Some threats can appear in more than one top event. The associated frequencies may be different for different top events or for similar top events in different asset categories. The most important threats are, dependent on the asset categories:

- Explosion
- Fire
- Leakage
- Poor maintenance
- Material defects
- Power failure
- Software failure
- Cyber attack
- External interference (excavating, piling, chain trenching etc.)

Threats may have one or more barriers that help preventing the top event, or barriers can mitigate consequences. Barriers can be physical or procedural. Examples are: redundancy, high quality materials, training, inspection, testing etc. These barriers are analysed for their probability of failure on demand. Often these barriers are reviewed with other, more in depth analysis like HAZOP.

The Risk assessment is performed for different asset types, one or more risks are identified to mitigate the risks. Summarized, the risks are:

- pipeline ruptures: the failed section is isolated with valves and transmission is resumed through parallel pipelines or via alternative pipeline routes. The effectiveness will depend on the actual transport situation e.g. the temperature and/or the location of the pipeline.
- compressor station failure: the compressor can be placed in a bypass mode and in most cases other compressor stations on the pipeline route can take over the required compression capacity. During the design of the system, one compressor is placed as back-up, the N+1 philosophy.
- nitrogen production plants failure: These plants are used for converting H-gas to L-gas. Spare capacity in other plants and the storage facility can be used to compensate production loss for a short period.
- blending stations failure: blending stations are used to mix different gas types, including nitrogen and in most cases spare capacity in other blending stations can be used as back-up for a failure.
- Export station: export stations are designed with the N+1 philosophy, there is spare capacity available in the form of an additional metering run.

Generally speaking there is an underlying consistent robust design with spare capacity in the gas transmission system. In the 60 years of GTS operation no failure in the international gas transmission has occurred. The overall estimate is that the ballpark failure rate is 1/100 years.

3.3 Commercial/Financial

The volume of gas traded on the virtual gas trading platform TTF was more than three times the volume of all other continental exchanges put together, making it the most liquid continental hub. One of the factors behind the evolution of liquidity at the TTF in recent years was the decision to socialize quality conversion between the H-gas and L-gas network, creating a single traded market. The very high liquidity of TTF provides confidence for suppliers and investors,. Seeing the liquidity of the TTF there are no particular commercial or financial risks identified.

3.4 Social

Although the social risks seem to be limited the past period has shown that (perceived) shortages of gas can lead to (extremely) high prices which have a negative impact on the purchasing power of individuals and on the economy activity of companies. This in turn may lead to social unrest, for instance because of a loss of jobs and income and increased energy poverty.

In order to limit this impact a so-called price ceiling has been introduced for the year 2023 to limit the price small consumers (households, small companies and) have to pay for their energy consumption. The price ceiling for gas is € 1,45 pet m^3 up to a consumption of max 1,200 m^3.

For small and medium sized companies with a high energy consumption the regulation “Allowance for energy costs for energy-intensive SMEs” has been introduced[18].

[18] https://www.rvo.nl/subsidies-financiering/tek/tek-regeling

3.5 Natural

There has been a 3.4 Richter Scale earthquake in Zeerijp, Groningen region in January 2018. This has been the most severe gas production-induced earthquake since 2013. The Dutch State Supervision of Mines recently advised the Dutch Minister of Economic Affairs and Climate Policy to end the gas production for the safety of the inhabitants of Groningen.

As such, the seismic activity in the Dutch Groningen region has had effects on the political decision to end the L-gas production from the Groningen field as soon as possible. This also because of the negative impact on the safety, property protection, health and welfare of the people of Groningen. Nevertheless, as said, earlier the security of gas supply in neighbouring countries has always been part of the assessment on allowed L-gas production and will be part of the future assessments of the L-gas situation.

3.6 Malicious acts

The explosions that partially destroyed the Nord Stream pipelines have demonstrated the gas infrastructure's susceptibility to hostile activity. Not only pipelines but also LNG-facilities, gas storages and, in the Netherlands, the conversion facilities, can become victim of such acts. Therefor the discussion with the owners/operators of these infrastructure about the measures that can be taken to reduce both the chance of a malicious act and its potential impact has been intensified.

Given the Dutch off shore gas infrastructure also the coast guard and the navy are involved in these discussions, just like the national security services.

4 Risk analysis and assessment

4.1 General

Article 7 of the Regulation states that, in the assessment of the risks affecting the security of gas supply, various scenarios shall be examined and the probable consequences assessed. In running through the scenarios, parameters such as exceptionally high gas demand or supply disruption, such as disruption of the main transmission infrastructure, storage facilities or LNG terminals and disruption of supplies from third country suppliers may be applied. Exceptionally high gas demand is the standard starting point for the scenarios set out below.

The Dutch high-pressure network is robust. All the main subsystems in this network are equipped with a back-up system (redundancy, also known as N+1 subsystems). If very high availability is required (for critical functions) then a whole system performs redundantly (in duplicate) and independently or there is another system elsewhere in the gas transport network that can take over the function (a back-up system), however this is not the case for pipelines. If a disaster should occur at the dispatching centre in Groningen, then 'control' of the network is also possible from another (classified) location in the Netherlands.

As described in section 1.2.5. (Gas production in the Netherlands), earthquakes in Groningen, where until recently the majority of Dutch gas was produced, have led to a lowered allowed annual production level, and the Groningen field is soon to be closed.

The scenarios detailed below are clustered into three different groups:

1. Scenarios related to the N-1 formula
2. ENTSOG scenarios
3. Scenarios identified by the Gas Platform

4.2 Scenarios related to the N-1 formula

Chapter 2 described three different ways of interpreting the N-1 formula and presented the outcome of these three different calculations.
The first calculation is based on the available transport capacity but not taking into account the gas consumption trends, the long-term impact of energy efficiency measures and the utilisation rates of existing infrastructure. Although the outcome is far above 100% one cannot conclude that the Netherlands complies with the infrastructure norm because transport capacity is not linked to supply and demand, which should be the case according to the Regulation.

In analysis two account gas consumption trends are taken into account, just like the long-term impact of energy efficiency measures and the utilisation rates of existing infrastructure. The outcome, which is above 100%, is based on a calculation compliant with the regulation. However, in line with the N-1 formula in the Regulation only the Dutch gas demand has been taken into consideration and not the Dutch export of L-gas to Germany, Belgium and France and the same is true for the Dutch H-gas transit flows (especially) to Germany.

Therefor analysis three includes the export and transit flows as well might therefor give the best SoS indication[19]. In this analysis high and low values for three different parameters (Groningen production, supply from German H-gas storages, Dutch gas demand) have been taken into consideration. In all possible combinations the outcome of the formula is within the bandwidth of 60% - 93%.
This outcome is lower than some years ago. This is mainly due to the fast reduction of production of the Groningen field and the drop of H-gas supply. Due to the high gas prices demand has decreased also (which has a positive effect on the formula outcome), which has led to a new but fragile demand/supply balance.

Looking at the current market and the outcome of the EU infrastructure norm the following specific risks have been identified:

1. EU infrastructure norm: chance of insufficient capacity available on a peak day.
2. After a cold winter, the Dutch seasonal storage levels may not be able to reach a filling level of 90%
3. All available supply routes have an extremely high utilization rate and there are no alternative routes from the east anymore
4. There is no back-up option for the supply infrastructure
5. Congestion occurring due to changed direction of gas flows

1. EU infrastructure norm: Insufficient capacity available on a peak day
An analysis, performed by GTS, shows that there might be insufficient entry capacity to comply with the EU infrastructure norm. See section 2 of this report.
Without the production capacity of the Groningen field the gap between peak supply and peak demand is even bigger. A temperature analysis for gas year 2023/2024 shows that the Groningen field is necessary as of minus 6 degree Celsius (and colder) for security of supply.

2. After a cold winter, the storage levels cannot reach 90%
In a cold winter the Dutch storages have to produce approximately 105 – 115 TWh. That is roughly 85%-95% of the available working gas volume in the storages.
For gas year 2023/2024 an analysis conducted by GTS shows that in summer 2024 only an amount of approximately 50 TWh is available for injecting in the seasonal storages.
However an extra 60 TWh is needed in order to reach a storage level of 90% at the end of the summer of 2024. This means there is a risk that without additional measures storages will be insufficiently filled in the winter of 2024/2025. Also the filling level of 73% that is necessary following the EU storage rules that were adopted in 2022 may not be reached.

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[19] Article 5 SoS regulation 1938: Each Member State or, where a Member State so provides, its competent authority shall ensure that the necessary measures are taken so that in the event of a disruption of the single largest gas infrastructure, the technical capacity of the remaining infrastructure, determined in accordance with the N – 1 formula as set out in point 2 of Annex II, is able, without prejudice to paragraph 2 of this Article, to satisfy total gas demand of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years. *This shall be done taking into account gas consumption trends, the long-term impact of energy efficiency measures and the utilisation rates of existing infrastructure*.

3. All supply routes have an extremely high utilization rate and there are no alternative supply routes from the east anymore
Due to the lack of Russian gas, there is no gas coming through the eastern supply anymore. All supply has to come from pipeline gas from Norway, domestic Dutch production and LNG. Import via Belgium and UK (through LNG terminals) is high all year long. Dutch LNG possibilities have been increased by expanding GATE and creating the new FSRU from EET. But also these supply sources are almost fully used all year through.
The fact that all these supply routes are used at an extremely high utilization rate, does mean that Northwest Europe requires all the available gas to satisfy the demand. As a consequence, when one these supply routes are underperforming in winter, then the only solution is produce extra volume out of the storages in order to satisfy the demand. When supply routes are underperforming in the summer, it will cause storages to be less filled.

4. There is no back-up option for the supply infrastructure
As written above, Northwest Europe is extremely dependent on the available supply routes, which currently have a high utilization rate, and no back-up capacity. That means that maintenance and/or disruptions at installations and pipelines will have an impact on the supply level, with the same consequences as described under point 3.

5. Congestion occurred due to changed direction of gas flows
In 2022 the import from Belgium via entry point Zelzate became physically congested. Especially Germany needed all possible gas from the West in order to fill their storages and to guarantee SoS. Infrastructure is therefore potentially also in future a bottleneck because the market will still need a lot of gas from the West in the coming years. These bottlenecks in the infrastructure are a risk for SoS.

4.3 ENTSOG scenarios
In 2021 ENTSOG has performed a Union wide simulation of supply and infrastructure disruption scenarios[20]. The simulation predates the Russian invasion of Ukraine and the sabotaging of the Nord Stream pipelines. Given that the analysis was performed prior to these events it was determined that the scenarios were not suitable (and relevant) to assess the robustness of the Dutch gas network in this risk assessment report.

5. Conclusions

The analysis presented in this National Risk Assessment demonstrates that the current gas crisis can create a gas shortage. Gas supplies cannot be considered as reliable as in previous years. As a result of the stop of Russian gas supplies to north western Europe, the supply situation is tense. In high demand scenarios – harsh winter conditions – there is still the chance a gas shortage in Europe. Although LNG import capacity has been increased (and doubled in the Netherlands), it is not sure that this capacity can be used at full capacity for sufficient hours per year. This is because the total worldwide LNG demand/supply balance is tight till at least 2026.

Calculations of the N-1 formula show that if only the technical/infrastructural capacities and demand under peak circumstances are taken into account the N-1 value for the Netherlands is over 230%. If, as required by Regulation (EU) 2017/1938, import and domestic demand are based on realistic expectations at peak circumstances, the N-1 values is still more than 145%.
However, if also the exports to neighbouring countries, in particular Germany, are taken into account and which have been increased considerably in the past year, the N-1 value fluctuates between 70% and little more than 90%. Because of this and the foreseen closure of the Groningen field combined with a potential H-gas shortage, the Netherlands has to prepare itself for a security of supply situation just like many other countries. This will be addressed in the preventive action plan and the emergency plan. It works to the advantage of the Netherlands that there is still some national production from gas fields on and off shore.

Furthermore, there have been particular (geo)political risks identified.
In the end, to prepare for and to overcome a gas crisis and to guarantee security of supply, there should be more (LNG) supply and a structural gas demand reduction.

Annex 1: Technical capacities GTS in 2022

Name of location	NWP	Direction	Capacity (GW)
Emden Ept (Gassco)	301113	entry	40,15
		exit	0,0
Cluster Enschede/Epe storages	Cluster	entry	13,1
		exit	8,8
Enschede (Eneco-UGS Epe)	301397	entry	3,9
		exit	2,0
Enschede (Innogy-UGS Epe)	301198	entry	4,3
		exit	2,2
Enschede (Nuon-UGS Epe)	301309	entry	4,9
		exit	2,9
Hilvarenbeek (Fluxys)	300131	entry	0,0
		exit	24,8
Cluster Oude Statenzijl storages (H)	Cluster	entry	35,0
		exit	16,1
Oude Statenzijl (Astora Jemgum)	301391	entry	23,5
		exit	23,5
Oude Statenzijl (Etzel-Crystal-H)	301400	entry	26,8
		exit	14,8
Oude Statenzijl (Etzel-EKB-H)	301360	entry	23,6
		exit	14,5
Oude Statenzijl (Etzel-Freya-H)	301401	entry	24,2
		exit	18,3
Oude Statenzijl (EWE Jemgum)	301453	entry	23,5
		exit	23,5
Oude Statenzijl (EWE-H)	301361	entry	12,8
		exit	12,7
Oude Statenzijl Renato (OGE)	301185	entry	13,5
		exit	13,8
Rotterdam (Gate)	301345	entry	21,0
		exit	0,0
Vlieghuis (RWE)	300142	entry	0,0
		exit	3,7
VIP-TTF-THE-H	301569	entry	21,3
		exit	27,9
VIP-TTF-THE-L	301568	entry	0,0
		exit	33,7
VIP-BENE	301546	entry	17,85
		exit	33,0
Eemshaven Energy Terminal (EET)	301574	entry	15,0
		exit	0,0

Appendix 2: Detailed explanation of N-1 calculations

<u>Analysis I</u>

Demand side

D max = 3,145 GWh/d
Peak demand (D max) is calculated from demand figures of the Klimaat- en energieverkenning 2022 as provided for 2024 of the GTS Investment Plan 2022.

Supply side

EP m = 1,986 GWh/d
Entry points (EP m) value is the total value based on the lesser rule of the various entry points.

S m (100%) = 4,076 GWh/d
S m (30%) = 3,559 GWh/d
Storages value (S m) is the total send out capacity of the storages directly connected to the GTS grid for both 100% and 30% level of the working gas volume.

P m = 1,326 GWh/d
Production capacity (P m) is the total capacity of the Groningen field (based on 11 clusters) and the small fields.

LNG m = 864 GWh/d
Parameter LNG m consists of total production capacity of the GATE and EET terminals.

I m = 878 GWh/d
The technically largest infrastructure is the import terminal of Norwegian gas.

Results of analysis I in the N-1 formula:

100% UGS deliverability:

$$\mathbf{234\% = \frac{1,986 + 1,326 + 4,076 + 864 - 878}{3,145} \times 100\%}$$

Reduced UGS deliverability (30% full):

$$\mathbf{218\% = \frac{1,986 + 1,326 + 3,559 + 864 - 878}{3,145} \times 100\%}$$

Analysis II: Analysis where entry, import and domestic demand are based on realistic expectations at peak circumstances

This analysis is based upon the realistic capabilities of the infrastructure and no consideration is given to export expectations.

Demand side

D real = 3,145 GWh/d
Peak demand (D max) is not changed and also calculated from demand figures of the Klimaat- en energieverkenning 2022 for 2024 of the GTS Investment Plan 2022.

Supply side

EP real = 253 GWh/d
The only entry point where in realistic peak circumstances import of gas can be expected is Norway, for the other entry points connected to Belgium, Germany and the United Kingdom no import is expected at peak circumstances because the capacity is expected to be necessary for own use.

Entry point	Realistic capacity [GWh/d]
Emden EPT (Gassco)	253
VIP THE-H	0
VIP BENE-H	0
BBL company	0

S real (100%) = 3,656 GWh/d
S real (30%) = 3,139 GWh/d
At peak circumstances it is expected that most storages will operate identically as assumed in analysis I, the only exception are the German caverns connected to Oude Statenzijl which are assumed to send both to Germany and to The Netherlands (50%/50%). Resulting table:

Storage facility (GWh/d)	Capacity (100% full)	Capacity (30% full)
EnergyStock	431	431
Norg	801	702
Grijpskerk	620	225
Alkmaar	360	360
Bergermeer	469	446
Epe storages	356	356
Peakshaver	199	199
Oude Statenzijl storages	420	420
Total	3,656	3,139

P real = 763 GWh/d
The value of P is reduced compared to analysis I, because part of the Groningen field is not realistically available at peak circumstance. Only 5 of the 11 remaining clusters of the Groningen field are directly available to meet peak demand.

Entry point	Capacity [GWh/d]
Groningen field (5 clusters)	469
Small fields	294
Total	763

LNG real = 732 GWh/d
The values of the LNG terminals have also been adapted to realistic values. For both terminals the capacity is reduced to the lesser amount based upon supply capacity of the terminal and transportation capacity of the GTS network.

LNG terminal	Capacity [GWh/d]
Gate	492
EET	239
Total	732

I real = 801 GWh/d
In realistic circumstances the single largest gas infrastructure in The Netherlands is UGS Norg, because the expected import value at the Emden import terminal is lower than the expected send out value of UGS Norg.

Results of analysis II in the N-1 formula:

100% UGS deliverability:

$$\mathbf{146\% = \frac{253 + 763 + 3,656 + 732 - 801}{3,145} \times 100\%}$$

Reduced UGS deliverability (30% full):

$$\mathbf{130\% = \frac{253 + 763 + 3,139 + 732 - 801}{3,145} \times 100\%}$$

Analysis III: Analysis where entry, import, export and domestic demand are based on realistic expectations at peak circumstances.

In this analysis the assumptions of chapter 2.4 are further adapted to realistic circumstances by adding the export to neighbouring countries to the “D real” parameter. This is logical because the Netherlands is the only L-gas supplier for Germany, Belgium and France and it has always been an important transit country for H-gas. Especially in the current situation where Germany is not supplied anymore by Russian gas they are fully reliant on imports from Norway, Belgium and the Netherlands. The results are calculated for two scenarios where the parameters for which the situation is unclear at the moment are varied between two levels. The first (high) scenario is a combination of high supply and low demand, the second (low) scenario is a combination of low supply and high demand, resulting in a bandwidth. Above that the resulting bandwidth is calculated for both the 100% and 30% UGS deliverability.
The parameters for which the situation is unclear and the chosen levels are:

Parameter	Belonging to…	Highest outcome formula [GWh/d]	Lowest outcome formula [GWh/d]
Groningen field	P real	469	0
Oude Statenzijl caverns	S real	420	0
Domestic and L-gas export market	D real	3,525	4,147

Demand side

D real (high) = 4,945 GWh/d
D real (low) = 5,359 GWh/d
The value for this parameter is expanded with the export to neighboring countries, above that is the G/L-gas market (domestic and export) chosen at two levels. The level for the low scenario is based upon the Klimaat- en energieverkenning 2022 scenario for 2024 of the GTS Investment Plan 2022 and L-gas Taskforce group. The value at the high scenario is 90% of the value at the low scenario reflecting the reduced market size caused by high gas prices. The H-gas export is based upon technical capabilities and historical data and it is assumed that this value is not influenced by the gas prices. Resulting values for the demand:

Parameter	Highest outcome formula [GWh/d]	Lowest outcome formula [GWh/d]
Domestic market	2,831	3,145
L-gas export	901	1,002
H-gas export	1.212	1,212
Total	4,945	5,359

Supply side

EP real = 253 GWh/d
The value for EP is the same as in analysis II.

S real (high) (100%) = 3,656 GWh/d
S real (high) (30%) = 3,139 GWh/d
S real (low) (100%) = 3,236 GWh/d
S real (low) (30%) = 2,719 GWh/d
At peak circumstances it is expected that the most storages will operate identically as assumed in analysis I, the only exception are the German caverns connected to Oude Statenzijl where it is not certain that these caverns will send to The Netherlands at peak circumstances, thus also for these caverns two levels are chosen resulting in the following values for the German caverns:

Value at high scenario		Value at low scenario	
Capacity (100%)	Capacity (30%)	Capacity (100%)	Capacity (30%)
420	420	0	0

For the rest of the storages the values are identical to the values in analysis I for both the high and the low level.

P real (high) = 763 GWh/d
P real (low) = 294 GWh/d
The production of the Groningen field is also uncertain, where it is not certain whether the field will be available for production or will be closed. The following values will be used:

Entry point [GWh/d]	Value at high scenario	Value at low scenario
Groningen field	469	0
Small fields	294	294
Total	763	294

LNG real = 732 GWh/d
The value for LNG is the same as in analysis II.

I m = 801 GWh/d
The value for I is the same as in analysis II.

Results of analysis III in the N-1 formula:

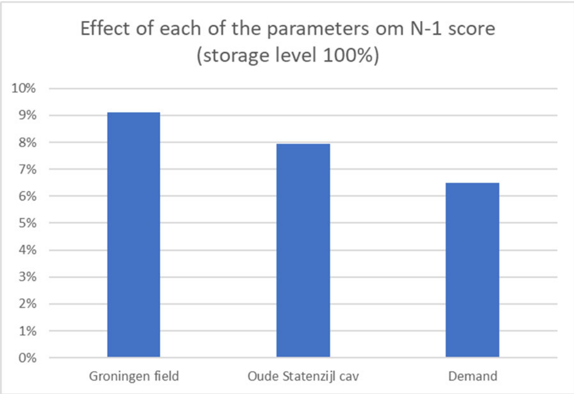
100% UGS deliverability:

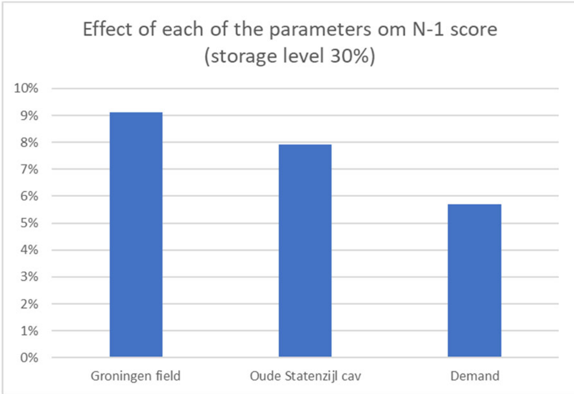
$$\mathbf{69}\% = \frac{\mathbf{253+294+3{,}236+732-801}}{\mathbf{5{,}359}} \times \mathbf{100}\% \text{ to}$$
$$\mathbf{93}\% = \frac{\mathbf{253+763+3{,}656+732-801}}{\mathbf{4{,}945}} \times \mathbf{100}\%$$

Reduced UGS deliverability (30% full):

$$60\% = \frac{253+294+2{,}719+732-801}{5{,}359} \times 100\% \text{ to}$$
$$83\% = \frac{253+763+3{,}139+732-801}{4{,}945} \times 100\%$$

The effect of each of the three parameters (Groningen field, Oude Statenzijl caverns and market demand) on the N-1 score is depicted in the following graphs:





Appendix 3: Possible further measures

Decreasing gas demand by enhanced energy transition measures and high prices

In 2019, the national Climate Act was passed. Several measures are discussed in a nationwide discussion about the energy transition and the required 55% emission reduction in 2030. Several proposals have been made concerning the build environment such as new building norms, new ways to finance energy saving measures and a joint approach to reduce energy consumption. An important new decision is that the legal obligation to connect every house to the gas network has been withdrawn (as discussed in 4.5.3). Furthermore, the horticulture sector has the announced its ambition to become climate-neutral.

Due to the high prices on the international gas market, there has been a reduction in the use of natural gas in the chemical industry, refineries and in households.[21]

It remains to be seen if this reduction is structural. The current reduction should become structural by taking measures like further insulation and/or industrial process improvements.

Accelerated reduction of export

Germany is actively seeking to reduce their import of L-gas by converting their markets faster than previously agreed upon.

In the upcoming years until GY 2029/30, combined L-gas exports from the Netherlands to Belgium, France and Germany are expected to be reduced at an average rate of approximately 10% per year due to the conversion programs. Consequently, L-gas demand met with imports from the Netherlands is expected to fall to 0 in Belgium by GY 2024/25, to 0 in France by GY 2029/30 and to 0.3 TWh in Germany by GY 2029/30 both in an average and cold GY.[22]

One should however bear in mind that conversion from L-gas to H-gas in those countries in itself does not lead to a lower level of gas demand. That is why all those countries will consider these conversion as an extra H-gas demand, which should be covered by extra H-gas supply. This additional H-gas does not have to be supplied through the Netherlands. However, it impacts the tight LNG supplies. Also, consequently, part of the foreseen (extra) German LNG has to be used for the German L-to-H conversion.

Expansion of LNG capacity

As described in section 1.2.8, the Dutch government in cooperation with Gasunie has invested in additional LNG capacity, which has resulted in an increase of the national LNG import capacity to 24 BCM annually and further expansion measures are under consideration[23]. This additional LNG capacity enhances security of supply.

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[21] KEV 2022

[22] L-gas market conversion report

[23] https://www.gasunietransportservices.nl/uploads/fckconnector/67a7791e-9754-5341-b853-18026c541786/3234948804/Draft%20Addendum%20IP2022%20EN%20-%20GTS.pdf?lang=en